Eastwick, Philadelphia County, Pennsylvania

Flood Risk Management
Continuing Authorities Program Section 205

Draft Integrated Feasibility Report & Environmental Assessment

August 31, 2023

U.S. ARMY CORPS OF ENGINEERS
PHILADELPHIA DISTRICT

Executive Summary

Study Information

The U.S. Army Corps of Engineers (USACE) Philadelphia District (NAP) has prepared this draft integrated feasibility report and environmental assessment (IFR/EA) for the Eastwick section of Philadelphia, Pennsylvania Flood Risk Management Study ("study"). The purpose of the study is to investigate and identify technically sound, economically justified, and environmentally acceptable flood risk management (FRM) solutions for Eastwick. The authority for this study is the Continuing Authorities Program (CAP) Section 205 of the Flood Control Act of 1948 (P.L. 80-858), as amended.

Eastwick is an urban residential neighborhood located in the southwest corner of the City of Philadelphia (19153 zip code), Philadelphia County, Pennsylvania (Figure ES-1). The overall study area is highlighted in yellow while the location of the specific study recommendation is identified by the star symbol. As indicated by both the White House Council on Environmental Quality Climate and Economic Justice Screening Tool (CEJST) and the US Environmental Protection Agency (USEPA) Environmental Justice Screening and Mapping Tool (EJScreen), Eastwick is an economically disadvantaged and environmental justice community.

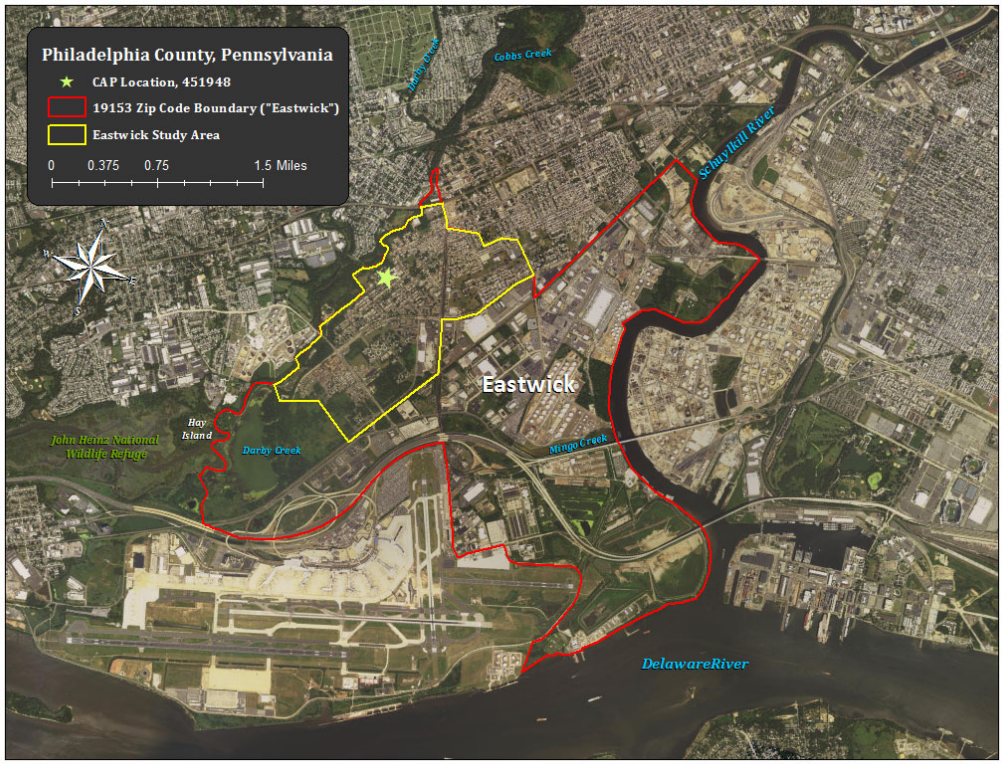

Figure ES-1: Eastwick FRM Study Area

This draft report is being released for concurrent review to the general public, stakeholders and governmental agencies for review and comment. A public meeting will be held to share and discuss the status of the study during the concurrent comment review period for this draft report. Comments will be addressed in the final report where specifics of the tentatively selected plan (TSP) will be optimized. This draft report includes the most up to date hydraulic analysis, including but not limited

to induced flooding and complementary measures (including lowering banks and/or floodplains, increasing natural high ground elevations, and realignment of high ground/berm development at select locations). If any of the complementary measures are deemed effective at minimizing induced flooding, they would need to be evaluated under other engineering disciplines and assessed for environmental and other effects. Given the sensitivity of the induced flooding, additional analyses will be conducted under separate authority or in partnership with stakeholder efforts based on draft report concurrent (Public, stakeholder and USACE Agency Technical Review (ATR)) comment content. These analyses will help to best manage risk associated with the Tentatively Selected Plan (TSP) associated with induced flooding and complementary measures. Additional risks associated with flooding from the Delaware River are not specifically addressed by this study and will require additional partnership or potentially a separate study authority to address.

Problem Statement

The Eastwick neighborhood of Philadelphia experiences recurring flooding that results in considerable economic damages to homes, businesses, industry, and public infrastructure. Of significant concern is the flooding of structures, primarily residential, from Cobbs Creek during high streamflow events. Flooding especially occurs between 78th and 82nd Streets, from the creek to Chelwynde Avenue. There is an opportunity to implement FRM solutions to manage storm-related risks to people, property and infrastructure within the study area. The planning objective of this study is to manage flood risk to people, property and infrastructure associated with Cobbs Creek and Darby Creek floodwaters. A constraint of the study includes contaminated material and associated groundwater located in the landfill underneath an impervious cap installed by the USEPA. The proposed FRM alternatives will be developed to avoid contact and/or impact of existing hazardous, toxic, radioactive waste within the study area.

Plan Formulation

The goal of the Eastwick FRM Study is to manage the study area's risk from flooding, while contributing to National Economic Development (NED) consistent with protecting the Nation's environment, in accordance with national environmental statutes, applicable executive orders, and other Federal planning requirements.

In support of this goal, the planning objective of this study is to manage flood risk to people, property and infrastructure associated with Cobbs Creek floodwaters flowing between the high elevation points of the Clearview Landfill and S. 78th Street into the Eastwick neighborhood study area between the years 2030 to 2080.

An additional planning objective may be to reduce residual flooding and potential induced flooding in the study area. This potential objective will be better defined after the concurrent review of the draft report.

Structural measures including levees and floodwalls and nonstructural measures including structure elevation, floodproofing, and acquisition/buyout were considered. In addition, elements from regional local planning initiatives such as Floodplain Management Plans were considered in the formulation of alternatives and development of the TSP.

Alternative Plans Considered

A variety of alternatives have been considered towards the formulation of a TSP, including:

- No action plan.

Structural alternatives include:

- A levee is an earthen-berm embankment built to reduce the risk of flooding and would be located in the vicinity of Eastwick Park.
- A floodwall is a concrete barrier which is built to reduce the risk of flooding and would be located in the vicinity of Eastwick Park.

Nonstructural alternatives include:

- Structure elevation (elevating homes): this has been ruled out because elevating attached homes would potentially cause structural damage to the houses.
- Dry floodproofing includes making changes to an individual home to block water from entering. Floodproofing did not reduce the structure risk due to the height of floodwaters.
- Acquisition/buyout. This alternative includes purchasing properties that are at high risk of flooding and potentially reverting the acquired land to open space. Consideration of the acquisition of structures was performed for a number of annual exceedance probabilities (AEP) floodplains. This alternative is feasible but negatively impacts community cohesion.

Other alternatives considered included channel modification, flow detention as well as a number of land use/regulatory measures.

Tentatively Selected Plan

The USACE, in partnership with the Philadelphia Water Department (PWD), has identified a recommended plan of constructing a levee along the left bank of Cobbs Creek within the city-owned Eastwick Regional Park and Clearview Landfill (Figure ES-2). The levee typical section includes a crest elevation of +24.7 ft (NAVD88) with a 10-ft wide crest and 2H:1V riprap side slope on the creek side and 3H:1V grass side slope on the community side. The height of the levee above existing grade is approximately 15 ft. The length of the levee would be approximately 1,370 feet. The levee was laid out such that the inner toe is at least 50 feet away from the nearest structure. The plan also assumes that the distance from the outer toe of the levee to the left bank of Cobbs Creek is also covered with grass. The preliminary levee design crest was sufficient to pass the 1% AEP (commonly known as the '100-year storm') flooding without overtopping. The TSP presents an opportunity to provide Federal benefits in a disadvantaged community as Eastwick classifies as an environmental justice community per USACE guidance.

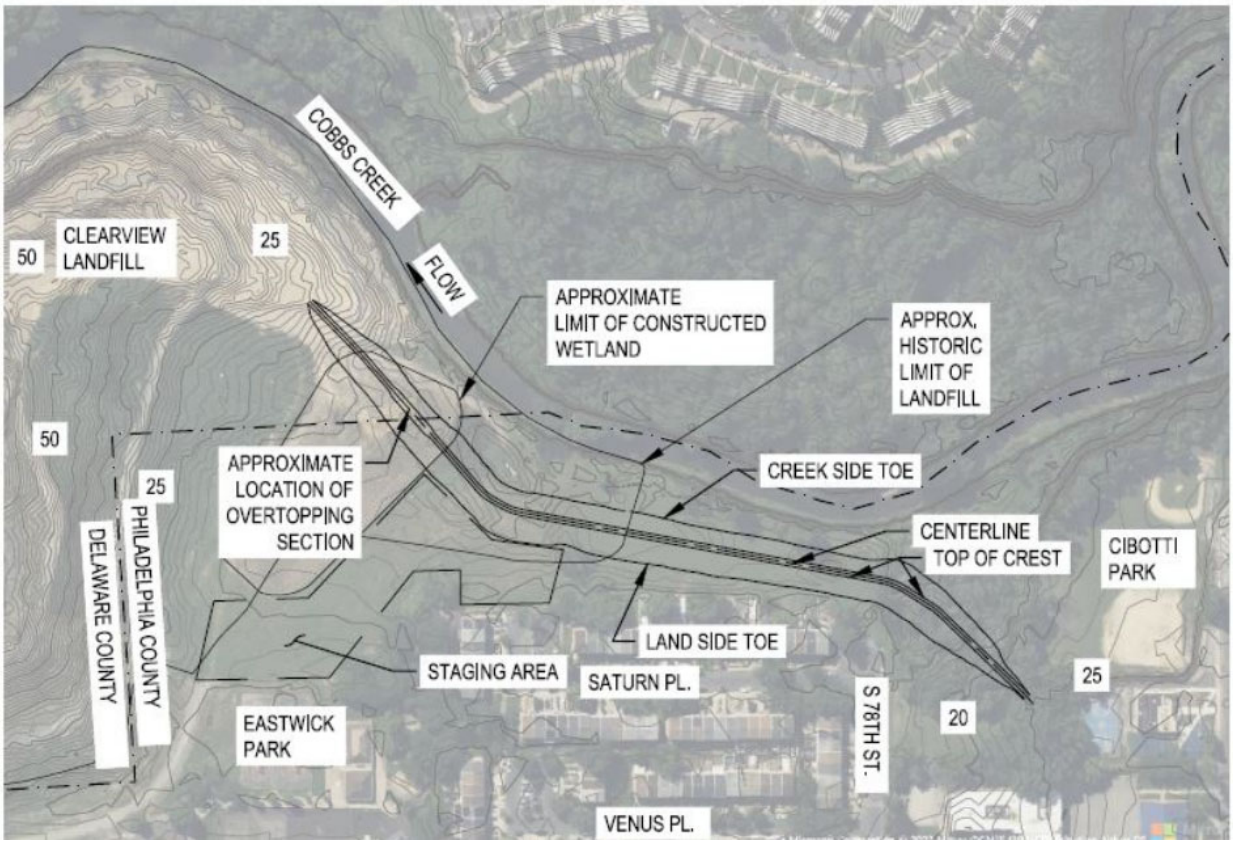

Figure ES - 2. General Layout of Tentatively Selected Plan

The TSP transits the city-owned Eastwick Regional Park and terminates near the Eastwick Recreation Center. As a result, the TSP would have impacts on parks and recreation particularly on the creek side of the levee, but the landward side of the levee may offer new recreational opportunities.

The TSP will be further designed and optimized and ultimately become the recommended plan in the Final IFR/EA. Comments from the public, stakeholders and Federal and non-Federal agencies during the draft IFR/EA concurrent review period will be considered and addressed towards the development of the recommended plan.

Complementary measures are not included in the TSP. Construction costs do not consider costs associated with complementary measures. The addition of these costs may exceed the allowable Federal cost share ($10 million) under this study authority. This may require additional Federal partnership or USACE Study authority with greater cost limits to consider the inclusion of the complementary measures.

Pursuant to section 7 of the Endangered Species Act of 1973, as amended, the USACE determined that the TSP is not likely to adversely affect federally listed species or their designated critical habitat. Compensatory mitigation for wetlands may be required as part of the recommended plan.

The TSP is projected to cost $13,332,000 in construction costs which would be cost shared 65%/35% Federal/non-Federal (of which $2,354,000 is for Planning, Engineering & Design [PED]).

Additional costs include $67,000 in Average Annual Operations, Maintenance, Repair, Replacement and Rehabilitation (OMRR&R) over the 50-year period of analysis, $107,600 for Land, Easements, Rights-Of-Way, Relocation, and Disposal Areas (LERRD), $358,000 for environmental monitoring (10 years X $35,800/year) and $80,000 for adaptive management costs.

The plan selection is in compliance with ER 1105-2-100 *Planning Guidance Notebook* and the ASA(CW) policy directive on *Comprehensive Documentation of Benefits in Decision Document* (05 January 2021). In review of NED, RED, OSE, and EQ planning accounts, the levee alternative (TSP) is the NED Plan and the Net Total Benefits Plan. A life safety analysis has also been performed which identifies that there is not a measurable life safety risk associated with the TSP. The TSP will be optimized prior to the Final IFR/EA. Additionally, detailed comprehensive benefits analyses, induced flooding and complementary measures and levee tie-in into the Clearview Landfill will be further investigated during this time frame.

In its current alignment, the TSP is expected to reduce damages in the area by $128 million in Present Value terms over the 50-year period of analysis. In FY2023 Price Level and FY2023 Federal Discount Rate (2.5%), the levee alternative has a Benefit-Cost Ratio (BCR) of 8.4 with $3,986,000 in Average Annual Net Benefits (AANB). Note that the BCR and AANB have been reduced to reflect the induced flooding impacts.

Environmental Assessment

Based on the data presented and continuing coordination with State and Federal resource agencies, no significant adverse environmental impacts are expected to occur as a result of the proposed action. Compensatory mitigation may be required as part of the recommended plan. Currently, the reviews by other Federal, State and local agencies, Tribes, input of the public, and an internal USACE review indicate that the TSP would not cause significant adverse effects on the quality of the human environment; therefore, preparation of an Environmental Impact Statement is not required and a Finding of No Significant Impact (FONSI) for the proposed action is appropriate.

Induced Flooding

For the With Project conditions levee plan (TSP), both downstream and upstream impacts were evaluated. Placement of a levee along Cobbs Creek is efficient in eliminating modeled flows through the Eastwick neighborhood. This has the effect of pushing more flow downstream because that flow is no longer leaving Cobbs Creek. More flow downstream leads to marginal water surface elevation (WSEL) increases. Additionally, placement of a levee cuts off a portion of the adjacent floodplain, where floodwaters cannot spread out. This constriction leads to marginal WSEL increases upstream. Generally, WSEL increases dissipate with distance from the potential levee. Moving downstream from Cobbs Creek into Darby Creek, and through the Hook Road bridge, flows spread out through the larger, wider floodplain, and attenuate slightly, leading to WSEL increases that decrease moving downstream toward the Delaware River. Similarly, the largest upstream WSEL increases are generally limited to reaches on both Darby and Cobbs between the confluence and the upstream B&O railroad bridges. These bridges both have limited capacity to pass large floods, leading to backup at the upstream faces of each. This leads to upstream WSEL increases that dissipate to less than 0.5 ft upstream of the railroad crossing.

Residual Flooding

While the TSP levee plan is highly effective, the focus of the plan is to reduce risk associated with Cobbs Creek overflow into Eastwick. As discussed throughout this document, Eastwick is subject to additional impacts from other sources. These include stormwater runoff in excess of storm sewer capacity, and tidal impacts from the Delaware River. Analyses will be conducted prior to the release of the Final report to more definitely quantify impacts of residual flooding due to these other flooding sources. Residual risk associated with TSP is calculated to be 27%.

Complementary Measures

Complementary measures are measures in addition to the TSP that manage the risk of frequent or induced flooding to provide a more comprehensive, integrated FRM solution. To potentially mitigate induced flooding and reduce residual flooding, several complementary measures were assessed. These included lowering banks/floodplain upstream and downstream of Hook Road, increasing natural high ground elevations at multiple locations, and realignment of high ground near the southeast corner of Eastwick to prevent interaction with Darby Creek and the John Heinz National Wildlife Refuge. Complementary measure analyses are not performed in detail associated with this CAP study authority and will need to be performed through subsequent or separate study phases, programs or authorities either from the Federal or non-Federal entities. This decision is a function of the limited capacity, scope and funding levels associated with the USACE CAP Section 205 Program.

Natural and Nature-Based Features (NNBF)

NNBF as complementary measures to USACE's structural levee TSP have been identified to increase the ecological, social, and aesthetic value of the system and will be further evaluated during TSP optimization. Some of these features include trails with seating, levee ramps and stairs, outdoor classrooms/amphitheater, bioswales, managed riparian habitat, tree screens, and levee overlooks.

Specifically, USACE is working with our Engineering With Nature (EWN) partners including the University of Pennsylvania to consider NNBF to potentially incorporate into the final levee design. For example, adding a bike path on the top of the levee to tie into the bike path planned at the Clearview Landfill is one potential consideration. Concept designs are provided in Appendix E. Recreational features will continue be considered throughout plan optimization.

Real Estate Acquisition

The implementation of the TSP requires two parcels within the City of Philadelphia. One parcel is privately owned and the other is owned by the City. The minimum estates required for these parcels are a Temporary Work Area Easement and Perpetual Flood Protection Levee/Floodwall Easement. There are no proposed non-standard estates for these parcels.

In addition, the proposed levee is partially located in Delaware County. Because a portion of the project is on property outside of Philadelphia County, it cannot be acquired by the current NFS. If the NFS is unable to acquire all the property interests necessary for the project, then the project will not be able to be constructed as the NFS cannot meet the real estate terms of the Project Partnership Agreement. One resolution is to work with the adjacent jurisdiction where part of the project resides

to sign on the PPA as a co-sponsor. Note also that the design may be modified during the feasibility phase which could potentially result in the project only being on property the current NFS is authorized and able to acquire.

The Federal Government currently owns no lands in the project area. The PWD is the Non-Federal Sponsor (NFS).

DRAFT

FINDING OF NO SIGNIFICANT IMPACT
EASTWICK, PHILADELPHIA COUNTY, PENNSYLVANIA
FLOOD RISK MANAGEMENT FEASIBILITY STUDY
AND INTEGRATED ENVIRONMENTAL ASSESSMENT
CONTINUING AUTHORITIES PROGRAM SECTION 205

The U.S. Army Corps of Engineers, Philadelphia District (USACE) has conducted an environmental analysis in accordance with the National Environmental Policy Act of 1969, as amended. The draft Environmental Assessment (EA) for the Eastwick FRM Continuing Authorities Program Section 205 Project addresses the need for FRM along a portion of Cobbs and Darby Creeks located in Eastwick, Philadelphia County, Pennsylvania.

The draft EA, incorporated herein by reference, evaluated alternatives to reduce flood damages in Eastwick. In addition to a "no action" plan, 4 other alternatives were evaluated. These include a floodwall, levee, nonstructural, and hybrid combination of those three. The placement of a 1,370' linear foot levee feature (the TSP) is the recommended National Economic Development (NED) Plan.

For all alternatives, the potential effects were evaluated, as appropriate. A summary assessment of the potential effects of the recommended plan are listed in the Table below:

Summary of Potential Effects of the Recommended Plan Table

	Insignificant effects	Insignificant effects as a result of mitigation*	Resource unaffected by action
Aesthetics	X		
Air quality	X		
Aquatic resources/Wetlands		X	
Invasive species			X
Fish and wildlife habitat		X	
Threatened/Endangered species/Critical habitat	X		
Historic properties	X		
Other cultural resources	X		
Floodplains	X		
Hazardous, toxic & radioactive waste	X		
Hydrology & Hydraulics		X	
Land use		X	
Navigation			X
Noise levels	X		
Public infrastructure			X
Socioeconomics	X*		

	Insignificant effects	Insignificant effects as a result of mitigation*	Resource unaffected by action
Environmental justice	X*		
Soils			X
Tribal trust resources			X
Water quality			X
Climate change			X

*Beneficial

All practicable and appropriate means to avoid or minimize adverse environmental effects were analyzed and incorporated into the TSP. Best management practices (BMPs) as detailed in the EA will be implemented, if appropriate, to minimize impacts.

Compensatory mitigation for wetlands may be required as part of the recommended plan.

Public review of the draft EA and FONSI is currently ongoing. All comments submitted during the public review period will be responded to in the Final EA and FONSI.

Pursuant to section 7 of the Endangered Species Act of 1973, as amended, the USACE determined that the TSP is not likely to adversely affect federally listed species or their designated critical habitat.

Pursuant to Section 106 of the National Historic Preservation Act of 1966, as amended, the USACE determined that the TSP has been modified so that little likelihood exists for the proposed project to impact a historic property, and the non-structural alternative homes are not considered to be historic properties. The USACE has determined that the proposed undertaking will have No Effect on historic properties eligible for or listed on the National Register of Historic Places (NRHP) in compliance with 36 CFR 800.4(d)(1). The PASHPO, in their correspondence dated November 2, 2020 are in concurrence with this determination.

This project entails actions that fall under the Clean Water Act of 1972, as amended, as fill may be placed in the wetlands as part of the TSP. Section 404(b)(1) Guidelines (40 CFR 230) are applicable to this project. As such, a 404(b)(1) review was conducted for the project.

Pennsylvania State concurrence with the USACE determination of consistency with the Pennsylvania Coastal Resources Management Program will be obtained from Pennsylvania Department of Environmental Protection (PADEP), pursuant to the Coastal Zone Management Act of 1972. USACE will comply with CZM consistency requirements to the extent practicable and all effort will be made to minimize adverse impacts to the coastal zone.

All applicable environmental laws have been considered and coordination with appropriate agencies and officials has been completed.

Technical, environmental, and economic criteria used in the formulation of alternative plans were those specified in the Water Resources Council's 1983 Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies. All applicable laws, executive orders, regulations, and local government plans were considered in evaluation of

alternatives. Based on this report, the reviews by other Federal, State and local agencies, Tribes, input of the public, and the review by my staff, it is my determination that the recommended plan would not cause significant adverse effects on the quality of the human environment; therefore, preparation of an Environmental Impact Statement is not required.

(Signed in Final Feasibility Report after Public Review)

_____	_____
Date	Jeffrey M. Beeman Lieutenant Colonel, Corps of Engineers District Commander

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1.0 Introduction

1.1 Study Purpose Scope

The U.S. Army Corps of Engineers (USACE) Philadelphia District (NAP) has prepared this draft integrated feasibility report and environmental assessment (IFR/EA) for the Eastwick, Philadelphia County, Pennsylvania Flood Risk Management Study ("Study"). It includes input from the non-Federal sponsor (NFS), local governments, natural resource agencies, non-governmental organizations, and the public. The purpose of the study is to investigate potential flood risk management (FRM) solutions for Eastwick. A recommendation for Federal participation in a FRM plan that is technically sound, economically justified, and environmentally acceptable is presented in this draft IFR/EA.

The Federal objective of water and related land resource project planning is to contribute to National Economic Development (NED) consistent with managing and reducing risk to the nation's environment, pursuant to national environmental statutes, applicable executive orders, and other Federal planning requirements [Principles and Guidelines (P&G), 1983]. Water and related land resources projects are formulated to alleviate problems and take advantage of opportunities in ways that contribute to this objective. This report: (1) summarizes the current and potential water resource problems, needs, and opportunities for FRM; (2) presents the results of the plan formulation for FRM solutions; (3) identifies specific details of the tentatively selected plan (TSP), including inherent risks and (4) details the extent of Federal Interest and local support for the plan.

1.2 Study Authority*

The authority for this project is Section 205 of the Flood Control Act of 1948 (P.L. 80-858), as amended. Under this authority, USACE is authorized to plan and implement small FRM projects with and without specific Congressional authorization. Each project is limited to a Federal cost-share of not more than $10 million, including all project-related costs for feasibility studies, design and implementation.

1.3 Non-Federal Sponsor

The Philadelphia Water Department (PWD) on behalf of the City of Philadelphia has signed a Feasibility Cost-Sharing Agreement (FCSA) and is acting as the non-Federal sponsor (NFS) for the study, with a responsibility for 50 percent of the costs of the feasibility study.

1.4 Study History

A determination of Federal interest in pursuing this study was approved by the USACE North Atlantic Division (NAD) on April 24, 2018. The initial appraisal of Federal interest involved reviewing existing conditions, communicating with local stakeholders, proposing a single FRM alternative for Eastwick, and conducting a preliminary benefit cost analysis. The USACE concluded that there are feasible opportunities to address flooding in the Eastwick

Neighborhood. The feasibility study will investigate several alternatives to address the problems and needs related to flooding in the study area. A FCSA for this feasibility study was executed between the USACE and PWD on May 08, 2019.

1.5 Study Area

Eastwick is an urban residential neighborhood located within the City of Philadelphia (19153 zip code), Philadelphia County, Pennsylvania (Figure 1-1). Historically known as "The Meadows", Eastwick is one of 153 recognized neighborhoods within Philadelphia County (Planphilly.com) and is located within the southwestern most section of the County, west of the Schuylkill River. Eastwick is generally bounded by S. 56th Street, the Chester Branch of the Reading Railroad, S. 70th Street, Passyunk Avenue, Dicks Avenue and the Cobbs Creek Parkway on the north and northeast, by the Schuylkill River on the east, by the Delaware River, Fort Mifflin Road, Enterprise Avenue, Island Avenue and the Delaware Expressway (I-95) on the south, and by the Delaware County Line, Darby Creek, and Cobbs Creek to the west and northwest (Figure 1-2). It is traversed lengthwise by the Southeastern Pennsylvania Transportation Authority Regional Rail (SEPTA) Airport Line.

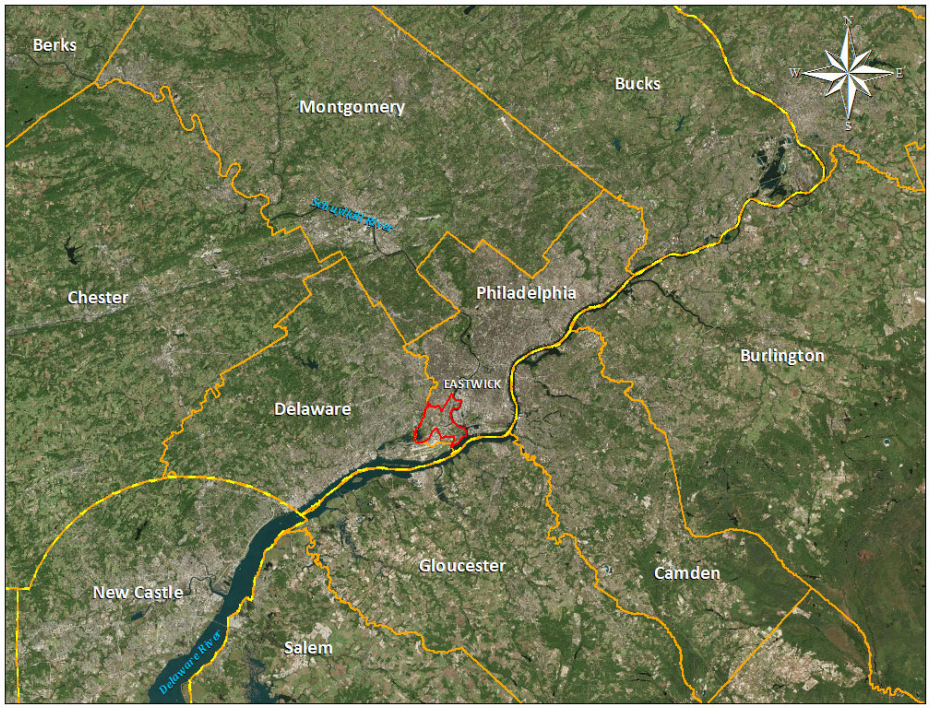


Figure 1-1: 19153 Zip Code Boundary (Eastwick), Philadelphia County, Pennsylvania

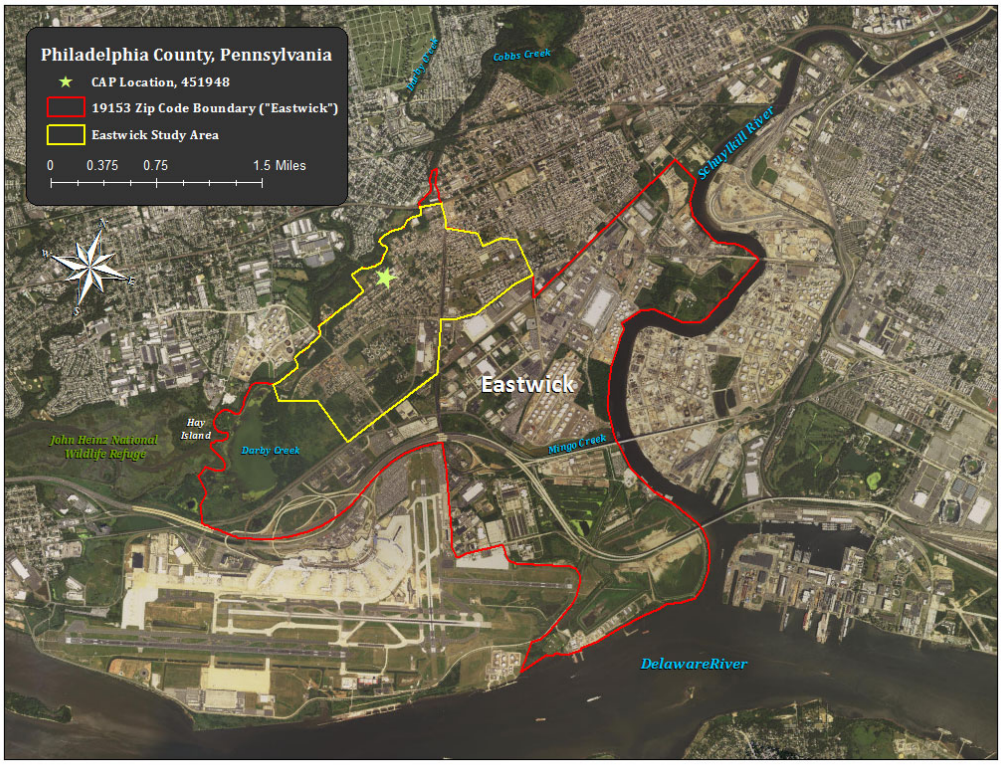


Figure 1-2: 19153 Zip Code Boundary (Eastwick) and Study Area

The focus of this feasibility study is the 0.2% Annual Exceedance Probability - AEP (500-year) floodplain (Figure 1-). This area has been the subject of community meetings and surveys such as a 2014 survey conducted by the PWD to request information from residents regarding flooding in their neighborhood. The results of that survey and input from community meetings indicate that residents are concerned about flooding and associated mitigation.

As the feasibility study progressed, evaluation of structural measures revealed potential for induced flooding outside the above focus area for FRM and resulted in a larger area for consideration of impacts and potential mitigation (Figure 1-).

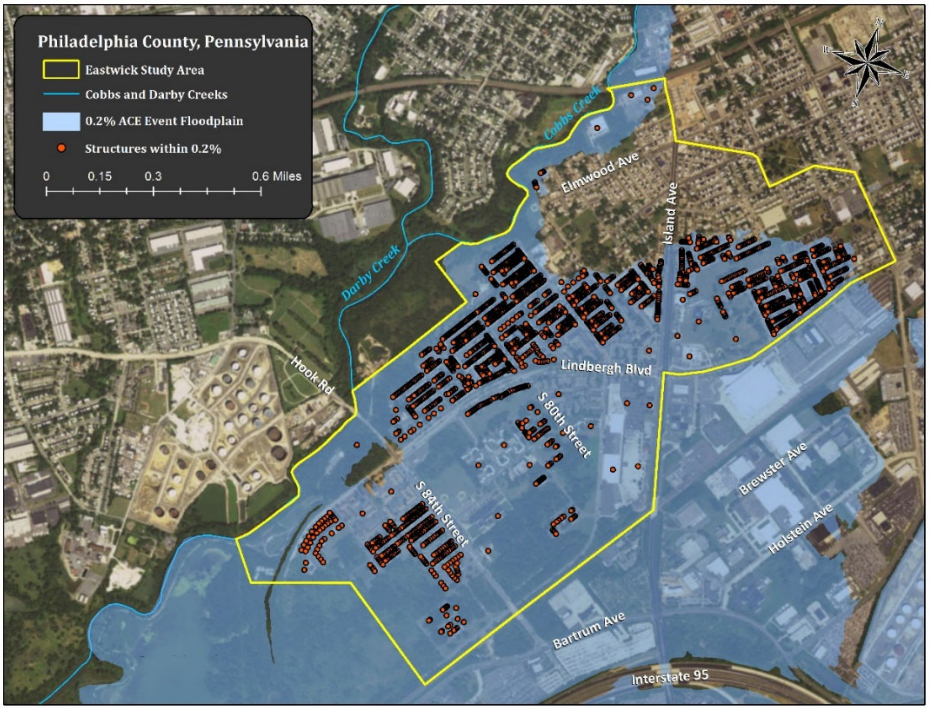


Figure 1-3: Structures in 0.2% AEP Floodplain

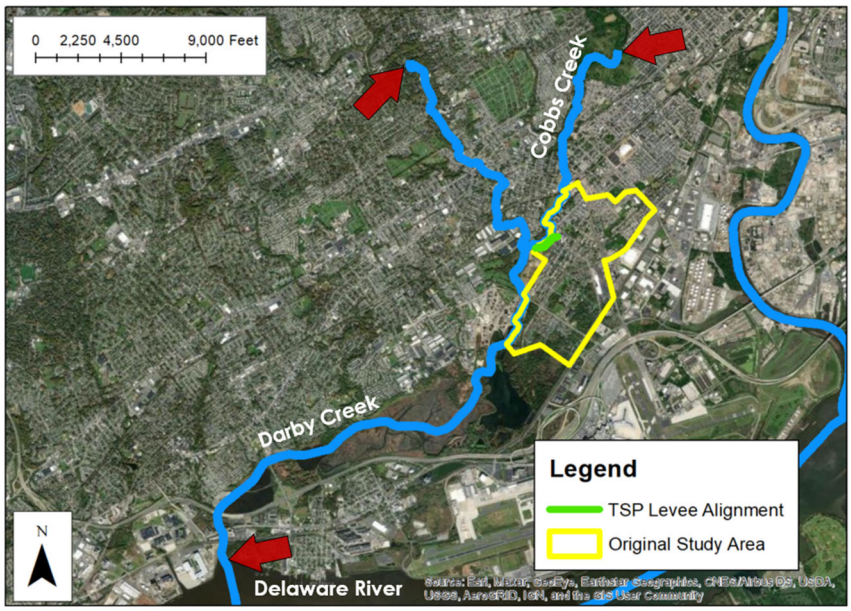


Figure 1-4 - Study Area Expansion. Original Study Area is Shown in Yellow, while the Study Area Expanded Upstream to Model Extents at USGS Gage Locations and Downstream to Darby Creek Confluence with Delaware River (demarcated with Red Arrows).

2.0 Prior Studies and Actions

2.1 Eastwick Resident Survey of Flood Information

Based on historical floods and in direct response to flooding caused by Tropical Storm Lee on September 7, 2011, PWD sent a questionnaire to Eastwick residents requesting information such as source and depth of flooding. This survey was made available to the public through the PWD's website as well as in physical form. In total 293 residents replied to PWD. Of the 293 responses, 139 included a date related to a specific flooding event. Approximately 100 Eastwick residents within the study area experienced flooding during Hurricane Floyd, 37 during Hurricane Irene and 17 during Tropical Storm Lee. On many occasions, the same residence reported flooding during multiple events. Based on the responses, PWD developed a geospatial shapefile with attribute data about the properties affected from September 1999 to September 2011 (Figure 2-1:).

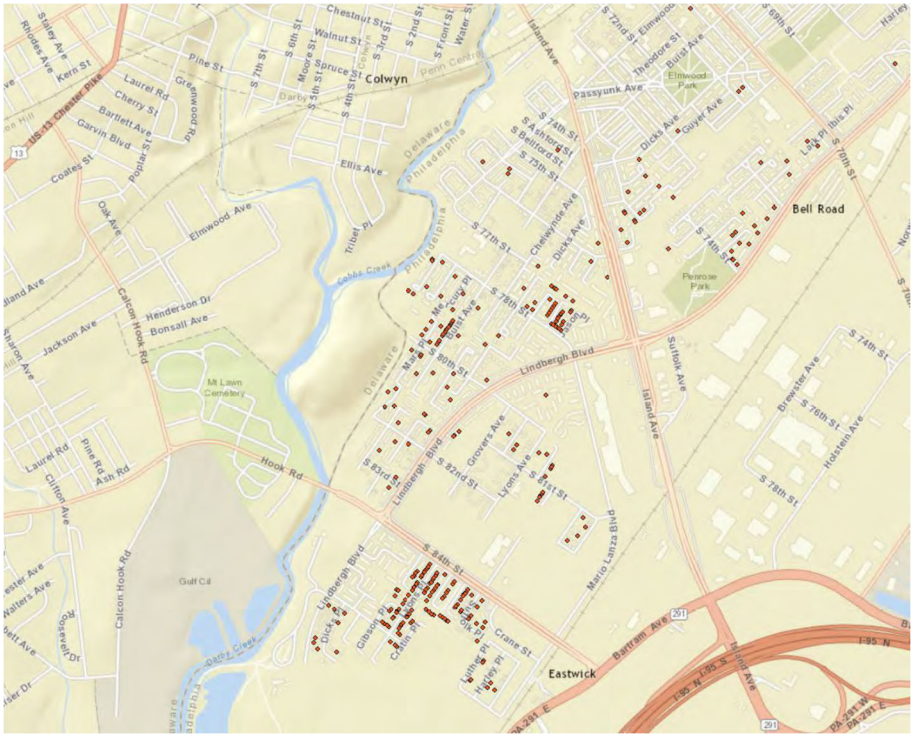


Figure 2-1:. Locations (Orange Dots) of Returned Flood Questionnaire.

2.2 Eastwick Stream Modeling and Technical Evaluation

In December 2014 USACE-NAP completed the Eastwick Stream Modeling and Technical Evaluation report. The study was conducted under the USACE Planning Assistance to States (PAS) program. The purpose of the study was to preliminarily evaluate whether a levee would provide FRM for the Eastwick neighborhood during extreme rainfall events without

adversely impacting other properties and residents along Darby and Cobbs Creeks. The evaluation focused on two locations for construction of a levee, both within or adjacent to the footprint of the Lower Darby Creek Area Superfund Site (Clearview Landfill) (Figure 2-2: Lower Darby Creek Area Superfund Site (Clearview Landfill)Figure 2-2).

Figure 2-2: Lower Darby Creek Area Superfund Site (Clearview Landfill)

The study was preliminary in nature and made a set of assumptions about conditions. Major assumptions included unrefined preliminary hydrology, and roughly calibrated 1D hydraulic modeling. The evaluation concluded that there might be potential for construction of a levee in the northern section of the Superfund site, but that such a levee would likely cause the

peak flow of Darby and Cobbs Creeks to increase during a 2% AEP or greater event and would have the effect of raising upstream and downstream surface water elevations during these flood events. The study recommended that if the City of Philadelphia determined there was sufficient evidence to advance the levee concept into designs, additional studies and analyses were needed.

2.3 Darby and Cobbs Watersheds Hydrologic Study

In September 2016, USACE-NAP completed the Darby and Cobbs Watersheds Hydrologic Study. The purpose of the investigation was to determine more accurate flow-frequency relationships in the lower Darby-Cobbs watershed in the vicinity of southwest Philadelphia, PA. Funding for the study was provided by USACE Headquarters from the Hydrology, Hydraulic and Coastal Section HQ General Investigation Remaining Accounts for Fiscal Year 2016. Recent studies, including the Eastwick Stream Modeling and Technical Evaluation described above, revealed that the hydrologic information for the area was outdated, stream gage information may be inaccurate, and supporting data was lacking. The study reviewed existing flow-frequency estimates in the watershed, investigated discrepancies between the existing estimates, and suggested other methods to provide the best estimates for use in related studies.

3.0 Flood History and Character in the Study Area

The Eastwick neighborhood in Southwest Philadelphia is bounded on its west by Cobbs and Darby Creeks and is subject to frequent and severe fluvial flooding from multiple sources, as shown conceptually in Figure 3-1. Fluvial, or terrestrial, flooding is the result of high flows in creeks and rivers, as opposed to tidal flooding driven by coastal events, and storm surge on the Delaware River. Pluvial flooding, or flooding driven by precipitation and overland stormwater runoff is also an issue in Eastwick, often overwhelming the storm sewer network, and the Mingo Creek Pump Station. Given the unknowns and complexity associated with the storm sewer network, and the scale of the issue (much less impact than Cobbs Creek overflow), internally generated runoff was also excluded from the current study. Fluvial, or river and creek, flooding is the main focus of the current FRM feasibility study.

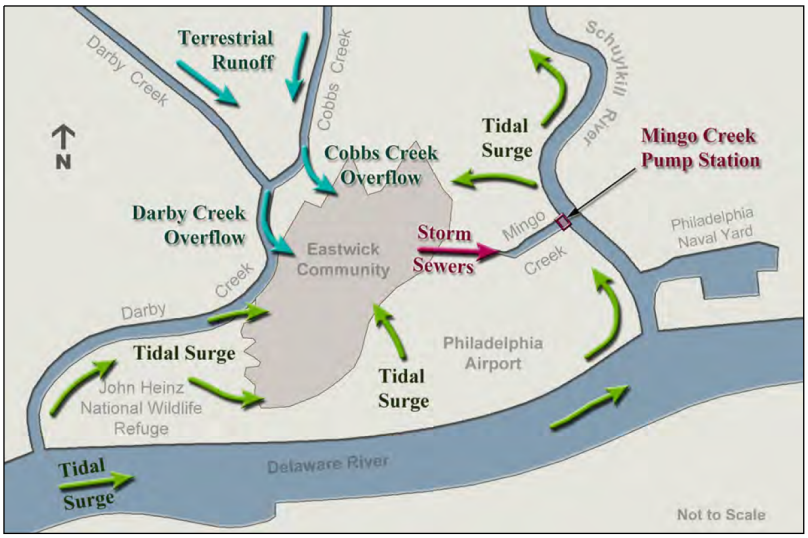


Figure 3-1: Conceptual Diagram of Eastwick Flooding Sources (source: AKRF, 2022)

As discussed in previous USACE studies, results from questionnaires provided to residents of Eastwick (2012) by PWD indicated dates of flood-producing fluvial events, as shown in Table 3-1Table 3-1.

Significant storms in the watershed were Hurricane Floyd in 1999, Hurricane Irene in 2011, and Tropical Storm Lee in 2011. Subsequent to the questionnaire, and after previous USACE studies, Hurricane Isaias in 2020 was also a significant event, with an AEP of less than 10% (greater than 10-year average recurrence interval - ARI). High water mark data for Isaias was collected in the days following the event by USACE Philadelphia District staff. Notably, Hurricane Ida in 2021, which caused record or near-record flows on the Schuylkill River and the nearby streams, including Perkiomen Creek, did not result in high flow impacts on either Darby or Cobbs Creek, with an AEP of greater than 50% (ARI of less than 2 years).

Table 3-1: Significant Events from Resident Questionnaires

Date	Storm Event Name (if named)	Estimated Annual Exceedence Probability (AEP, %)	Estimated Average Recurrence Interval (ARI, years)
September 15, 1999	Hurricane Floyd	<0.5	>200
August 1, 2004		-----	-----
September 28, 2004	Tropical Storm Jeanne	-----	-----
August 28, 2006		-----	-----
June 6, 2009		-----	-----
August 2, 2009		-----	-----
August 1, 2010		-----	-----
August 9, 2010		-----	-----
August 27, 2011	Hurricane Irene	<10	>10
September 7, 2011	Tropical Storm Lee	<5	>20

While Eastwick is also subject to tidal impacts, FRM measures specific to coastal flooding are not the focus of the current study. Tidal boundary conditions are included and considered in the analyses, but only include changes to mean higher high water (MHHW) over the design life (2025 – 2075).

Drivers for flooding in Eastwick are both the mainstem Darby and Cobbs Creeks, however three smaller tributaries enter Darby Creek downstream of the Cobbs Creek confluence, shown in (Figure 3-2:).

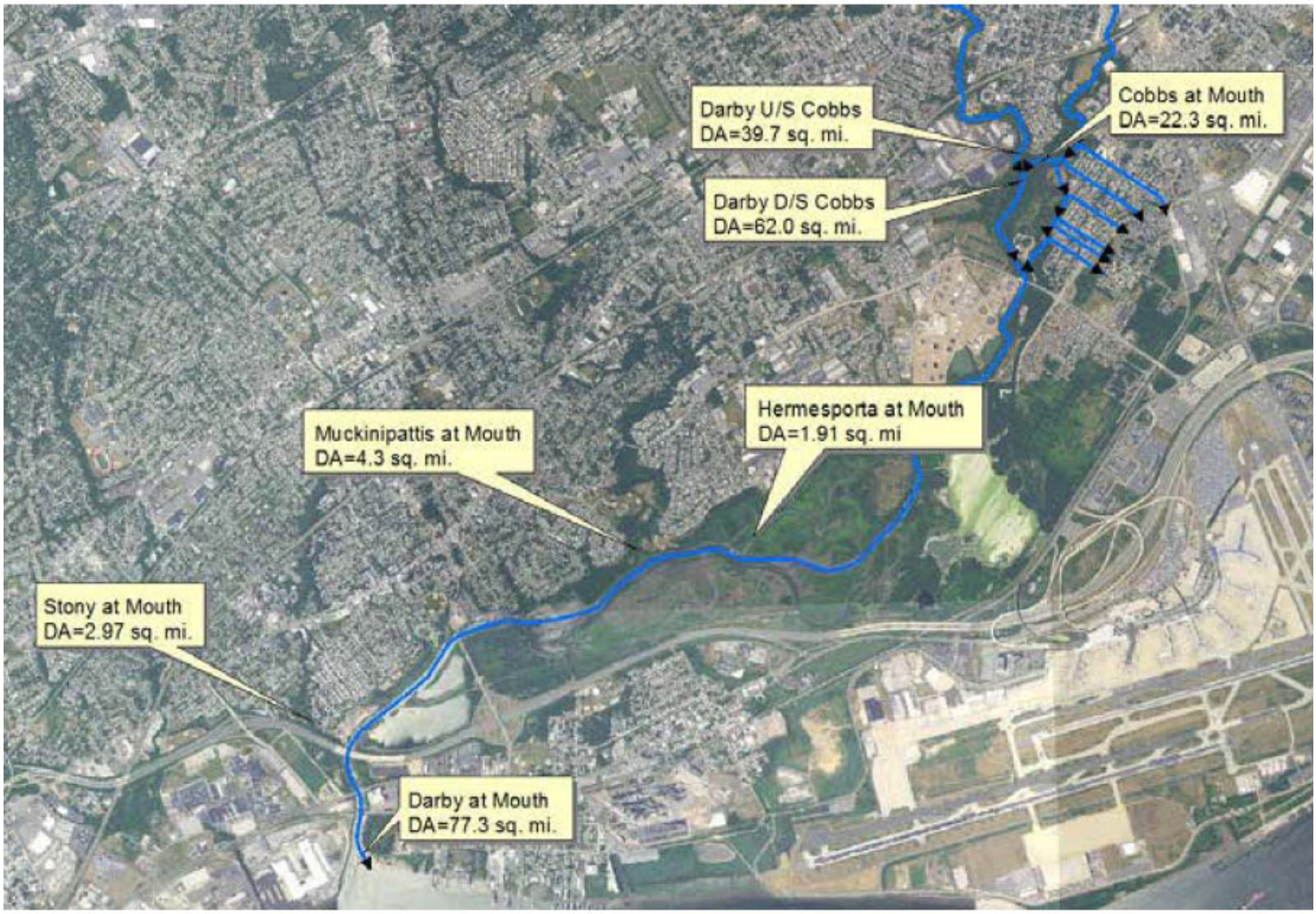


Figure 3-2: Mainstem Darby and Cobbs Creeks with Lower Tributaries (USACE, 2016)

4.0 Baseline Conditions/Affected Environment*

4.1 Physical Setting

4.1.1 Topography and Land Use

The Eastwick area in South Philadelphia was historically a low-lying marshland that was frequently flooded by the Darby and Cobbs Creeks. This area was reportedly raised by the placement of fill material over a 20+ year span from the 1940s into the 1960s. The fill consisted of various unconventional materials such as rubbish, dredged sediments from the Schuylkill River, and fly ash.

After being filled, the area was developed mainly as a residential neighborhood. Over the years, certain sections of residential buildings within Eastwick have experienced severe structural distress associated with ground subsidence and differential settlement of the fill.

4.1.2 Regional Geology and Stratigraphic Conditions

A detailed discussion of the regional geology and stratigraphic conditions is discussed in the Geotechnical Sub-Appendix of the Engineering Appendix (Local Geology and Subsurface Conditions).

4.1.3 Previous Studies

A detailed discussion of all previous engineering and planning previous studies are provided in the respective appendices.

4.2 Climate, Weather, and Climate Change

The Darby-Cobbs watershed has a moderate, humid, continental climate. Winters are comparatively short and mild while the warm season is long and frequently humid. While the average relative humidity for the year fluctuates, the relative humidity in the summer is often higher than 65 percent, and generally increases during afternoons. About two thirds of the time, skies are clear to partly cloudy, and the average amount of sunshine is about 57 percent of the possible amount. Storms are generally numerous enough that they insure an adequate and dependable supply of moisture throughout the year.

The watershed is near the path of the major weather systems that move across the nation; therefore, the weather is variable. Changes in the temperature, the velocity of the wind, the humidity, and other weather elements tend to occur from day to day and from week to week, and seasonal weather varies from year to year. During winter and spring, changes occur almost daily. During summer and fall, changes are less frequent because the high- and low-pressure systems that are responsible for the weather move more slowly in these seasons than they do in winter and spring.

From June through October, the weather remains approximately the same for a week or more at a time. Hot humid days and mild nights generally result when a pressure system remains stagnant for several days in the summer. Cool nights are typical when a pressure system remains stagnant for several days in the fall. Several of these spells can be expected in most

years, though extreme heat is noticeably absent in some summers. During winter and spring, unseasonably cold spells last for only a few days because the weather systems move more rapidly than in summer and fall.

By many accounts, climate change is expected to continue to warm the region throughout the 21st century. Although the potential indirect effects of climate change in the project area are difficult to quantify or qualify, direct changes of temperature and precipitation, river discharge, wildfire can be estimated based on recent climate models and future emissions scenarios. Intolerant flora and fauna, as well as species currently existing on the edge of their range, are expected to be at greatest risk of local extirpation as a result of altered environmental conditions expected under some climate change scenarios (USEPA, 2022). The Climate Hydrology Assessment Tool allows users to easily access both existing and projected climate data to develop repeatable analytical results using consistent information: reducing potential error and increasing the development of information so that it can be used earlier in the decision-making process, ideally in the development of risk registers. A detailed climate change assessment using the Climate Hydrology Assessment Tool is provided in Attachment 2 in the H&H Sub-Appendix of the Engineering Technical Appendix.

4.3 Air Quality

The Clean Air Act of 1970 requires the EPA to set National Ambient Air Quality Standards (NAAQS) for six principal pollutants ("criteria air pollutants") that can be harmful to public health and the environment. These criteria air pollutants include Carbon Monoxide (CO), Lead (Pb), Nitrogen Dioxide (NO2), Ozone (O3), Particulate Matter (PM) and Sulfur Dioxide (SO2). Standards for these pollutants are developed to protect the health of "sensitive" populations such as asthmatics, children, and the elderly, and to protect against decreased visibility and damage to animals, crops, vegetation, and buildings. Stationary sources include power plants that burn fossil fuels, factories, boilers, furnaces, manufacturing plants, gasoline dispensing facilities, and other industrial facilities. Mobile sources include vehicles such as cars, trucks, boats, and aircraft. Ambient air quality is monitored by PADEP and is compared to the NAAQS throughout the state.

The study area is located within Philadelphia County, which is included in the Philadelphia-Wilmington-Atlantic City 8-hour Ozone Marginal Nonattainment Area (2008 and 2015), PA-NJ-MD-DE (Philadelphia-Wilmington-Atlantic City Area). Ozone is controlled through the regulation of its precursor emissions, which include oxides of nitrogen (Nox) and volatile organic compounds (VOCs). Additionally, Philadelphia County is also part of a "maintenance area" for previous violations of the 2006 Particulate Matter (PM2.5) NAAQS, as well as for Carbon Monoxide (CO).

4.4 Surface Water Resources

4.4.1 Background

Eastwick was developed within a coastal plain region, characterized by low elevation and nearly flat topography with shallow broad valleys and marshlands. Early in Eastwick's history, the back channels of the Delaware River began silting-in because of extensive farming and mining practices along the upper reaches of the Schuylkill and Delaware Rivers.

In the 1920s, nearby Hog Island (as it was known) was transformed into an airfield for the Philadelphia National Guard with fill material pumped from the Schuylkill and Delaware Riverbeds. In addition to hydraulically filling in Hog Island for what is now Philadelphia International Airport (Figure 4-1), the 1950s experienced massive amounts of hydraulic fill in Eastwick, also then known as The Meadows, for facilities such as tanker terminals, roadways, and industrial sites. Other types of fill material, consisting mainly of silt, solid waste, sand, gravel and topsoil were also placed over the unconsolidated native soils (organic mats of vegetation underlain by sand and silt) and sediments (Quaternary Trenton Gravel at the surface overlying bedrock of the Wissahickon Formation). Up until the mid-1970s the City of Philadelphia was using incinerator fly ash, and demolition and construction materials to fill in low lying areas within Eastwick.

Figure 4-1: Location of Philadelphia Airport

4.4.2 Drainage and Flooding

Drainage has always been a problem in Eastwick due to low and flat terrain. The process of storing, moving, and placing the fill materials exposed large volumes of fill to erosion. This increased the sedimentation load on the adjacent streams.

The far western edge of Eastwick is drained by the bordering Cobbs Creek and Darby Creek Watersheds, which flow south and west through the John Heinz NWR and into the Delaware River. The Cobbs Creek watershed drains 21.9 square miles of Philadelphia and Delaware counties above its confluence with Darby Creek. At this point, it merges with Darby Creek, which drains an additional 38 square miles prior to emptying into the John Heinz NWR.

Upstream of the confluence of Cobbs Creek and Darby Creek, along the southeastern bank of Cobbs Creek, and located between the high elevation points of the Clearview Landfill and S. 78th Street (Figure 4-2), water overflows the stream bank during periods of heavy rain. The extent of inundation depends on the WSEL of Cobbs Creek. The bank elevation of Cobbs Creek between the Clearview Landfill and S. 78th Street is +12 ft (NAVD88). Once WSELs reach between 12-ft and 16-ft, the floodplain is encroached upon and the flooding of structures in the study area begins. This inundation does not appreciably reduce the peak flow on Cobbs Creek since the water does not leave the Cobbs Creek watershed and the ponded volume is small relative to the size of the watershed. If the WSEL of Cobbs Creek is greater than +16 ft (NAVD88), discharge is diverted from the Cobbs Creek watershed and flows east into the Mingo Creek Drainage Basin, eventually ponding at the low-lying area bounded by Lindbergh Boulevard, Island Avenue and S. 84th Street. Ponding within the low area of Lindbergh Boulevard, Island Avenue and S. 84th Street is augmented by local runoff that exceeds the storm sewer capacity. The surrounding street elevations are approximately +6 ft (NAVD88). If the volume reaching this low area is large enough, the structures surrounding this area will also flood as water overflows from the ponding area. During Hurricane Floyd in September 1999, areas to the south of S. 84th Street experienced this high-volume flooding scenario of overflows expanding beyond the ponding area.

A more detailed view of the flooding in the lowest areas of the project indicates that a complete understanding of the hydraulic complexities is needed to fully account for the existing and future without project flooding. In addition, these details are important because these flooding issues may be impacted by study alternatives and possibly create induced flooding. Figure 4-3 shows an overview of the project area with selected topographic elevation contours highlighted as indicated in the legend. Additional detail on the drainage and flood history can be found in the Hydrology and Hydraulics Sub-Appendix of the Engineering Appendix.

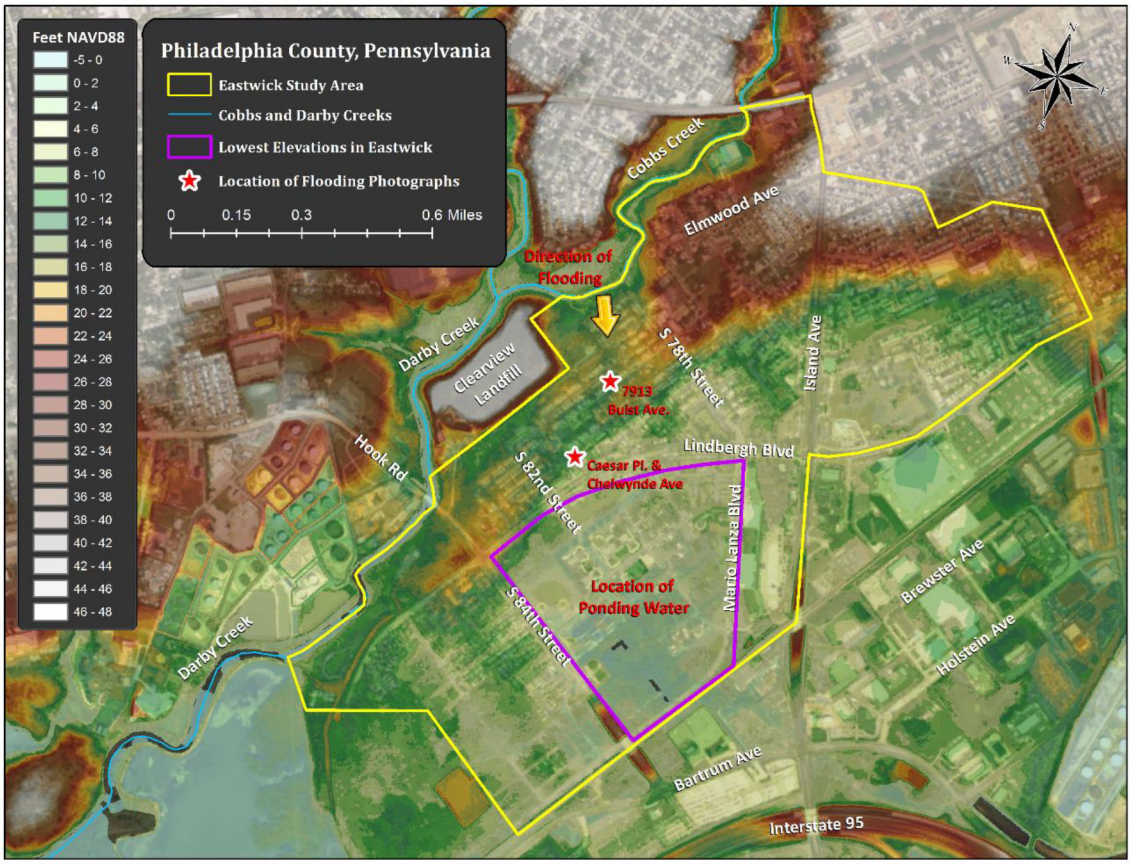


Figure 4-2 Study Area Inundation Corridor

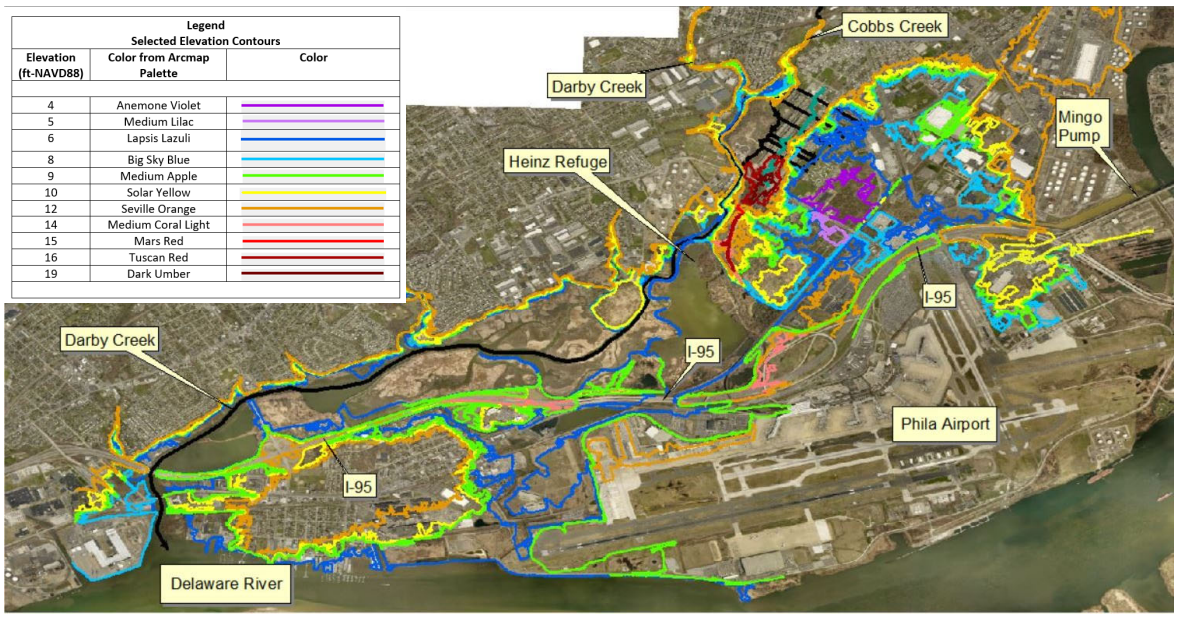


Figure 4-3: Study Overview with Selected Elevation Contours

4.4.3 Existing Water Control Structures

There are five existing dams located in the Darby Creek watershed (four in the Township of Upper Darby and one in the Borough of Clifton Heights). These dams have very limited storage capacity and do not affect flood flows in the communities within Philadelphia and Delaware County (FEMA 2019). USEPA maintains several stormwater management features associated with the Clearview Landfill, including created wetlands, and multiple outlets to Cobbs/Darby Creeks. Coordination with USEPA during the remainder of the study is prudent, particularly for interior drainage, to account for and incorporate existing infrastructure. Similarly, the City of Philadelphia maintains the existing storm sewer network throughout Eastwick, which ultimately drains to the Mingo Creek Pump Station, and into the Schuylkill River via pumping. There are multiple existing berms throughout the US Fish and Wildlife Refuge (USFWS) John Heinz NWR, and along the SEPTA tracks to the southeast. Together, these berms influence exchange of water between lower Eastwick and the John Heinz NWR. Further discussion of flow through and around Eastwick area is provided in later sections, and in the H&H sub-appendix.

4.4.4 Hydrology and Hydraulic Analysis

Hydrology & hydraulics analyses are detailed in the Hydrology & Hydraulics Sub-Appendix of the Engineering Appendix and are generally summarized below.

Hydrology

Updating from the USACE 2016 analysis, subsequent years (2016 through 2022) were added to the gage records at all USGS gages (refer to Hydrologic and Hydraulic Sub-Appendix for gage locations). A flow frequency analysis was performed utilizing updated gage information. This process was repeated for both Darby and Cobbs USGS gages. Hydrologic updates for the current study are summarized below, with results shown in Figure 4-4 and Table 4-1.

- Update the 2016 estimates to include years up to 2022, including Hurricane Isaias
- Evaluation of both Mt. Moriah (Cobbs) and Providence Road (Darby) gages
- Recommended continued use of peak scaling factors to ensure Darby Creek peak flow > Cobbs Creek peak flow
- All frequency hydrographs modeled after the shape of the hydrograph for Hurricane Isaias on both Darby and Cobbs Creeks
- Results of hydrologic updated analyses utilized in updated hydraulics analyses

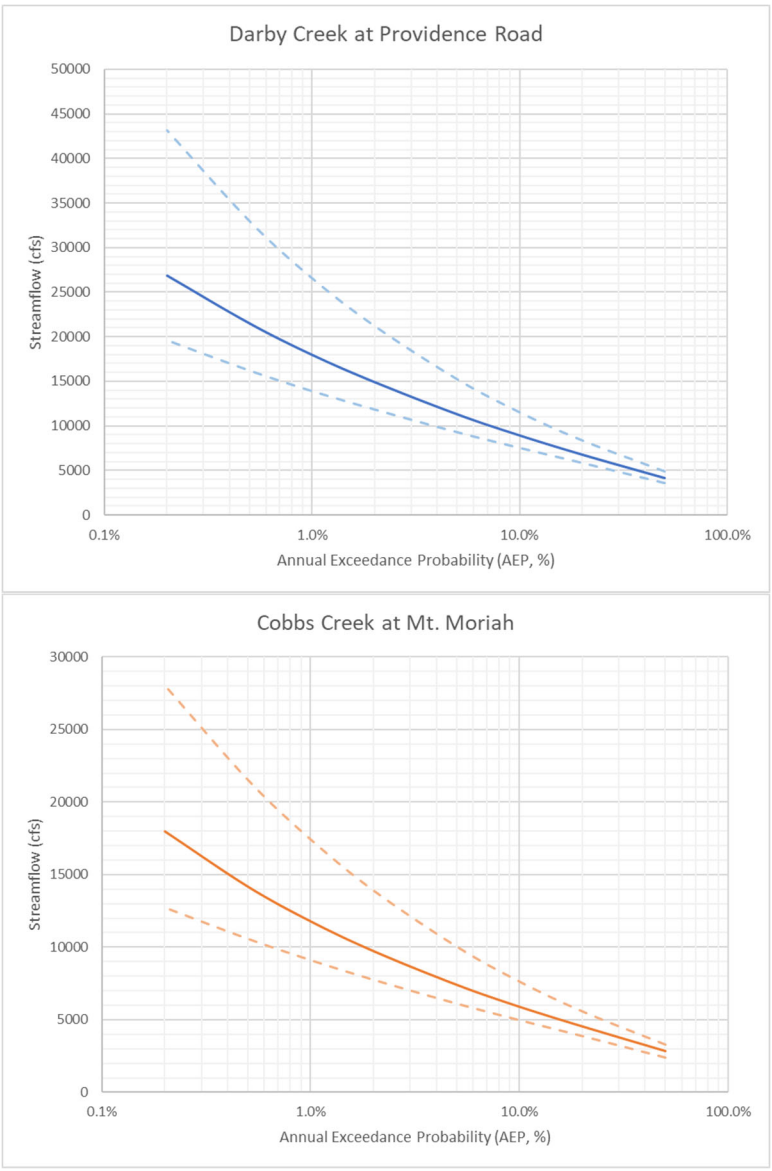


Figure 4-4:. Flood Frequency Curves for Darby and Cobbs Creeks (expected curve is solid line, and 5th and 95th confidence limits are dashed lines)

Table 4-1: Peak Flood Frequency Estimates for Current Study

Event	AEP (%)	Discharge for Cobbs Creek at Woodland Ave (CFS)	Confidence Limits		USACE 2016 Adjustment Factor	Discharge for Darby Creek at Providence Road (CFS)	Confidence Limits		Discharge for Cobbs Creek at Mt. Moriah (CFS)	Confidence Limits	
			5%	95%			5%	95%		5%	95%
2yr	50.0%	3120	3586	2639	1.369	**4271**	4909	3613	**2848**	3273	2409
5yr	20.0%	4984	6094	4262	1.378	**6867**	8398	5873	**4549**	5563	3891
10yr	10.0%	6468	8344	5459	1.384	**8952**	11548	7555	**5905**	7617	4983
20yr	5.0%	8128	10991	6710	1.388	**11281**	15256	9313	**7419**	10033	6125
50yr	2.0%	10667	15221	8499	1.395	**14880**	21233	11856	**9737**	13894	7758
100yr	1.0%	12915	19073	9981	1.394	**18003**	26588	13914	**11789**	17411	9111
200yr	0.5%	15540	23581	11592	1.399	**21741**	32990	16217	**14186**	21526	10582
500yr	0.2%	19714	30715	13945	1.406	**27717**	43185	19607	**17995**	28038	12730

Hydraulics

A hydraulic model of the stream reaches of interest near Eastwick was utilized to simulate multiple historic events for calibration/validation. Following acceptable calibration/validation, multiple hypothetical frequency events ranging from 50% AEP to 0.2% AEP were simulated.

Previous studies that the hydrologic analysis builds upon are detailed below, including updates to those previous efforts for this current feasibility report.

USACE (2014) – Study provided preliminary hydraulics, utilized in Allee, King, Rosen and Fleming, Inc. Environmental Consulting Firm (AKRF) (2022) and Princeton Hydro modeling (2017, 2022, respectively). Implicitly utilized in current study, as AKRF modeling used as baseline for updated analyses.

Princeton Hydro (2017) – Princeton Hydro study provides flooding estimates for Irene and Lee utilizing 1D/2D combined hydraulics. Their study formed the conceptual basis for AKRF updates to USACE 2014 hydraulics. The current USACE study reviewed the Princeton Hydro results to conceptualize impacts of complementary features, however none of model files from Princeton Hydro were utilized.

AKRF (2022) – AKRF completed this analysis for the current non-federal sponsor, the City of Philadelphia. This current study utilized ARKF modeling files as base for updates and modifications. AKRF hydraulic model utilized 2014 USACE model, and updated to 1D/2D combined hydraulics, calibrated to Isaias collected by USACE (2020). The current USACE study utilized AKRF hydraulic model as base for updates.

Below is a list of updates to the current USACE hydraulic model:

- Refined estimates of FFA utilizing re-rated Isaias estimates, and updated flow change locations.
- Utilized AKRF calibrated Isaias modeling as a base for hydraulics updates.
- Updated topographic data with latest available (2022 LiDAR from City of Philadelphia).
- Modified 2D elements to suit the current level of analysis, with refinement around points of interest.
- Calibrated/validated to additional sets of high-water marks (Floyd, Irene, Lee).
- Following calibration, the hydraulic model was setup and run for frequency events from 50% to 0.2% AEP.
- Utilized latest HEC-RAS capability to allow varying n-values along cell face, allowing larger cell sizes, but maintaining resolution of n-value delineations.

The HEC-RAS model domain is shown in Figure 4-5. Additional information is available within the Hydrology and Hydraulics Sub-Appendix.

Uncertainty

Risk and uncertainty analysis is ongoing and will be completed in later phases. Additional details are included in the H&H Sub-appendix I of the Engineering Appendix; however, below is a list of factors to be updated or considered in subsequent analyses:

- *Risk/uncertainty, optimization/update economics*
- *Investigate Debris Blockage Sensitivity at proximate bridges*
- *Investigate Levee overtopping/superiority*
- *Additional gage installation/ data collection recommendations*
- *Investigate potential storage in USFWS impoundment*
- *Sedimentation assessment*
- *Additional Topographic/Bathymetric Survey*

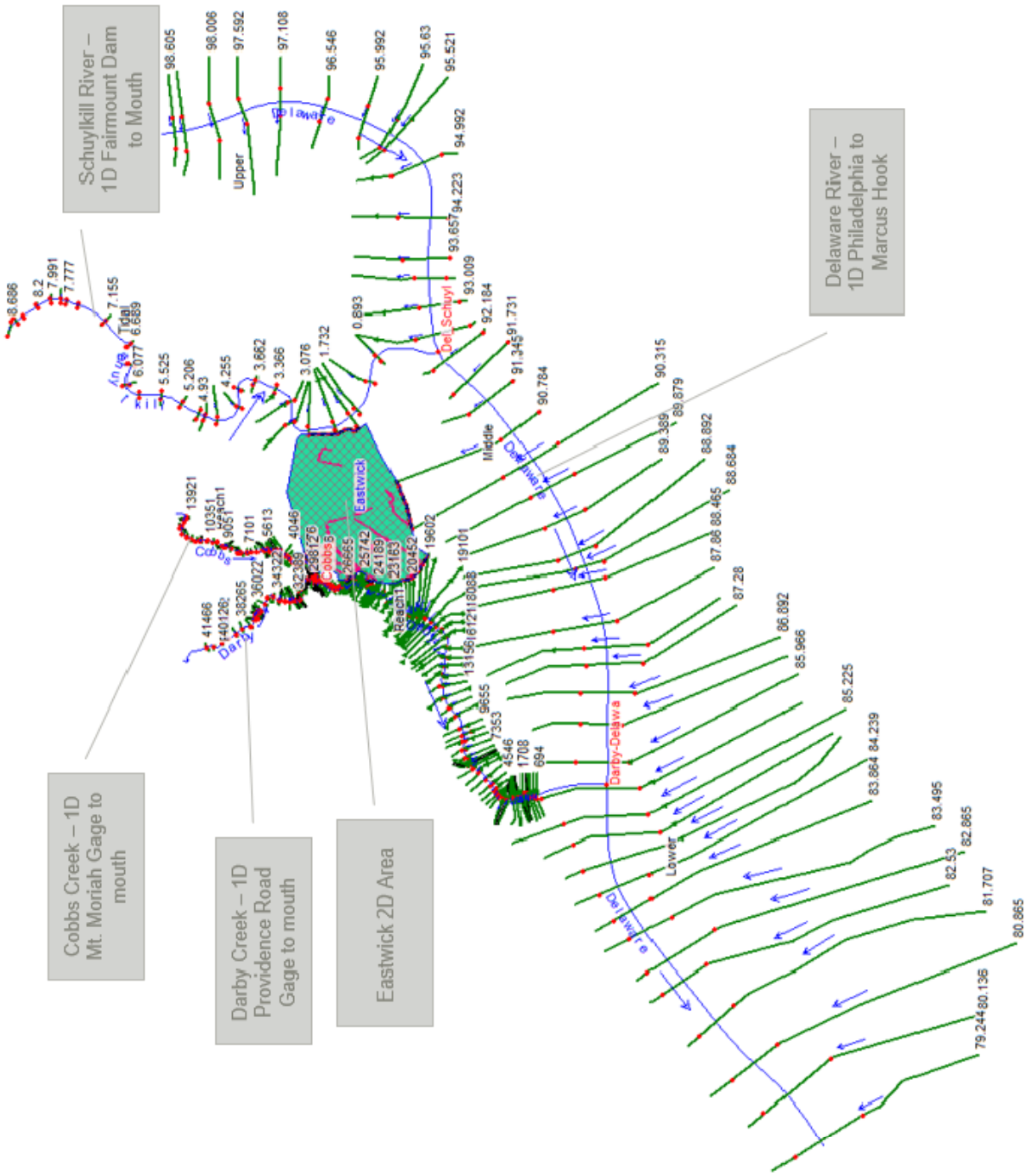


Figure 4-5: HEC-RAS Model Domain

4.4.5 Water Quality

According to the Cobbs Creek Integrated Watershed Management Plan (Philadelphia Water Department Darby-Cobbs Watershed Partnership, 2004) the entire 18.75 miles of Cobbs Creek and its tributaries within the watershed are impaired due to urban runoff/storm sewers and habitat modification. There are multiple water quality concerns noted, including:

- High fecal coliform during dry weather
- High fecal coliform as well as Combined Sewer Overflow (CSO) impacts during wet weather
- Stream banks noticeably full of trash when the water surface is low during dry periods
- Limited diversity of fish and benthic life
- Degraded aquatic and riparian habitats
- Periodic, localized occurrences of low dissolved oxygen primarily associated with plunge pools and areas of stagnant water (behind dams)
- Utility infrastructure threatened by bank and streambed erosion.

The 2004 Cobbs Creek Integrated Watershed Management Plan also uses benthos as an indicator of long-term water quality and the overall health of the aquatic system. Benthic organisms respond to changes in the aquatic environment making them good indicators of water quality conditions. The diversity of benthos of Cobb Creek is reported to be limited with mostly moderately pollution tolerant species (Philadelphia Water Department Darby-Cobbs Watershed Partnership, 2004).

The Pennsylvania Department of Environmental Protection (PADEP) classifies the Cobbs Creek watershed as moderately to severely impaired. The sources of impairment are primarily habitat modification, municipal point sources, and urban runoff/storm sewers based upon a year 2000 assessment (Philadelphia Water Department Darby-Cobbs Watershed Partnership, 2004).

PADEP is required under Section 303(d) of the Clean Water Act (CWA) to list the stream segments in the state that do not meet water quality standards or do not achieve its designated water use. This list is referred to as the "Impaired Waters and 303(d) List." PADEP has classified all streams in the Darby-Cobbs Creek watershed as impaired, except for upper Darby Creek. The 2022 Pennsylvania Integrated Report map viewer shows Cobbs Creek in the vicinity of the study area to be impaired for “aquatic life” (due to municipal point source discharges), “fish consumption” (due to PCB’s), and “recreation” (due to pathogens/bacteria and microbes), while Darby Creek in the vicinity of the study area is designated impaired for “fish consumption” (due to PCB’s), and “recreation” (due to pathogens/bacteria and microbes) only (PADEP, 2020).

The reach of Cobbs Creek that is located adjacent to the study area is a F5 stream in the Rosgen classification system (Philadelphia Water Department Darby-Cobbs Watershed Partnership, 2004). An F-5 stream classification refers to an entrenched, meandering, riffle/pool channel on low gradients with a high width-to-depth ratio (ranging between 12 >1.2). Such streams are located in highly weathered material and are unstable, with high

bank erosion rates. USEPA has installed bank stabilization materials on Cobbs Creek at and near the Lower Darby Creek Area Superfund Site (Clearview Landfill).

4.5 Biological Resources

4.5.1 Vegetation

While much of the study area is an urban residential area, parks and forested areas that provide habitat with a variety of native and non-native trees such as maple (*Acer* spp.), ash (*Fraxinus* spp.), cherry (*Prunus* spp.), and white pine (Pinus spp.) and shrubs and vines such as blackberry (*Rubus* spp.), poison ivy (*Toxicodendron radicans*), and multiflora rose (*Rosa multiflora*). Additionally, USEPA is restoring forested habitat at the Clearview Landfill.

The forested riparian area at the north end of the study area generally slopes downward toward Cobbs Creek in a series of floodplain terraces. This area is dominated by boxelder maple (*Acer negundo*), green ash (*Fraxinus pennsylvanica*), and invasive Japanese knotweed (*Fallopia japonica*).

4.5.2 Wetlands

Numerous wetlands are located within the floodplains of Cobbs Creek and Darby Creek in the study area (Figure 4-6). The largest remaining tidal freshwater wetlands in the state of Pennsylvania at the John Heinz NWR. Wetlands were identified within the study area adjacent to Cobbs Creek between 77th and 78th Streets. Additionally, USEPA constructed a mitigation wetland within the footprint of the Clearview Landfill/Lower Darby Creek Area Superfund Site. This wetland also works as part of the landfill's stormwater management.

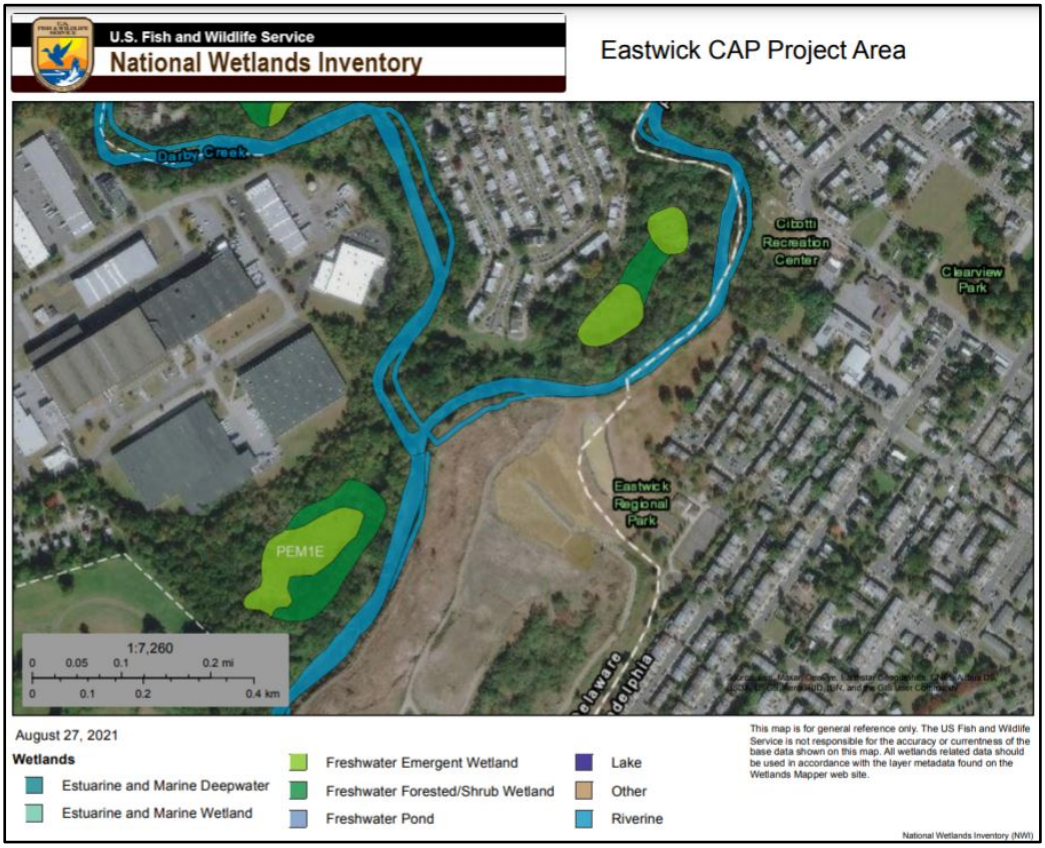


Figure 4-6: Wetland Areas Near the Study Area

A wetland delineation was completed on May 18, 2023 to confirm potential wetlands between 77th and 78th Streets along Cobbs Creek. Results of the wetland delineation indicate that a small, forested wetland occurs in this location (Figure 4-7). A copy of the wetland delineation forms is provided in Sub-Appendix A1 of the Environmental & Cultural Appendix.

The levee will be constructed through Clearview Landfill Area C, which contains habitat planted in 2022 and wetlands associated with the Clearview Landfill stormwater system. While no delineation was conducted at the Clearview Landfill, the extent of the wetlands at the landfill restoration site were estimated (Figure 4-8). It is assumed that within five years these wetlands will develop into forested wetlands.

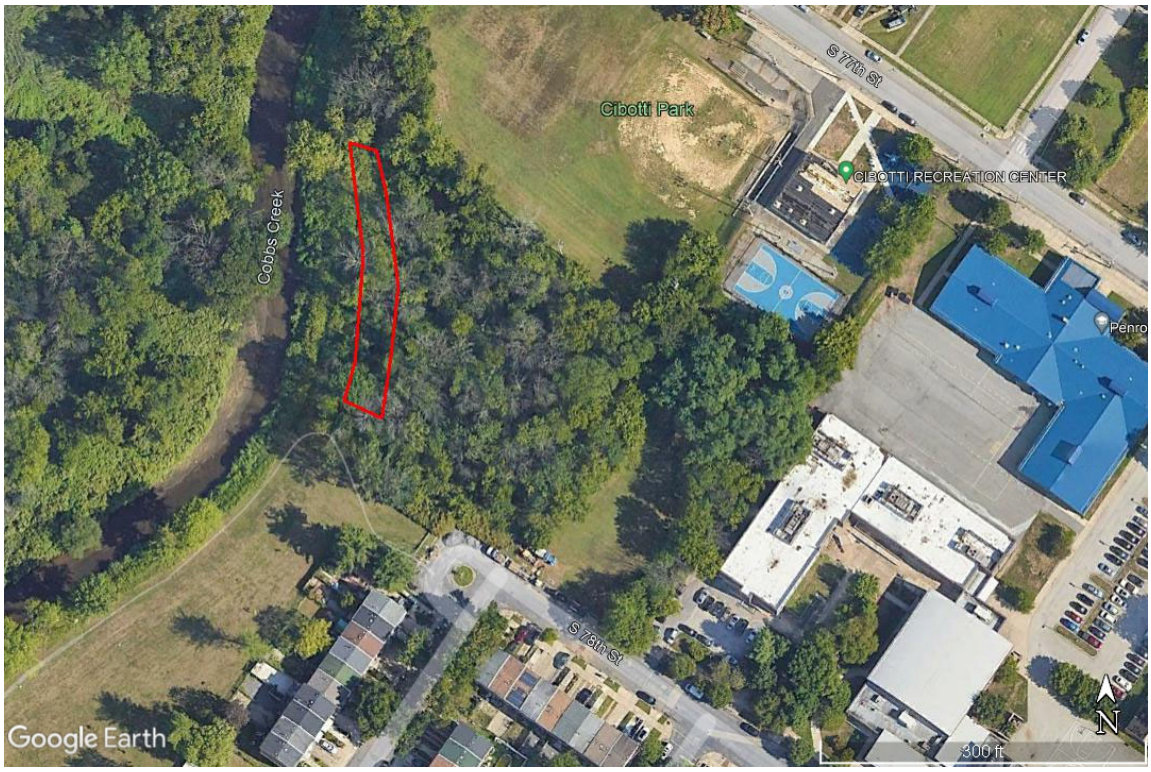


Figure 4-7: Forested Wetland Between 77th and 78th Streets along Cobbs Creek (Red Polygon)

Figure 4-8: Estimated Areal Extent of Wetlands in Clearview Landfill Rest. Area C (Yellow Polygons)

4.5.3 Fish and Wildlife

4.5.3.1 Fisheries and Aquatic Species

The study area is located within the 0.2% AEP floodplain of Cobbs Creek and Darby Creek near their confluence plus areas where induced flooding may occur from the TSP. Darby Creek empties directly into the Delaware River roughly 5 miles downstream of the study area. Darby and Cobbs Creeks are tidally influenced in the study area due to their hydrologic connection and proximity to the Delaware River. Diverse aquatic life is found in the study area because of the unique aquatic habitat provided by this hydrologic setting, as well as the presence of extensive freshwater tidal marshes located at the John Heinz NWR.

In 2003, PWD biologists performed multiple surveys along the tidal and non-tidal portions of Cobbs and Darby Creeks to determine the numbers and types of fish present and to assess the overall fish population diversity. The sampling location nearest to the Eastwick study area was in Cobbs Creek several hundred feet upstream of its confluence with Darby Creek. Over 1700 individuals representing 25 species of fish were collected during a 40-minute electrofishing sampling period for a total sampled area of 1349.42 m^2. While species diversity and abundance were high at this location, relative to other parts of the watershed, two highly tolerant species, banded killifish (*F. diaphanus*) and mummichog (*F. heteroclitus*), comprised over 70% of the total fish assemblage, and more than 80% of all fish collected were tolerant of poor water quality, which suggests chemical and/or physical perturbation. The study notes, that this site was the only site in Cobbs Creek that contained an intolerant species (eastern silvery minnow, *Hybognathus regius*). While an Index of Biotic Integrity (IBI) could not be determined due to a lack of tidal reference streams, various metrics were used to assess biological integrity. For example, this sampling location had the highest percentage of top carnivores and the lowest percentage of individuals with disease, eroded fins, lesions, and tumors in Cobbs Creek watershed. Also, Modified Index of Well-Being (10.78) and Shannon Diversity Index (1.77) values indicated a fair quality fish assemblage (PWD, 2004).

4.5.3.2 Wildlife

Except for the John Heinz NWR, the study area generally lacks species diversity as a direct result of the elimination of habitat. Animals that occur in the study area are adapted to an urban environment and able to co-exist with the level of human activity within most of the watershed. Common mammal species expected throughout the area include white-tailed deer (*Odocoileus virginianus*), eastern chipmunk (*Tamias striatus*), groundhog (*Marmota monax*), opossum (*Didelphis virginiana*), striped skunk (*Mephitis mephitis*), red fox (*Vulpes vulpes*), eastern cottontail (*Sylvilagus floridanus*), raccoon (*Procyon lotor*), big brown bat (*Eptesicus fuscus*), little brown bat (*Myotis lucifugis*), muskrat (*Ondatra zibethicus*), Norway rat (*Rattus norvegicus*), and the gray squirrel (*Sciurus carolinensis*). These species are also known throughout the rest of the State.

Several species of herptiles may also be found in riparian areas and areas of open water in the vicinity of the study area. Some of these include the common musk turtle (*Sternothaerus odoratus*), eastern box turtle (*Terrapene* c. *carolina*), painted turtle (*Chrysemys picta x*

marginata), snapping turtle (*Chelydra serpentina*), as well as the invasive red-eared slider (*Trachemys scripta elegans*). Northern water snakes (*Nerodia sipedon sipedon*) are also common. Common frogs and toads throughout the area include the bull frog (*Lithobates cates-bianus*), green frog (*Lithobates clamitans*), wood frog (*Lithobates sylvaticus*), spring peeper (*Pseudacris crucifer*), American toad (*Anaxyrus americanus*), and Fowler's toad (*Anaxyrus fowleri*). Snakes that may be found in grassy or forested areas include the Eastern garter snake (*Thamnophis sirtalis sirtalis*) and northern brown snake (*Storeria dekayi dekayi*).

A much wider diversity of species exists in undeveloped riparian and wetland areas throughout the watershed, especially downstream of the study area in the John Heinz NWR. Additional mammalian species found there include the American beaver (*Castor canadensis*), the American mink (*Neogale vison*), long-tailed weasel (*Neogale frenata*), meadow vole (*Microtus pennsylvanicus*), white-footed mouse (*Peromyscus leucopus*), meadow jumping mouse (*Zapus hudsonius*), and woodland vole (*Microtus pinetorum*). A few of the additional herptiles found in the refuge include the PA state-endangered, Southern coastal plain leopard frog (*Lithobates sphenocephalus utricularius*) and the northern red-bellied turtle (*Pseudemys rubriventris*).

The John Heinz NWR is an area of "Exceptional significance", as determined by the Pennsylvania Natural Heritage Inventory (PA NHI). The PA NHI identifies and maps areas that support species of concern (those considered rare, threatened or endangered at state or federal level), exemplary natural communities, and broad expanses of intact natural ecosystems that support important components of Pennsylvania's native species biodiversity (Pennsylvania Natural Heritage Program, 2011).

4.5.4 Protected Species

Several federal and state laws regulate work in areas where species that have been determined to be threatened, endangered, or of conservation concern may be present. Protected species in the vicinity of the study area are outlined below.

Federally Protected Species

Endangered Species Act
A query of the USFWS Information for Planning and Conservation (IPAC) database on July 25, 2023 indicates that one species federally listed as endangered, northern long-eared bat (*Myotis septentrionalis*) and one proposed endangered, tricolored bat (*Perimyotis subflavus*). The Pennsylvania Natural Diversity Inventory (PNDI) (PNDI-786856, dated August 14, 2023 indicates that there is no potential to impact these species. See Sub-Appendix A2 of the Environmental & Cultural Appendix for the IPAC and PNDI reports.

Additionally, the monarch butterfly (*Danaus plexippus*) is a candidate species that has the potential to occur in the project area. There are no Section 7 Endangered Species Act (ESA) consultation requirements for candidate species, but this species is being considered for listing under ESA.

Bald and Golden Eagle Protection Act
A bald eagle nest is known to occur downstream of the study area at the John Heinz NWR, within the 0.5% AEP floodplain of Darby Creek. Bald eagles and their nests are protected under the Bald and Golden Eagle Protection Act.

Migratory Bird Treaty Act
The IPAC database indicates 25 vulnerable migratory birds and birds of conservation concern (BCC) (subset of migratory birds) have the potential to occur in the study area (see Sub-Appendix A2 of the Environmental & Cultural Appendix. These include the following species:

- American Oystercatcher (*Haematopus palliatus*) BCC Rangewide (CON), Breeds Apr 15 to Aug 31
- Bald Eagle (*Haliaeetus leucocephalus*), Non-BCC Vulnerable, Breeds Oct 15 to Aug 31
- Black-billed Cuckoo (*Coccyzus erythropthalmus*), BCC Rangewide (CON), Breeds May 15 to Oct 10
- Black Skimmer (*Rynchops niger*) BCC Rangewide (CON), Breeds May 20 to Sep 15
- Blue-winged Warbler (*Vermivora pinus*), BCC – BCR, Breeds May 1 to Jun 30
- Bobolink (*Dolichonyx oryzivorus*), BCC Rangewide (CON), Breeds May 20 to Jul 31
- Canada Warbler (*Cardellina canadensis*), BCC Rangewide (CON), Breeds May 20 to Aug 10
- Cerulean Warbler (*Dendroica cerulea*), BCC Rangewide (CON), Breeds Apr 29 to Jul 20
- Chimney Swift (*Chaetura pelagica*), BCC Rangewide (CON), Breeds Mar 15 to Aug 25
- Eastern Whip-poor-will (*Antrostomus vociferus*), BCC Rangewide (CON), Breeds May 1 to Aug 20
- Golden Eagle (*Aquila chrysaetos*), Non-BCC Vulnerable, Breeds elsewhere
- Gull-billed Tern, (*Gelochelidon nilotica*), BCC Rangewide (CON), Breeds May 1 to Jul 31
- Hudsonian Godwit (*Limosa haemastica*), BCC Rangewide (CON), Breeds elsewhere
- Kentucky Warbler (*Oporornis formosus*), BCC Rangewide (CON), Breeds Apr 20 to Aug 20
- King Rail (*Rallus elegans*), BCC Rangewide (CON), Breeds May 1 to Sep 5
- Lesser Yellowlegs (*Tringa flavipes*), BCC Rangewide (CON), Breeds elsewhere
- Long-eared Owl (*Asio otus*), BCC Rangewide (CON), Breeds Mar 1 to Jul 15
- Prairie Warbler (*Dendroica discolor*), BCC Rangewide (CON), Breeds May 1 to Jul 31
- Prothonotary Warbler (*Protonotaria citrea*), BCC Rangewide (CON), Breeds Apr 1 to Jul 31

- Red-headed Woodpecker (*Melanerpes erythrocephalus*), BCC Rangewide (CON), Breeds May 10 to Sep 10
- Ruddy Turnstone (*Arenaria interpres morinella*), BCC – BCR, Breeds elsewhere
- Rusty Blackbird (*Euphagus carolinus*), BCC – BCR, Breeds elsewhere
- Short-billed Dowitcher (*Limnodromus griseus*), BCC Rangewide (CON), Breeds elsewhere
- Willet (*Tringa semipalmata*), BCC Rangewide (CON), Breeds Apr 20 to Aug 5
- Wood Thrush (*Hylocichla mustelina*), BCC Rangewide (CON), Breeds May 10 to Aug 31

Pennsylvania State Protected Species

Pennsylvania Fish and Boat Commission Aquatic species of Concern
A list of aquatic species of concern under the jurisdiction of PA Fish and Boat Commission (PAFBC) was provided during the scoping phase for this study. These aquatic species of concern include the following:

- Atlantic sturgeon, *Acipenser oxyrinchus* (Federal and PA Endangered),
- Hickory shad, *Alosa mediocris* (PA Endangered),
- American eel, *Anguilla rostrata* (Species of Greatest Conservation Need [SGCN]),
- American shad, *Alosa sapidissima* (SGCN),
- Blueback herring, *Alosa aestivalis* (SGCN), and
- Alewife, *Alosa pseudoharengus* (SGCN)
- Northern red-bellied cooter, *Pseudemys rubriventris*, PA Threatened

If necessary, surveys will be conducted to confirm the presence of the northern red-bellied cooter in the study area.

Pennsylvania Game Commission
Two Pennsylvania state listed bird species, the marsh wren (*Cistothorus palustris*, PA Special Concern Species) and the least bittern (*Ixobrychus exilis*, PA Endangered) and one plant species, waterhemp ragweed (*Amaranthus cannabinus*, Special Concern Species), have the potential to occur in the study area (PNDI-786856, May 8, 2023,).

Least bittern are small herons which are known to breed in the marshes of John Heinz NWR. Least bitterns migrate to the north where they nest in reeds and grasses of marshes (PGC 2023). Marsh wrens also breed in reeds and grasses of marshes. This habitat does not occur within the footprint of the TSP but is located nearby at the John Heinz NWR (NatureServe 2023).

Pennsylvania Department of Conservation and Natural Resources
Waterhemp ragweed is a herbaceous plant that grows in intertidal marshes, mudflats, and river shores. This plant flowers from mid-April through mid-May and fruits from June through early July. This plant has the potential to occur in the study area. Waterhemp ragweed is not expected to occur within the footprint of the TSP, which would not occur in intertidal marshes,

mudflats or river shores. The levee would be constructed within the banks of Cobbs Creek. The majority of the of the levee footprint would be in upland, which has been landscaped or heavily impacted by Japanese knotweed.

A long list of state-listed bird and plant species are located downstream of the study area within the floodplain of Darby Creek; these include:

State Listed Birds

- Northern harrier (*Circus cyaneus*), Threatened
- Peregrine falcon (*Falco peregrinus*), Threatened
- Least bittern (*Ixobrychus exilis*), Endangered
- Black-crowned night-heron (*Nycticorax nycticorax*), Endangered
- Marsh wren (*Cistothorus palustris*), Special Concern Species

State Listed Plants

- Waterhemp ragweed (*Amaranthus cannabinus*), Special Concern Species
- Three-awned grass (*Aristida dichotoma var. curtissii*), Special Concern Species
- Swamp beggar-ticks (*Bidens bidentoides*), Threatened (proposed Endangered)
- Beggar-ticks (*Bidens laevis*), Special Concern Species (proposed Endangered)
- Velvety panic-grass (*Dichanthelium scoparium*), Endangered
- Walter's barnyard-grass (*Echinochloa walteri*), Endangered
- Wrights spike rush (*Eleocharis obtusa var. peasei*) Endangered
- Little-spike spike-rush (*Eleocharis parvula*), Endangered
- Multiflowered mudplantain (*Heteranthera multiflora*), Endangered
- Forked rush (*Juncus dichotomus*), Endangered
- Bugleweed (*Lycopus rubellus*), Endangered
- Southern red oak (*Quercus falcata*), Endangered
- Willow oak (*Quercus phellos*), Endangered
- Long-lobed arrow-head (*Sagittaria calycina*), Endangered (proposed Special Concern Species)
- Subulate arrowhead (*Sagittaria subulate*), Special Concern Species
- River bulrush (*Schoenoplectus fluviatilis*), Special Concern Species
- Smith's *bulrush* (*Schoenoplectus smithii*), Endangered
- Wild senna (*Senna marilandica*), Special Concern Species
- Indian wild rice (*Zizania aquatica*), Special Concern Species

4.6 Cultural Resources

As a federal agency the USACE has certain responsibilities for the identification, protection and preservation of cultural resources that may be located within the Area of Potential Effect (APE) associated with the proposed Eastwick FRM feasibility study Present statutes and

regulations governing the identification, protection and preservation of these resources include the National Historic Preservation Act of 1966 (NHPA), as amended; the National Environmental Policy Act of 1969; Executive Order 11593; and the regulations implementing Section 106 of the NHPA (36 CFR Part 800). Significant cultural resources include any material remains of human activity eligible for inclusion on the National Register of Historic Places (NRHP). This work is done in coordination with the Pennsylvania State Historic Preservation Office (PASHPO), Tribal Nations and other consulting parties.

Conduct of a historic preservation analysis in accordance with the National Historic Preservation Act of 1966, as amended by USACE NAP indicated a No Effect determination. This determination was made with PASHPO concurrence. As a result, there was no Phase IA or any need to develop a Programmatic Agreement.

The FRM study area includes much of the Eastwick Neighborhood along Darby and Cobbs Creeks. This area was identified in a Federal Interest Determination (FID) document prepared by the USACE in 2018 titled "Eastwick, Philadelphia County, Pennsylvania Continuing Authorities Program (Section 205) Flood Risk Management (P2# 451948)". The USACE concluded that there are feasible opportunities to address flooding in the Eastwick Neighborhood. The feasibility study investigated several alternatives to address the problems and needs related to flooding in the study area.

Area of Potential Effect
The USACE has determined that the proposed undertaking will have No Effect on historic properties eligible for or listed on the National Register of Historic Places (NRHP) in compliance with 36 CFR 800.4(d)(1). The PASHPO, in their correspondence dated November 2, 2020, are in concurrence with this determination.

Previous Investigations
A previous investigation assessed most of the APE for the levee/floodwall alternatives and provides the historic context relevant to the study. The report is entitled, *Phase I Archaeological Survey Report, Remedial Investigation and Feasibility Study, Lower Darby Creek Area Site, Operable Unit 1 – Clearview Landfill, Delaware and Philadelphia Counties, Pennsylvania* prepared for the US Environmental Protection Agency by TetraTech NUS, Inc. and dated March 2011.

Another investigation that provides relevant information regarding the study area and existing cultural resources is entitled, *Phase IA Archaeological Assessment of Cobbs Creek Watershed Habitat Improvement Project, Philadelphia County, Pennsylvania* prepared for the USACE by Greenhorne & O'Mara Consulting Engineers dated July 2010.

Temporal Context

An extensive temporal context can be found in the Phase I Archaeological Survey Report for the Clearview Landfill referenced above. A copy of the report can be found in the Sub-Appendix A3 in the Environmental & Cultural Resources Appendix.

4.7 Parks and Recreation

Eastwick Park & Regional Playground are located within the study area and have been subject to flooding. The park includes tennis courts, slides, a jungle gym, a pickleball court and a shaded picnic area. The park also includes Eastwick Recreation Center. Upgrades to the playground facilities were completed in 2022, with a ribbon cutting ceremony in September. Interior work remains needed in the recreation center.

4.8 Noise

The study area experiences moderate background noise due to its proximity to major transportation hubs and industrial facilities. Some sources of background noise include air traffic associated with the Philadelphia Airport (about 1-1.5 miles away), multiple train lines, an interstate highway, and nearby industrial activity. Capping and planting of the adjoining Lower Darby Creek Area Superfund Site (Clearview Landfill) generates construction noise; Scheduled completion is in December 2023.

4.9 Hazardous, Toxic and Radioactive Waste (HTRW)

The Clearview Landfill is located within the study area to the east of Darby and Cobbs Creeks and to the southwest of Eastwick Park (Figure 2.1). The landfill operated from the 1950s to the 1970s and was added to the USEPA Superfund program's National Priorities List (NPL) in 2001.

From November 2011 to September 2012, USEPA conducted a Time-Critical Removal Action near the Southern Industrial Area (SIA) portion of the landfill, to remove high levels of polychlorinated biphenyls (PCBs). Almost 4,000 tons of PCB waste were excavated and shipped to another facility for disposal.

In 2014, USEPA selected the final cleanup plan for the Clearview Landfill – Operable Unit 1 (OU1). OU1 includes the contaminated soil, waste, and shallow leachate (liquid coming out of the landfill). The plan calls for constructing an evapotranspiration (ET) cover over approximately 50 acres to contain landfill waste and contaminants; excavating contaminated soils outside the existing cover and placing them under the new ET cover; and collecting and treating leachate.

The ET cover system selected for the site was designed to: (1) minimize the amount of precipitation into the waste mass, thereby reducing the amount of leachate produced; (2) reduce the potential for physical contact with the waste and contaminated soil; and (3) reduce the potential for exposure of the waste due to erosion and off-site migration of contaminants.

The cover consists of foundation and soil cover layers for a total thickness of up to 4 feet and densely planted trees. The existing landfill surface will be re-graded to prepare a compacted foundation layer during interim grading. To complete the ET cover, another soil cover layer will be placed over the foundation layer during final grading.

Additionally, the ET cover is designed to extend beyond the Landfill to cover contaminated soil and waste as much as practical. Some areas with contaminated soil or waste cannot be covered with a thick ET cover because they are within a 100-year floodplain, in close proximity to the residential properties, or underlain with saturated waste at depths below the groundwater table. For these areas and portions of the city park, the top 2 feet of surface soils are excavated, backfilled with clean soil to the grade to prevent exposure to potentially contaminated material, and planted with select species of grasses, trees, and shrubs, depending on their respective planned land use.

Between September 2016 and June 2017, USEPA conducted an additional Time-Critical Removal Action on residential properties to remove soil contaminated with polycyclic aromatic hydrocarbons (PAHs) that posed a health threat. USEPA cleaned up 33 residential properties and removed almost 3,000 cubic yards of contaminated soil. After the Time-Critical Removal Action for the residential properties was completed, additional residential properties remained which required cleanup; however, these properties did not qualify for the Removal Action.

In August 2017, USEPA began a new Superfund cleanup for OU1. This cleanup is referred to as the Remedial Action. The first step of the OU1 Remedial Action was to continue addressing residential yards in the Eastwick neighborhood that had contaminated soil related to the Clearview Landfill. According to USEPA, as of April 2020, 162 residential property parcels have been cleaned up as part of this action. Approximately 15 parcels remain that require remediation.

In early 2019, Remedial Action activities were initiated at the Clearview Landfill site. These activities included: the permanent relocation of businesses on the landfill, removal of contaminated soil from the City Park, construction of a new forested cover over the landfill waste, and stabilization of the streambanks.

Following the relocation of the businesses, the buildings and above ground structures were demolished and removed from the site. Some concrete pads that were once associated with the buildings have been designated to remain to serve as staging areas for future operation and maintenance (O&M) purposes.

Remedial action construction activities at the landfill have recently been completed as of July 2023.

4.10 Socioeconomics

Listed below in Table 4-2 are relevant demographic and socioeconomic data for Eastwick, PA. As Eastwick is a neighborhood encapsulated by the City of Philadelphia, demographics

and socioeconomic data is represented using results for ZIP Code Tabulation Area (ZCTA5) 19153. For comparison, relevant data is shown alongside results for the State of Pennsylvania and for the United States as a whole. Additional information can be found in the Economics Appendix.

Table 4-2: Eastwick (ZCTA5 19153) Demographics

Category	Eastwick (PA) ZCTA5 19153	Pennsylvania	United States
Population	12,909	13,002,700	331,449,281
Persons Age 65 year or Over	16.4%	19.0%	16.8%
High School Graduate or Higher	78.1%	91.0%	88.5%
Bachelor's Degree or Higher	21.4%	32.3%	32.9%
Persons with a Disability (Under 65 Years)	11.3%	9.8%	8.7%
Median Household Income (2020 Dollars)	$54,485	$63,627	$64,994
Persons in Poverty	19.0%	12.1%	11.6%

Racial Demographics	Eastwick (PA) ZCTA5 19153	Pennsylvania	United States
White	11.9%	81.0%	75.8%
Black or African American	75.1%	12.2%	13.6%
American Indian or Native Alaskan	0.1%	0.4%	1.3%
Asian	5.0%	3.9%	6.1%
Native Hawaiian or Pacific Islander	0.0%	0.1%	0.3%
Other Race	0.9%	0.1%	0.0%
Two or More Races	6.9%	2.3%	2.9%

The neighborhood of Eastwick, PA, as represented by ZCTA5 19153, has a population of 12,909 according to the 2020 U.S. Census. As the neighborhood boundaries slightly eclipse the boundaries of ZCTA5 19153, the true population may be slightly larger, but the relevant percentages for demographic and racial data would not be expected to change.

In terms of vulnerable population, Eastwick has a percentage of persons age 65+ that is approximately in line with the greater United States and lower than the State of Pennsylvania. However, the percentage of persons with a disability is higher than both state and national averages.

In terms of education, Eastwick also lags behind both state and national averages for percentage of persons acquiring High School graduation (or equivalency) and for acquiring a bachelor's degree or higher. The decline in educational opportunities results in similarly depressed median household incomes and an increase in poverty.

For racial demographics, Eastwick is a primarily Black or African American community with over 75% of the population. This is well above the state average of 12.2% and the national average of 13.6%.

In summary, based on socioeconomic and demographics data gathered from the 2020 U.S. Census, the neighborhood of Eastwick, PA would be characterized as an underserviced and vulnerable community.

4.11 Visual and Aesthetic Values

The existing visual and aesthetic values within the study area are typical of an urban neighborhood. The study area is in an urban residential area containing multiple schools, recreational facilities, religious institutions, and several commercial businesses. The Lower Darby Creek Area Superfund Site (Clearview Landfill) is located west of the neighborhood and east of Darby and Cobbs Creeks. The landfill represents topographic relief in the neighborhood. As of 2023, the landfill cap was being completed and has recently been densely planted with trees. The study area has unique visual value in that it is located along a creek and associated riparian corridor. The creek, adjacent fringes of woodland, and public park areas provide aesthetic value as natural, open space. John Heinz NWR is in the southern part of the study area and is highly valued for its natural beauty as a diverse mix of aquatic, riparian, woodland, and meadow habitats.

5.0 Future Without Project Conditions

The Future Without Project Condition is based on hydrologic and hydraulic considerations (WSE, tidal influence, flood events), economics and environmental resources.

5.1 Future Without Project Economic Conditions

The FWOP Average Annual Damages (AAD) are $15,432,000 while the FWP AAD are $10,906,000 resulting in a Reduced AAD of $4,526,000.

5.2 Future Without Project Hydrology and Hydraulic Conditions

5.2.1 Flood Damage Analysis

At the current level of study, hydraulic analysis of future conditions includes existing conditions with an increased starting WSE at Year 50 to represent intermediate sea level rise. Additional work is needed to determine the impacts of compound flooding (i.e., if high rainfall and high storm surge occur at the same time), to be completed in later phases. USACE guidance on the issue of compound flooding is still in development. (Also note that the hydraulic 50-year period of analysis is 2025-2075 while the economics 50-year period of analysis is 2030-2080). This discrepancy in the period of analysis timeframes will be addressed prior to the Final IFR/EA to use a consistent period of analysis of 2030-2080). Tidal boundary condition increases from SLC for future conditions result in minor differences from Existing Conditions, with differences dissipating downstream of the Hook Road (84th St.) Bridge.

5.2.2 Nonstationarity Detection Tool

This is an ongoing analysis, the results of which will be shared as they become available. Stationarity, or the assumption that the statistical characteristics of hydrologic time series data are constant through time, enables the use of well-accepted statistical methods in water resources planning and design in which future conditions rely primarily on the observed record. However, recent scientific evidence shows that—in some places, and for some impacts relevant to the operations of USACE—climate change and human modifications of the watersheds are undermining this fundamental assumption, resulting in nonstationarity. The Detection Tool enables the user to apply a series of statistical tests to assess the stationarity of annual instantaneous peak streamflow data series at any USGS streamflow gage site with more than 30 years of annual instantaneous peak streamflow records through Water Year 2014.

For this study, two gages were assessed with the NDT tool: *USGS Gage 01475548 Cobbs Creek at Mt. Moriah Cemetery and USGS Gage 01475510 Darby Creek near Darby, PA.* Neither analysis detected strong non-stationarities in the observed record, and as such there is insufficient evidence to reject the null hypothesis of statistical stationarity at this site.

Results from the NDT are further discussed in Attachment 2 Climate Change Assessment in the Hydrology and Hydraulics Sub-Appendix.

5.2.3 Climate Hydrology Assessment Tool

This is an ongoing analysis, the results of which will be shared as they become available. USACE guidance for projected changes to climate hydrology and how these changes might affect water resources project planning, design, construction, operation and maintenance is found in Engineering and Construction Bulletin 2018-14 Rev 2, Guidance for Incorporating Climate Change Impacts to Inland Hydrology in Civil Works Studies, Designs, and Projects, released on August 19, 2022.

The qualitative analysis required by this ECB includes consideration of both past (observed) changes as well as potential future (projected) changes to relevant hydrologic inputs as part of a first-order statistical analysis of the potential impacts to particular hydrologic elements of the study. This analysis can be very useful in considering FWOP conditions and the potential direction of climate change. Examples of this type of analysis are provided in the Economics Appendix.

For the Darby Creek and Cobbs Creek stream segments of the Lower Delaware Watershed of the Delaware-Mid Atlantic Coastal Headwaters (HUC 0204), there is no statistically significant linear trend for the mean of projected annual maximum monthly streamflow between 2000 and 2099 (p-value = 0.09>0.05). Therefore, neither the projected hydrology data nor the observed peak flow data investigated on the mainstem of the Lower Delaware Watershed at Eastwick, PA have linear trends.

Results from the CHAT are further discussed in Attachment 2 Climate Change Assessment in the Hydrology and Hydraulics Sub-Appendix.

5.2.4 Sea Level Change

In accordance with USACE Engineering Regulation (ER) 1100-2-8162, potential effects of relative sea level change (RSLC) were analyzed over a 50-yr economic analysis period and a 100-yr planning horizon. Research by climate science experts predicts continued or accelerated climate change for the 21st century and possibly beyond, which would cause a continued or accelerated rise in global mean sea level. ER 1100-2-8162 states that planning studies will formulate alternatives over a range of possible future rates of SLC and consider how sensitive and adaptable the alternatives are to SLC. ER 1100-2-8162 requires that planning studies and engineering designs consider three future sea level change scenarios: low, intermediate, and high. The historic rate of SLC represents the “low” rate. The “intermediate” rate of SLC is estimated using the modified National Research Council (NRC) Curve I. The “high” rate of SLC is estimated using the modified NRC Curve III. The “high” rate exceeds the upper bounds of Intergovernmental Panel on Climate Change (IPCC) estimates from both 2001 and 2007 to accommodate the potential rapid loss of ice from Antarctica and Greenland, but it is within the range of values published in peer-reviewed articles since that time. For this feasibility study, the intermediate SLC curve was used. Future Without Project tidal conditions are reported in Table 5-1, projected to the year 2075, and shown in Figure 5-1.

SLC is further discussed in the Hydrology and Hydraulics Sub-Appendix.

Table 5-1: Sea Level Change (FWOP Conditions Highlighted in Blue)

	(MSL)	Datum in NAVD88 (Feet)					
Year/SLC Curve	1992	1992	2025 Int	2025 High	2075 Low	2075 Int	2075 High
Change in MSL from 1992, ft	0	0	**0.4**	0.61	0.76	**1.37**	3.31
Change in MSL from 2025 Int, ft	N/A	N/A	**N/A**	N/A	0.36	**0.97**	2.91
MHHW, ft	3.20	3.59	**3.99**	4.20	4.35	**4.96**	6.90
MHW, ft	2.80	3.19	**3.59**	3.80	3.95	**4.56**	6.50
MSL, ft	0.00	0.39	**0.79**	1.00	1.15	**1.76**	3.70
NAVD88, ft	-0.39	0.00	**0.40**	0.61	0.76	**1.37**	3.31
MLW, ft	-3.30	-2.91	**-2.51**	-2.30	-2.15	**-1.54**	0.40
MLLW, ft	-3.49	-3.10	**-2.70**	-2.49	-2.34	**-1.73**	0.21

8545240, Philadelphia, PA
NOAA's 2006 Published Rate: 0.00915 feet/yr

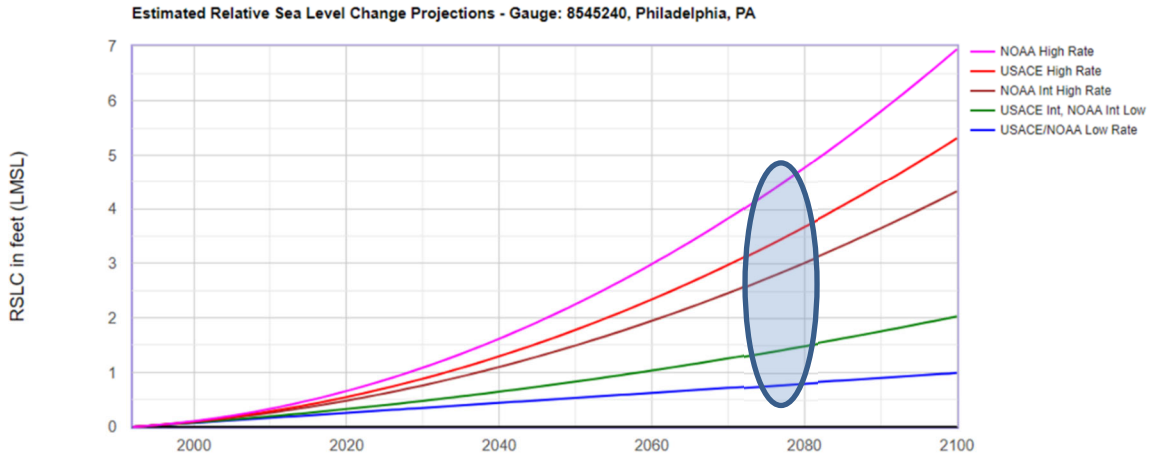


Figure 5-1: Sea Level Change for FWOP Conditions (2075, in blue circle)

5.2.5 Indicators for Flood Vulnerability Assessments

Vulnerability assessments are necessary to understand when and how changing conditions impact the performance, function, and reliability of our projects and programs. USACE has completed several activities associated with high level assessments of vulnerability to climate change. These include a preliminary assessment presented in USGS Circular 1331 and a high-level vulnerability analysis to climate change required by the Council on Environmental Quality. We are currently assessing vulnerability using a nationwide screening-level tool that is based on indicators related to hazard, exposure, and sensitivity. These indicators and their current use are described in a series of indicator fact sheets. These indicators will be updated periodically. This is an ongoing analysis, the results of which will be shared as they become available.

The Delaware River (HUC 0402) watershed is considered relatively vulnerable to climate change impacts for the flood risk reduction business line, being among the 20% most vulnerable watersheds for this business line in the CONUS (202 HUC04s). This is true for the dry scenarios and both the 2050 and 2085 epochs. Indicators used to compute the Flood

Risk Reduction WOWA score include: the acres of urban area within the 500-year floodplain, the coefficient of variation in cumulative annual flow, runoff elasticity (ratio of streamflow runoff change to precipitation change), and two indicators of flood magnification (indicator of how much high flows are projected to change over time), one of which includes contributions from upstream watersheds and the other focused only on the change in flood frequency within the watershed of interest. For the wet scenarios, the dominant indicator for the 2050 epoch is Urban Area, contributing 46% to the Delaware River watershed's vulnerability score. This indicator refers to the acres of urban area within the 500-year floodplain. For the 2085 epoch of the wet scenario, the dominant indicator is Flood Magnification, contributing 46% of the score. For the dry scenarios, the dominant indicator is Urban Area for both the 2050 and 2085 epochs, contributing 48% of the score for both.

Indicators for Flood Vulnerability are further discussed in Attachment 2 Climate Change Assessment in the Hydrology and Hydraulics Sub-Appendix.

5.2.6 Conclusion

Recent climate science literature is equivocal on observed trends in mean and extreme temperatures in this region but provides reasonable consensus that projected increases in extreme temperature events, including more frequent, longer, and more intense summer heat waves, can be expected in the long-term future compared to the recent past. Increases in precipitation have been both observed and projected for this region, though increased drought severity is also projected. As a result, projections of future stream flows are mixed and depend on the climate model and its assumptions. Observed trends in streamflow vary by season, but some evidence exists of increasing flows on average.

No strong nonstationarities or monotonic trends were detected at the closest gage upstream of the project for Cobbs Creek or for Darby Creek. Projections of runoff in the pre-2000 period show no significant trend, while projections post-2000 show a decreasing trend in the annual maximum monthly average runoff. This watershed is relatively vulnerable in the flood risk management business line compared to other CONUS watersheds, primarily due to the high population residing in the 500-year floodplain.

As indicated in Table 5-2, climate change has the potential to result in increased hazard to any constructed FRM measures at Eastwick. However, the residual risk due to climate change to the project is classified as low in both cases. The risk to the potential levee is low because the analysis presented here gives little evidence for increases in peak stream flows near term.

Table 5-2 - Residual Risk Due to Climate Change

Feature or Measure	Trigger	Hazard	Harm	Qualitative Likelihood
Levee	Higher river discharges	Flood frequency increase	More frequent overtopping of levee	Low; no significant trend in observations or consensus among projections

In the literature reviewed, a warmer and wetter climate is expected in the future. Air temperatures are expected to increase in the study region over the next century. The studies reviewed here generally agree on an increase in mean annual air temperature of approximately 2 to 5 degrees Celsius by the latter half of the 21st century for the Mid-Atlantic region. The literature also predicts projected increases in extreme temperature events, such as more intense summer heat waves. Projections of precipitation and hydrology in the study region are less certain than those associated with air temperature. However, the majority of the studies reviewed here project increases in precipitation and streamflow through the 21st century. Extreme high events (storms and floods) are projected to increase in the future. Low flows, however, have been projected to decrease in the future because of the projected temperature (and ET) increases.

However, the literature did not contain much consistency on how the hydrology within the project area could change. Analysis of projected annual maximum monthly streamflow data produces results consistent with the literature review findings (i.e., no statistically significant trends). The USACE VA Tool indicates that Flood Risk Reduction in the Delaware River (HUC 0402) watershed is more vulnerable to the impacts of climate change relative to other watersheds in the CONUS. This vulnerability is based on increasing flood flows (i.e., the monthly flow exceeded 10% of the time) and not the peak flows that drive FRM measures.

Although the risks to this project are identified as low, potential adaptation actions for climate-affected hydrology still exist. Potential adaptation actions to address project vulnerabilities include increasing height and level of protection of the levee, utilizing a floodwall at the crest. To be effective, this concept would first be extensively analyzed, designed, and coordinated across the system and its stakeholders to ensure effective risk management at downstream and upstream induced flooding locations, ensuring the project would not introduce unintended negative consequences.

5.3 Life Safety Risk

There is not a measurable life safety risk in the FWOP condition based on analyses of the population at risk, threatened population by water depth (0.01% AEP with 10% evacuation rate, non-breach life loss for the 0.01% AEP and incremental life loss for the 0.01% AEP and 10% evacuation rate). Additional information can be found in the Life Safety Analysis Sub-Appendix of the Engineering Appendix.

5.4 Environmental Future Without Project Condition

In the future without project condition, sea level would continue to rise in the study area. This would result in the transition/migration of wetlands in the study area (NOAA Sea Level Rise Viewer). In general, with a 1-foot increase in MHHW, there would generally be a transition of forested and shrub wetlands to unconsolidated shoreline and freshwater wetlands. These changes would be accompanied by changes in species composition and abundance.

6.0 Plan Formulation

The formulation approach used in this study is consistent with the national objectives as stated in the *Planning Guidance Notebook,* as well as the Corps *Planning Manual*. In general, FRM plans must contribute to the National Economic Development (NED) account consistent with protecting the Nation's environment, pursuant to national environmental statutes, applicable executive orders and other Federal planning requirements. Plans to address the needs in the study area must be formulated to provide a complete, effective, efficient, and acceptable plan for FRM.

Completeness is defined as *"the extent to which the alternative plans provide and account for all necessary investments or other actions to ensure the realization of the planning objectives, including actions by other Federal and non-Federal entities."*

Effectiveness is defined as *"the extent to which the alternative plans contribute to achieve the planning objectives."*

Efficiency is defined as *"the extent to which an alternative plan is the most cost effective means achieving the objectives."*

Acceptability is defined as *"the extent to which the alternative plans are acceptable in terms of applicable laws, regulations and public policies."*

Taken as a whole, the plan formulation approach recognizes the need to balance FRM with other social and environmental needs within the study area. In addition to the no action alternative, as represented by the future without-project condition, other options are considered.

6.1 Problems and Opportunities*

6.1.1 General Problem Statement

The Eastwick neighborhood of Philadelphia has a problem with flooding of structures, primarily residential, from Cobbs Creek during high streamflow events. Flooding especially occurs between 78th and 82nd Streets, from the creek to Chelwynde Avenue. An additional study problem is poor drainage associated with the historical filling activities.

Eastwick has a long history of impacts from storm events, most recently from Hurricane Isaias, including damaged homes, unnavigable roads, disrupted utilities, and negative impacts to health and safety. These events result in serious impacts to economic opportunities, social resiliency, and life safety.

Further, the community is vulnerable to flooding from different sources of water. Historically the flooding that Eastwick has experienced comes from riverine flooding from the Darby & Cobbs creeks which is the focus of the USACE Study. With climate change, we anticipate that flooding could get worse in Eastwick due to the increasing intensity of storms and possibly sea level rise. Flooding in Eastwick is very complex and will require a multi-pronged solution incorporating the efforts of different agencies to address the multiple

sources of flooding (Figure 6-1). Additionally, Figure 6-2 and Figure 6-3 show some photographs of flooding in several Eastwick neighborhoods.

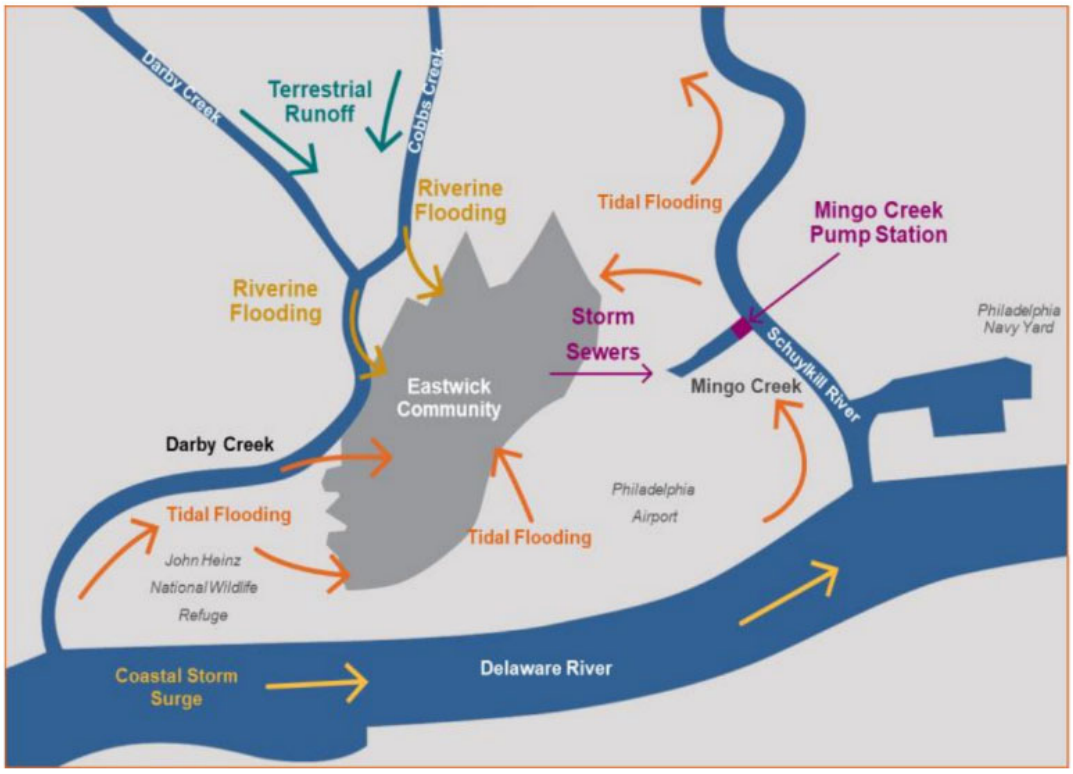


Figure 6-1. Overview of flooding sources in the vicinity of the Eastwick neighborhood.

Figure 6-2: 7913 Buist Avenue, Hurricane Floyd Flooding

Figure 6-3: Caesar Pl. & Chelwynde Ave., Amid/Post Hurricane Floyd

6.1.2 Opportunity Statement

The aforementioned water resource problems in the study area provide an opportunity to implement FRM solutions to manage storm-related risks to people, property and infrastructure within the study area.

6.2 Planning Goal and Objective*

The goal of the Eastwick FRM study is to manage the study area's risk from flooding, while contributing to NED consistent with protecting the Nation's environment, in accordance with national environmental statutes, applicable executive orders, and other Federal planning requirements.

In support of this goal, the planning objective of this study is to manage flood risk to people, property and infrastructure associated with Cobbs Creek floodwaters flowing between the high elevation points of the Clearview Landfill and S. 78th Street into the Eastwick neighborhood study area between the years 2030 to 2080.

An additional planning objective may be to reduce residual flooding and potential induced flooding in the study area. This potential objective will be better defined after the concurrent review of the draft IFR/EA.

6.3 Planning Constraints

Clearview Landfill is located within the study area. Contaminated material remains in the landfill underneath an impervious cap installed by USEPA. Contaminated groundwater is also associated with the landfill. The proposed FRM alternatives will be developed to avoid contact and/or impact of existing HTRW within the study area.

An additional constraint considers that Eastwick Park playground structures and recreation center should remain accessible to residents after implementation of any FRM measures.

6.4 Identification & Evaluation of Potential Management Measures

The following measures were considered for evaluation in this Eastwick Study.

Structural measures include:

Levees: A levee is an earthen embankment built to manage risk associated with the overflow of a river.

Floodwalls: Floodwalls are vertical structures typically built of concrete or steel to manage risk associated with the overflow of a river.

Free-Standing Barriers: Free-standing barriers are scaled-down levees or floodwalls applied to individual facilities (such as wastewater treatment plants), designed to prevent floodwaters from reaching the portion of the facility located above grade. Such barriers are typically designed to provide FRM to the 1% AEP water level. An example of use of free-

standing barrier is a ringwall (with gates or walkovers for access) around a flood-prone facility.

Channel Modification: Channel modification involves widening, deepening or straightening of existing channels, creation of new channels, and the modification of highway and railroad bridges that constrict the channel.

Flow Detention: A typical form of flow detention, known as a detention basin, is used to attenuate the peak flow rate of run-off by temporarily storing large volumes of stormwater, then releasing them at a controlled rate of flow.

Nonstructural measures include:

Land Use and Regulatory Measures: Land use and regulatory measures are designed to direct the location and nature of new development and redevelopment to manage risks from flooding and other hazards. The measures include: zoning and land use controls, new infrastructure controls, and landform /habitat regulation, construction standards and practices, insurance program modifications, and tax incentives.

Building Retrofit Measures: Building retrofit measures include structure relocation, structure elevation, structure rebuilding, free-standing barriers, wet floodproofing, dry floodproofing, and utilities protection.

Building retrofit measures are designed to manage risk to property from floodwaters by preventing the water from entering a structure, moving the structure out of flood prone areas, elevating the structure above flood elevations, or modifying the structure so that designated portions (e.g., lower floors or basements) are designed to flood without incurring damage. All exterior losses such as damage to grounds, utilities, roads, crops, etc., would be fully sustained in the future.

Retrofit measures are effective in managing flood risks to existing development. While many of these measures, such as elevation, are effective in managing risks to future development, these may also be implemented for that purpose through regulatory programs and construction standards aimed at new construction. To provide timely FRM for existing development requires physical changes or retrofits to the at-risk properties.

Land or Structure Acquisition Measures: Buyouts (acquisitions) required as part of a structural plan are not typically thought of in the category of nonstructural measures. This type of acquisition is considered a part of what is known as Land, Easement, Rights-of-Way, Relocation, and Disposal Areas (LERRD) and must be paid 100% by the non-Federal sponsor, with cost credit toward their share of the overall project cost.

On the other hand, the nonstructural measure involving purchase of property is the public acquisition of private developed or undeveloped lands vulnerable to flooding for long-term protection and preservation. Purchase of developed lands requires purchase and removal of buildings. A requirement is the preparation of a plan for the alternate use of the land, which may include recreation or open space uses.

Easements allow owners to retain full ownership of property but can either restrict certain uses or permit the use of land by the public or particular entities for specified purposes. Easements are generally established as part of the deed restrictions. For purposes of FRM, easements may restrict development of flood prone portions of property or could be used to create flowage areas where floodwaters are directed en route to waterbodies or detention basins.

Land acquisition may be used to purchase natural lands or flood-prone buildings. Land acquisition could be accomplished in a variety of ways, including donation with tax benefits, full fee acquisition, purchase of redevelopment rights, and combining acquisition with leases.

6.4.1 Evaluation Criteria

Where applicable, the evaluation of measures and alternatives was structured to mirror the current *Federal Principles and Guidelines for Water Resource Implementation Studies (P&G)* assessment criteria that any plan must be complete, effective, efficient and acceptable. The following specific criteria were used to help establish completeness, effectiveness, efficiency and acceptability:

- Reductions in flood damages
- Cost of implementation
- Potential for induced flooding
- Unavoidable impacts and significant environmental mitigation requirements
- Potential impacts to Federally listed threatened and endangered species
- Compliance with Federal and State regulations

Structural and nonstructural measures to be eliminated from further evaluation were identified, as well as those measures that are recommended for further evaluation in the next stages of the planning process.

A management measure is a feature or an activity that can be implemented at a specific geographic site to address one or more planning objectives. Management measures are the building blocks of alternative plans and are categorized as structural and nonstructural. Equal consideration has been given to these two categories of measures during the planning process.

An alternative plan consists of a system of structural and/or nonstructural measures, strategies, or programs formulated functioning together to meet, fully or partially, the identified study planning objectives subject to the planning constraints.

Alternatives are then developed further to create alternative plans. The measures identified to be carried forward in this FRM feasibility study were considered further to identify potential specific alternatives. The formulation of alternative plans is based upon engineering, economic, cost and environmental factors which are discussed in more detail in this section. An array of alternative plans was identified and through a series of iterations a TSP is justified based on the aforementioned analyses.

The results of the identification and evaluation of potential management measures discussed in this chapter indicate that two USACE FRM measures including: 1) a levee along with associated interior drainage features, and; 2) structure acquisition were identified as potential measures for further evaluation in Section 6.5 Alternative Plan Evaluation.

6.4.2 Outcome of the Screening - Structural Measures

The overall outcome of the screening of structural measures was that only the levee measure was identified for further alternative screening.

The selection of the levee as the structural measure for further comparison as an alternative plan is based on the analysis provided in Table 6-1: Evaluation of Structural Measures and the following text in this section.

Table 6-1: Evaluation of Structural Measures

Structural Measures	Evaluation Criteria			
	Completeness	Effectiveness	Efficiency	Acceptability
Local Protection				
Floodwall	May require mitigation for natural resource impacts, will likely require interior drainage modifications. Flood warning is critical for operation of any closure structures.	May be effective to the design height when accompanied by requisite features such as interior drainage.	Lower BCR associated with the floodwall than other alternatives.	Potentially acceptable, although a floodwall would create more of a physical barrier than a levee. A floodwall may cause induced flooding and may not be cost-effective due to likely contact with contaminants and need for stabilization in areas of softer material.
Levee	A levee is a partial solution (under the 205 authority) that is consistent with other local, state and Federal efforts to provide comprehensive FRM to the study area. Also, a levee may require mitigation for natural resource impacts, will likely require interior drainage modifications. Flood Warning is critical for operation of any closure structures.	May be effective to the design height when accompanied by requisite features such as interior drainage.	Cost effective based on current price levels and associated BCR and net benefit calculations.	A levee may cause induced flooding.

Free-Standing Barriers	Downstream impact of induced flooding must be evaluated; also whether any rise in floodway elevation will occur. Access must be designed according to building purpose (e.g., school or municipal office). Seepage analysis must be conducted. Requirements for interior drainage must be evaluated. Not applicable to most of the structures in the study area.	Flood risk management for building structure and contents is effective to the design depth, which is limited by hydrostatic pressure and site constraints. Does not reduce general flooding in area or municipal clean-up and general recovery costs (e.g., removal of vegetative flood debris and infrastructure repair).	Cost-effective for higher value facilities, such as wastewater treatment plants or schools. Depends on frequency and depth of flooding.	Adjacent or downstream property owners may object to displaced flooding affecting their property.
Area Protection				
Channel Modification	Would require mitigation for natural resource impacts.	Not likely to sufficiently address flooding.	Not likely to be cost-effective because major infrastructure changes would be involved.	Channel modification is not likely to be acceptable due to environmental impacts and inefficiency.
Flow Detention	Not likely to be feasible due to lack of sufficient naturally low lying, ponding, area where there is room to increase the footprint of the ponded area. If used, would also likely require additional flood risk management measures downstream.	Not likely to sufficiently address flooding.	Not likely to be cost-effective given the probable need for complementary measures.	Any structures would be located outside the existing study area and not likely to be acceptable. There would be significant environmental impacts.

6.4.2.1 Levees and Floodwalls

Levees and floodwalls are effective FRM measures in the following circumstances:

1. Damageable property is clustered geographically.
2. A high degree of risk management, with little residual damage, is desired.
3. A variety of properties, including infrastructure, structures, contents, and agricultural property require risk management.
4. Sufficient real estate is available for levee construction at reasonable economic, environmental, and social costs.
5. The economic value of damageable property protected will justify the cost of constructing the new or enhanced levee and floodwalls.

In addition, residents must be amenable to any visual effects associated with installation of a permanent levee or floodwall as these structures can block some, or all, of the view of the river, or otherwise reduce access.

In the Eastwick study area, the damageable property of residential structures and infrastructure is clustered together and a high degree of risk management is desired. The presence of the Clearview Landfill makes the design process challenging, but engineeringly feasible.

In general, floodwalls and levees function within the limits of their design to confine flood flows to the existing channel footprint and designated floodplain, prevent breakout of floodwaters, and provide FRM. Interior drainage facilities are often required to handle stormwater that ponds behind the barriers. Levees and floodwalls can be combined with closure structures, such as stoplog closures and gate closures. Levees are earthen embankments, whereas permanent floodwalls are usually built out of concrete or sheet pile, and temporary floodwalls can be constructed out of a variety of materials. Permanently installed, deployable flood barriers can also be used. These barriers can be constructed to deploy automatically when floodwaters reach the structure, using hydrostatic pressure to raise the barrier into place.

Levees: A levee in Eastwick has the potential to provide significant FRM in Eastwick. There is potential for induced flooding in other areas due to reduction of the floodplain in the study area. A cutoff wall would be needed within the levee, but it could be driven into the ground while protecting construction workers from contamination in the ground and groundwater. A levee would create change in the visual setting for residents in adjacent properties. The view would change from a flat park extending to Cobbs Creek to a grassy mound. Physical access to the other side of the levee could be achieved by walking over the levee. Physical access could be improved by inclusion of an accessible path over the levee and a walkway along the top.

The potential for significant FRM while maintaining community cohesion and access to Cobbs Creek resulted in a levee being carried forward for further consideration as part of this Federal study.

Floodwalls: A floodwall could provide significant FRM in Eastwick. As with a levee, there is potential for induced flooding in other areas due to reduction of the floodplain in the study area. Compared to the grassy slope of a levee, a floodwall would likely be a concrete wall. Treatment of the concrete with color and/or pattern could mitigate some of the aesthetic impact. A floodwall would serve as a much greater physical barrier to pedestrians than a levee; it would be impassible throughout the length of the floodwall, except for potentially at the northern and southern tie-in segments. The depth of excavation needed for a floodwall which is deeper than for a levee may result exposing contaminated material or groundwater which is likely located under the 2 to 4 ft of clean soils on the surface. When excavating at the southern end of the alignment near/in the landfill, the chance of encountering contaminated material gets higher. Encountering contamination could interrupt the construction schedule to remove material. Pilings/foundation treatment would be needed in softer areas.

In summary, a floodwall was screened out from further consideration due to the following considerations:

1. Cost and overall effectiveness of the levee rather than a floodwall as a flood risk management alternative.
2. A floodwall creates more of a barrier to pedestrians than a levee and thus effects aesthetic values. Plus the community-side of the levee would be grass covered partially as a result of aesthetic qualities.
3. While a floodwall could provide closure structures or sealable access doors or crossover stairs to provide access to pedestrians, trails and pathways could be constructed at some locations of the levee

6.4.2.2 Free-Standing Barriers:

Free-Standing Barriers would not be compatible with the rowhouses that make up much of the study area and would not address the overall flooding problem. Owners of individual stand-alone facilities and the City of Philadelphia might want to consider whether there are locations where free-standing barriers would be appropriate.

6.4.2.3 Channel Modification

Several locations of channel modifications were evaluated to determine their effectiveness in reducing the WSELs for flooding events. As shown in Figure 6-4, four areas of channel modification were considered, labeled LS1, LS2, RS3, and RS4. Modifications LS1, LS2 and RS3 include excavated benches into the flood plain. At each cross-section, the bench elevation was set at the 5% AEP WSEL to avoid impacts to the channel morphology. The lateral excavation limits (black lines) were set at the maximum practical distance from Darby Creek without affecting existing infrastructure. The existing overbank of RS4 is low lying ground not suitable for excavation. However, the land is impacted by high resistance Japanese knotweed and it was assumed to be replaced with low resistance short grass. The aim was to determine the maximum possible stage reduction of reducing the vegetal resistance in reach RS4. In addition, the 84th Street bridge was removed from the hydraulic model as an option.

Figure 6-4: Overview of Channel Modifications

The five modifications were analyzed in combination. Only the 5% AEP and 1% AEP results are provided in Table 6-2 for they allow an accurate, preliminary assessment of each option.

Table 6-2: Eastwick Overbank Modification Alternatives

Option		5% AEP Water Surface Elevation (ft-NAVD88)		
Label	**Description**	**X-25997**	**X-26372**	**X-579**
1	No Overbank Mods and No Levee	13.92	14.57	18.5
2	LS1 + LS2 + New Bridge +RS3+RS4 – No levee	13.58	13.58	16.98
Option		**1% AEP Water Surface Elevation (ft-NAVD88)**		
Label	**Description**	**X-25997**	**X-26372**	**X-579**
1	No Overbank Mods and No Levee	15.64	16.15	20.97
2	LS1 + LS2 + New Bridge +RS3+RS4 – No levee	15.48	15.48	19.36

A comparison of lines 1 and 2 for each return period shows the WSEL reductions if all practical downstream modifications are combined. While the downstream modifications reduce the WSELs, the WSELs on Cobbs Creek at the diversion point are still high enough to cause major damage in Eastwick. For example, the 1% AEP WSEL at X-579 of +19.36 ft (NAVD88) is approximately the same WSEL of the 1999 Floyd event, which caused extensive damage.

Given the residual flooding that would occur with channel modifications, they were removed from further consideration for FRM in Eastwick.

6.4.2.4 Flow Detention

Environmental impacts of detention basins would be significant at Eastwick. Potential downstream negative effects could include changes in the quality of water flowing out of the reservoir behind the dam and changes in downstream water temperatures. Downstream riparian areas that are dependent on overbank flows for recharge would probably experience reductions in size. Economic justification would be highly unlikely for alternatives that rely on detention basins. In a highly developed area, such as the study area and the upstream area where flow would be detained, there would not likely be a naturally low lying, ponding area where there is room to increase the footprint of the ponded area. For the above reasons, flow detention was eliminated from further consideration.

6.4.3 Outcome of the Screening - Nonstructural Measures

The overall outcome of the screening of nonstructural measures was that only the acquisition of structures was identified for further alternative screening.

This section includes a summary of the outcome of the screening analysis for nonstructural measures.

6.4.3.1 Land Use and Regulatory Measures

Land use and regulatory measures are generally appropriate for reducing damage to future development. They may also be effective in reducing future damages by regulating redevelopment, expansion, or reconstruction of existing buildings. However, in areas that are near full development, these measures are not effective in managing the existing hazard. Some measures, such as tax incentives, may be effective in supporting other efforts, such as retrofitting existing properties to reduce flood damages. The following provides a brief review of the applicability of specific land use and regulatory measures to the Eastwick FRM Study:

Zoning and Land Use Controls: Because the USACE has no authority to control land use and zoning, this measure is only recommended for further assessment as part of the non-Federal Flood Risk Management Plan (FPMP).

New Infrastructure Controls and Landform/Habitat Regulations: Because the USACE has no authority to implement new infrastructure controls or landform/habitat regulations, these measures are only recommended for further assessment as part of the non-Federal FPMP.

Construction Standards and Practices: The USACE does not typically have authority to enact community-level regulations. Thus, these measures should be included in other Federal agencies' risk management plans, and as part of the non-Federal FPMP.

Insurance Program Modifications: An assessment of the potential for insurance program modifications has not identified any authority to make changes as part of the study.

Tax Incentives: Changes in the Federal income tax code cannot be implemented as part of the current study. None of the additional tax-based measures are implementable by the USACE and are therefore only recommended as part of the non-Federal FPMP.

6.4.3.2 Building Retrofit Measures

Building retrofit measures include structure relocation, structure elevation, structure rebuilding, free-standing barriers, wet floodproofing, dry floodproofing, and utilities protection. The following provides a brief review of the applicability of specific building retrofit measures to the Eastwick FRM Study:

Structure Relocation: Structure relocation involves physically moving a structure to a different location out of a floodplain. Under some circumstances, this could include moving the structure to another location on the same lot.

Most of the structures experiencing the worst of the flooding in the study area are rowhouses, which are not compatible with structure relocation. Relocation of the limited number of freestanding structures would not address the overall flooding problem and would not be necessary if a broader FRM alternative is implemented. Because of the limited benefit of structure relocation, it was removed from further consideration.

Structure Elevation: Structure elevation involves raising the height of the finished first floor of a building above flood levels. Elevation of existing structures was screened out due to engineering constraints and other concerns. Piles would need to be driven under elevated homes but could not be by machinery located under homes elevated on cribbing. The structures would need to be moved out of the way, but there is limited space to move them. The overall process would potentially result in multiple cracks in the structures, especially in rowhouses. Residents would have to temporarily move out of their homes. Flooding of the area would still occur, with damage to vehicles, infrastructure, and other assets, as well as still necessitating evacuation of the area. Overall, residual risk associated with structure elevation would be quite high. Owners of the limited number of free-standing structures may want to consider whether they want to use elevation as an FRM measure. Engineering issues associated with elevating the majority of the structures with significant flooding eliminated this measure from further consideration within this study.

Structure Rebuilding: Structure rebuilding would involve removal of a structure and rebuilding it in place in conformance with Federal and local floodplain management requirements. This most often occurs with substantially damaged structures. The approach is typically only cost-effective for structures in poor condition and/or having a specialized function incompatible with other nonstructural techniques. Most structures in the study area are in relatively good shape and past flood damage has been addressed by homeowners. Rebuilding of a rowhouse, such as those in the study area, could render it incompatible with adjacent structures. Individual homeowners or the local government could consider implementing structure rebuilding where applicable. It was removed from further consideration in this study given its limited potential applicability and the fact that it would not address the larger issue of flooding.

Wet Floodproofing: Wet floodproofing allows floodwaters to enter a portion of a structure through use of vents or break-away wall panels. The floodwaters equalize internal and external hydrostatic pressure on the structure foundation. Wet floodproofing does not address issues associated with the force of flowing water, erosion, impact of debris, and the effect of any contaminants in the floodwater.

The portion of the structure that will be flooded is typically constructed or retrofitted with materials that will not be damaged by floodwaters. Use of wet floodproofing necessitates relocation or treatment of equipment, utilities and other contents that may be vulnerable to floodwaters. Wet floodproofing is inappropriate for areas used as living space. Within the study area several homes suffer flooding within space used for living. Other homes use the same space for a garage and/or basement, which would also necessitate relocation of vulnerable possessions.

Under FEMA's National Flood Insurance Program wet floodproofing is limited to enclosures below elevated residential and non-residential structures and to accessory and agricultural structures that have been issued variances by the community.

The limitations associated with wet floodproofing including wet floodproofing being resulted in it not being carried forward as part of a USACE FRM plan.

Dry Floodproofing: The high residual risk resulted in dry floodproofing not being carried forward as part of a USACE FROM plan. Individual homeowners may choose to implement the measure.

Utilities Protection: Utilities protection does not provide a comprehensive approach and was, thus, not carried forward as part of a USACE FRM plan. However, protection of utilities is generally a good idea and one that homeowners may want to engage in as part of their long-term flood preparation.

6.4.3.3 Land or Structure Acquisition Measures

The following provides a brief review of the applicability of specific land acquisition measures associated with the Eastwick FRM Study:

Structure Acquisition: As a nonstructural measure, a structure is bought by a public party and is no longer occupied. The structure is typically demolished, and the property reverted to open space, potentially for recreational use.

Applicability of the measure would be determined in part by first floor elevations. For the rowhouses in the study area, first floor elevations of a row of homes are often the same, so it is probable that a whole row would qualify for acquisition if one house does. Acquisition would be carried out by the City of Philadelphia as the NFS of the project. Per USACE policy, if acquisition is the recommended plan and it is decided that it will be implemented, then it must be mandatory and the non-Federal sponsor (the City in this case) needs to be willing and able to use eminent domain if necessary. The City would be responsible for obtaining all identified properties. The City would offer owners the approved appraised fair market value; the value would not change if eminent domain was used. Property owners would be eligible for Public Law 91-646 relocation benefits, as would tenants. Relocation benefits would be worked out in conjunction with property acquisition.

Acquiring and demolishing a flood-prone structure is the most successful means of ensuring that a structure will not experience losses from future flood events. However, property acquisition would mean that residents would be permanently displaced from their current homes, thus affecting community cohesion. Given the significant benefit of acquisition and the unclear status of its local acceptability as a FRM measure at the time of this screening, it was carried forward for further consideration as part of the Federally cost-shared plan and the non-Federal FPMP.

Purchase of Property: Purchase of property is the public acquisition of private developed or undeveloped lands vulnerable to flooding for long-term protection and preservation. Purchase of developed lands requires purchase and removal of buildings. A requirement is the preparation of a plan for the alternate use of the land, which may include recreation or open space uses.

Purchase of property can be an effective method of precluding future development and potential flood-related damage. However, any future development in the study area would be

subject to NFIP and local floodplain management regulations, and thus should be at limited risk to flood damage from the 1% AEP event. In addition, there would be no immediate NED benefit to the USACE in purchasing undeveloped lands. Thus, this technique was eliminated from further evaluation as part of the Federal FRM plan. However, if locals identify applicable properties, it may be appropriate for inclusion in the non-Federal FPMP or local plans, particularly if a suitable alternate use of the land could be identified.

Easements and Deed Restrictions: Easements allow owners to retain full ownership of property but can either restrict certain uses or permit the use of land by the public or particular entities for specified purposes. Easements are generally established as part of the deed restrictions. For purposes of FRM, easements may restrict development of floodprone portions of property, or could be used to create flowage areas where floodwaters are directed en route to waterbodies or detention basins.

Per USACE regulations, the non-Federal sponsor is typically required to obtain minimum easements for structural projects to ensure access to and maintenance of the FRM features.

Specific applications of this measure, such as prohibitions on parcel subdivision, are not covered under the USACE authority, and typically are exercised by local governments. A reduction in future damages may be realized by preventing intensification of development in flood-prone areas that would otherwise likely experience extensive construction in the future. This measure could be evaluated in conjunction with structural measures, both as part of a Federally cost-shared plan and as part of the FPMP.

Exchange of Property: This measure includes exchange of at-risk and/or environmentally sensitive undeveloped properties for comparable developable sites with reduced risk or sensitivity; the at-risk and/or sensitive properties become publicly owned and restricted from any future development.

Exchange of property and transfer of development rights measures were eliminated from further evaluation as part of the Federal FRM plan due to a lack of Federal authority. However, if the local community or the non-Federal sponsor were to acquire lands needed for the Federal project using such measures, they could potentially receive credit for the value of the property to offset their required cost-sharing obligations. These techniques would be appropriate for inclusion in the non-Federal FPMP. There is also a local effort to explore potential for exchange of existing developed property for property that would be newly developed.

The outcome of the screening process is based upon a general evaluation of nonstructural measures and there application as provided in detail in Table 6-3**,** Table 6-4 and Table 6-5 and the following text. A discussion is also provided regarding whether the measure was further evaluated as part of a potential Federal FRM project or not. These measures are grouped into the categories of land use and regulatory measures, building retrofit measures, and land acquisition measures. Land use and regulatory measures are not within the purview of USACE and are included for consideration by other governmental entities.

Table 6-3: General Evaluation of Nonstructural Measures (Land Use Regulatory)

Nonstructural Measures	Evaluation Criteria			
	Completeness	Effectiveness	Efficiency	Acceptability
Land Use/Regulatory				
Zoning/Land Use Controls	Limits new development/redevelopment in at-risk areas. Requires local adoption and enforcement of enhanced controls.	Technique would not reduce flood risk for existing structures; however, potentially very effective for new development. Less applicable in built-out areas, including most of the study area.	Reduces or eliminates future development in at-risk areas at relatively small costs.	Would require adoption at local level, beyond existing controls.
New Infrastructure Controls	May require secondary controls on new development that does not connect to municipal infrastructure.	Could limit or eliminate new construction in at-risk areas. Would not reduce flood risk for existing structures. Less applicable in built-out areas, including the study area.	Reduces municipal infrastructure spending (cost avoided), precludes development and thus risk in hazardous areas. Likely to lower property values in subject areas. Not applicable in the City of Philadelphia, where development is connected to local infrastructure.	May be challenged by property owners with buildable land in subject areas. May reduce or eliminate new growth, with effect on municipal tax base. May adversely affect property values in at-risk areas and be subject to legal challenge.
Landform/Habitat Regulations	Limits new development/redevelopment in at-risk areas. Requires local adoption and enforcement of enhanced controls.	Technique would not reduce flood risk for existing structures; however, potentially very effective for new development. May provide significant habitat	Restricts impacts to natural buffer areas, such as floodplains or riverbanks, which have risk management value. May lower property values.	May be challenged by property owners with buildable land in subject areas. May reduce or eliminate new growth, with effect on municipal tax base. May adversely affect

		protection. Less applicable in built-out areas.		property values in at-risk areas and be subject to legal challenge.

(Continued): General Evaluation of Nonstructural Measures (Land Use Regulatory)

Nonstructural Measures.	Evaluation Criteria			
	Completeness	Effectiveness	Efficiency	Acceptability
Construction Standards & Practices	Would require change in law and approval and adoption at local or state levels, as appropriate.	Would reduce risk of damage to new or redeveloped structures by mandating appropriate construction methods for relevant risks. Would not reduce flood risk for existing structures.	Can be very cost-effective for reducing risk to new or redeveloped structures. Small increase in construction costs can greatly reduce risk of future damage.	Increased costs of construction to meet standard may meet resistance.
Insurance Program Modifications	Requires change in authorizing legislation for NFIP (Act of Congress); not within authority of Corps to modify.	Could reduce new construction in at-risk locations, promote retrofit/relocation of repetitive loss properties. Not all at-risk properties are insured under NFIP.	Has not been evaluated; could work to reduce number of repetitive loss properties. May reduce construction and risk in flood hazard areas. Efficiency varies; some approaches may be a transfer payment and not a true NED benefit.	Increases in NFIP premiums (e.g., change to actuarial risk for pre-FIRM properties) likely to meet public resistance.
Tax Incentives	Would require change in law and approval and adoption at local, state, or Federal levels, as appropriate.	May promote retrofit of at-risk buildings or donation of at-risk property (e.g., for open space use).	Majority of land in study area floodplain is already developed; efficiency may be high for retrofit or future damages avoided through land donation.	If incentives are voluntary, likely to be accepted by property owners interested in land donation or structure retrofit.

Table 6-4: General Evaluation of Non-Structural Measures (Building Retrofits)

Nonstructural Measures	Evaluation Criteria			
	Completeness	**Effectiveness**	**Efficiency**	**Acceptability**
Building Retrofits				
Structure Relocation	New site and utility connections required. Existing site should be restored.	Removes building from floodplain and risk of damage. Does not reduce general flooding in area or municipal clean-up and general recovery costs (e.g., removal of vegetative flood debris and infrastructure repair). Would be impossible to achieve for rowhouses.	Depends on frequency of flooding; typically not cost-effective for structures that are damaged infrequently.	May have negative effect on community cohesion and character. Finding appropriate space in Philadelphia would be difficult, if possible. Negative effect on tax base if building is moved to different municipality.
Structure Elevation	May require variances under municipal height ordinance	Building structure and contents will not suffer damage during floods at or below design elevation. Does not reduce general flooding in area or municipal clean-up and general recovery costs (e.g., removal of vegetative flood debris and infrastructure repair). Piles couldn't be driven by machinery located under elevated homes, so the structures would have to be moved out of the way. There is limited space to move structures.	Depends on frequency of flooding and cost of elevation; typically not cost-effective for structures that are damaged infrequently.	May have negative visual effects on the structure or on neighborhood. Would be unacceptable as it is not structurally feasible.

Nonstructural Measures	Evaluation Criteria			
	Completeness	Effectiveness	Efficiency	Acceptability
		The overall process would likely result in multiple cracks in the structures. Residents would have to temporarily move out of the homes.		

(Continued): General Evaluation of Nonstructural Measures (Building Retrofits)

Nonstructural Measures	Completeness	Effectiveness	Efficiency	Acceptability
Structure Rebuilding	May require variances under municipal height ordinance if structure is rebuilt to the same number of stories as previous.	Building structure and contents will not suffer damage during floods at or below design elevation. Does not reduce general flooding in area or municipal clean-up and general recovery costs (e.g., removal of vegetative flood debris and infrastructure repair).	Depends on frequency of flooding; typically not cost-effective for structures that are damaged infrequently. Typically, only cost-effective for structures in poor condition and/or having a specialized function incompatible with other nonstructural techniques.	May have negative visual effects on neighborhood.

(Continued): General Evaluation of Nonstructural Measures (Building Retrofits)

Nonstructural Measures	Completeness	Effectiveness	Efficiency	Acceptability
Wet Floodproofing	Foundation stability testing required. The building may not be accessible or usable during flooding.	Does not reduce general flooding in area or municipal clean-up/recovery costs. Inundation of designated portions of structure reduces uplift from buoyancy. Appropriate only for areas with slow velocity flooding (less than three feet per second) and no flash-flooding.	May provide cost-effective flood risk management in areas of limited flooding depth. Efficiency is greatest in areas with frequent low-level flooding.	Typically, less alteration of structure is required than with other retrofit methods. Minimal impact on adjacent properties. May present environmental concerns due to water contamination. Not usually acceptable to residential occupants. Results in high residual risk.
Dry Floodproofing	Foundation stability testing required; determination of acceptable level of human intervention needed to install or operate devices.	Flood risk management for building structure and contents is provided to a limited depth of flooding (typically three feet or less) due to hydrostatic pressure and uplift buoyancy forces. Does not reduce general flooding in area or municipal clean-up/recovery costs.	May provide cost-effective flood risk management in areas of limited flooding depth. Efficiency is greatest in areas with frequent low-level flooding.	Typically, less alteration of structure is required than with other retrofit methods. Minimal impact on adjacent properties. Federal government prefers not to depend on structure occupants to install a flood shield when under risk of imminent flooding. Results in high residual risk.
Utilities Protection	Potential visual impact on structures that may require additional architectural treatment, anchoring and stability of raised platforms.	May eliminate damage to utilities. Does not reduce flooding to overall structure. Does not reduce general flooding in area or municipal clean-up/recovery costs.	Depends on frequency of flooding; typically not cost-effective for structures that are damaged infrequently.	Adjacent property owners may object if utility platform is elevated on exterior of structure.

Table 6-5: General Evaluation of Non-Structural Measures (Land Acquisition)

	Evaluation Criteria			
Land Acquisition	**Completeness**	**Effectiveness**	**Efficiency**	**Acceptability**
Structure Acquisition	Eliminates future damage to acquired structure and property. Requires local control of property; identification of appropriate future use (typically open space) and enforced prohibition on future development.	Eliminates potential for damage to structures and contents on purchased property.	Once land is purchased and any structures removed, there will be no future structure damage at site.	Affects community cohesion. Cost implications (purchase price and reduction in tax revenue) may meet resistance. If acquisition is in the final plan, implementation is mandatory for residents and the non-Federal sponsor must be open to using eminent domain.
Purchase of Property	Precludes new development in at-risk areas. Requires local control of property; identification of appropriate future use (typically open space) and enforced prohibition on future development.	Eliminates potential for damage to future development. Does not reduce level of flooding in community or associated recovery costs.	If land is undeveloped at time of purchase, there is no history of structure damage at site and any project benefit is limited to avoidance of future damage.	If developable but at-risk properties are converted to public use (e.g., open space), likely to be acceptable to public. Cost implications (purchase price and reduction in tax revenue for precluded future development) may meet resistance.
Easements and Deed Restrictions	Removes or limits development potential of at-risk properties. Requires willingness on part of owner and/or municipality to restrict future use as necessary. May require public ownership/management of property.	Reduces or eliminates potential for damage to structures and contents on purchased property. Does not reduce level of flooding in community or associated recovery costs.	Not likely to reduce damage to existing structures. May lower property value of deed-restricted area.	Will vary with impact on property values and municipal tax base, and ability to attract new development to community.

(Continued): General Evaluation of Nonstructural Measures (Land Acquisition)

	Evaluation Criteria			
Land Acquisition	**Completeness**	**Effectiveness**	**Efficiency**	**Acceptability**
Exchange of Property	"Land swap" requires available parcel and willing parties to exchange. May require public ownership of receiving parcel and administration of a "land bank".	Transfers development from at-risk to not at-risk location. Eliminates future damage from "sending" parcel. Does not reduce level of flooding in community or some associated recovery costs.	Once land is purchased and any structures removed, there will be no future structure damage at site. If land is undeveloped at time of purchase, there is no history of structure damage at site and any project benefit is limited to avoidance of future damage.	If development on "receiving" site is within same municipality, effects on tax base are avoided.

6.4.4 Outcome of Overall Screening of Measures

The results of the overall screening of management measures are included in Table 6-6. Two USACE FRM measures including a levee along with associated interior drainage features, and structure acquisition are identified as potential measures for further evaluation in alternative plan formulation to determine cost effectiveness as discussed in the next section.

Table 6-6: Recommendations for Further Evaluation

	USACE FRM Measure	Other Federal Agency FRM Measure	Non-Federal Flood Plain Management Plan (FPMP)	Eliminate from Further Evaluation
Structural Measures **Local Risk Management**				
Floodwall				✓
Levees	✓		✓	
Area Risk Management				
Channel Modification				✓
Flow Detention				✓
Nonstructural Measures *Land Use/Regulatory*				
Zoning/Land Use Controls			✓	
New Infrastructure Controls			✓	
Landform/Habitat Regulations			✓	
Construction Standards & Practices		✓	✓	
Insurance Program Modifications		✓		
Tax Incentives		✓	✓	
Building Retrofits		✓	✓	
Land Acquisition				
Structure Acquisition	✓		✓	
Purchase of Property			✓	
Exchange of Property			✓	
Easements and Deed Restrictions		✓	✓	

6.5 Alternative Plan Evaluation

This chapter includes a discussion of the comparison of three alternative plans including: 1) No action plan; 2) a levee along with associated interior drainage features, and; 3) a series of acquisition at Saturn place only, and for acquisition of structures in to 10%, 5% and 2% AEP floodplain across the study area.

The results of the analyses discussed in this chapter are that a levee in the TSP is an alternative that is more cost effective than other alternative plans and reduces risk to more homes and has less impacts on community cohesion than that of an acquisition program.

6.5.1 Alternative Plan Formulation Strategy

The general plan formulation strategy was to maximize NED net benefits while considering technical feasibility, environmental impacts, economic implications, and social consequences, for how they inform completeness, effectiveness, efficiency and acceptability of alternatives.

Potential alternatives were initially compared to each other using conceptual design and parametric costs. Professional judgment was applied and features subsequently added to the apparent likely alternative. A No Action alternative is required and served as the baseline against which all project benefits are measured. The economic period of analysis was 2030 to 2080.

6.5.2 Array of Alternative Plans

The initial array of alternative plans included the following:

1. No Action Alternative
2. Levee Within Eastwick Park
3. Acquisition of Structures on Saturn Place adjacent to Eastwick Park
4. Acquisition of Structures in the 10% AEP Floodplain
5. Acquisition of Structures in the 5% AEP Floodplain
6. Acquisition of Structures in the 2% AEP Floodplain

Alternative 1 - No Action Alternative

If USACE takes no action, the neighborhood of Eastwick will continue to experience flooding from water overflowing the stream bank upstream of the confluence of Cobbs Creek and Darby Creek, along the southeastern bank of Cobbs Creek, and located between the high elevation points of the Clearview Landfill and S. 78th Street, during periods of heavy rain. This plan may include additional Federal actions taken by other agencies to provide FRM, such as grants from FEMA to support disaster recovery for homeowners and businesses. The No Action alternative may also include actions taken by other parties, such as the State of Pennsylvania and the City of Philadelphia. This plan fails to meet the USACE study objectives and may not comprehensively meet the needs of the study area.

Alternative 2 – Levee Within Eastwick Park

The area within Eastwick Park between Cobbs Creek and private homes is relatively narrow. On the northern end, high ground to tie a levee into would be within undeveloped City of Philadelphia property. On the southern end, the Clearview Landfill provides high ground. There is limited area for variation in levee alignment. Figure 6-5 shows two potential alignments generally bracketing the extent of alignment options. The green alignment ties into the landfill near a creek side retaining wall installed by USEPA. The blue alignment ties into the landfill east of USEPA's restored wetland.

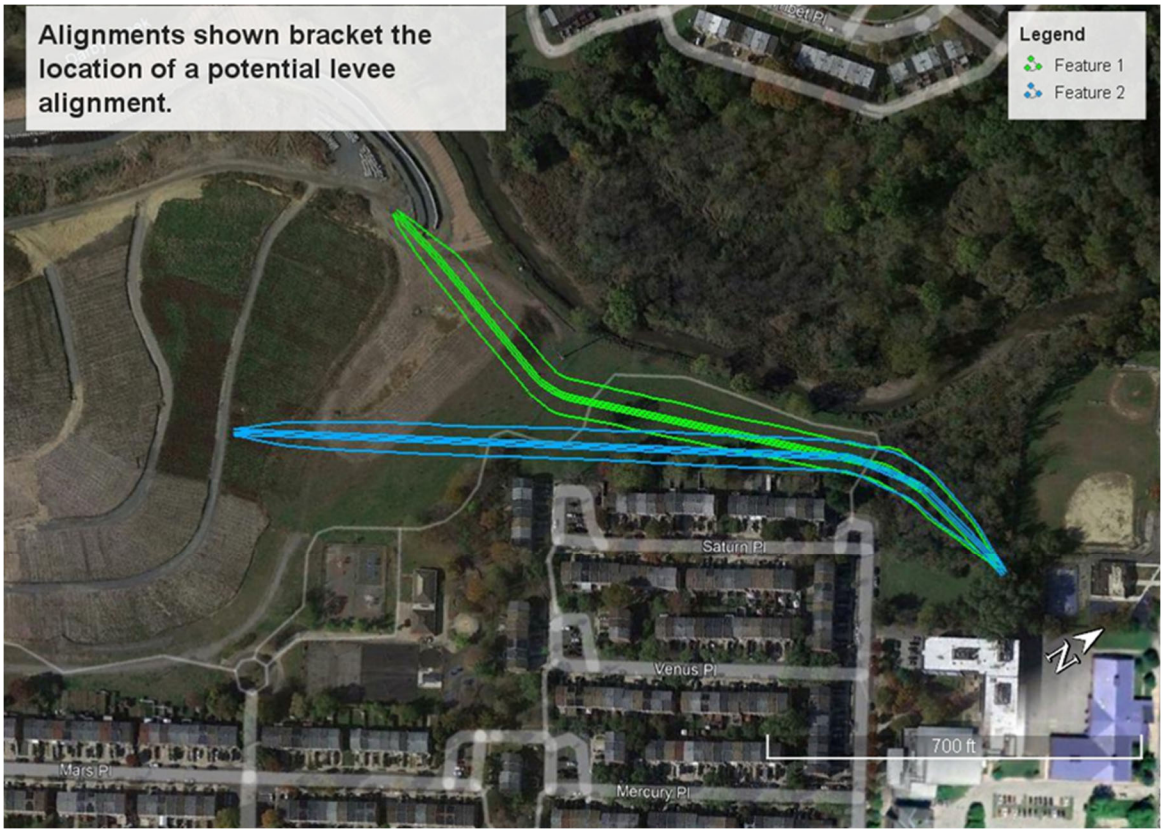


Figure 6-5: Potential Bracketing Levee Alignments

Alternatives 3-6 – Acquisition of Structures Within Eastwick

Four structure acquisition alternatives were developed for economic comparison according to their AEP floodplains. Applicable (stage level exceeds the FFE) structures were identified within the 10%, 5%, and 2% AEP floodplains, with 21, 77 and 212 eligible structures in each floodplain, respectively. A fourth structure acquisition alternative was considered for the acquisition of structures on Saturn Place adjacent to Eastwick Park. Structures were identified according to their First Floor Elevation (FFE) in comparison with the expected stage level at that event frequency. FFE is a combination of Foundation Height and Ground Elevation. Foundation Height was identified using a virtual inspection of each structure and Ground Elevation was estimated using LiDAR-derived Digital Elevation Models. All vertical datums are expressed in US Feet (NAVD88). Acquisitions just on Saturn Place were dropped from consideration due to a BCR below 0.7 in the initial screening of alternatives.

To estimate damages avoided, the structures were assumed to be acquired and the land restricted from further development.

6.5.3 Initial Screening of Alternatives

Economic efficiency of a potential 1,520 LF levee and of structure acquisition were calculated and compared. For levee calculations, the potential alignment located farther landward from

Cobbs Creek was selected in an effort to minimize risk of disturbing potential contaminated materials in the project area, minimize and avoid impacts on wetlands, and retain more of the existing floodplains. Using conceptual design, quantities of materials and associated costs were calculated. Management of interior drainage was not included in costs for this screening. In addition, induced flooding and residual flooding had not yet been considered. For structure acquisition, an assumption was made that each property would cost $300,000. Both sets of assumptions were refined after the initial screening of alternatives. At the initial level of screening, benefits were calculated based on input to the economics model from one-dimensional hydraulic modeling. Figure 6-6 and Figure 6-7 show the general plan and typical section for the potential levee, respectively, identified in the initial screening of alternatives. Table 6-7 and Table 6-8 show the initial quantities and cost calculations, for the potential levee, respectively, identified in the initial screening of alternatives.

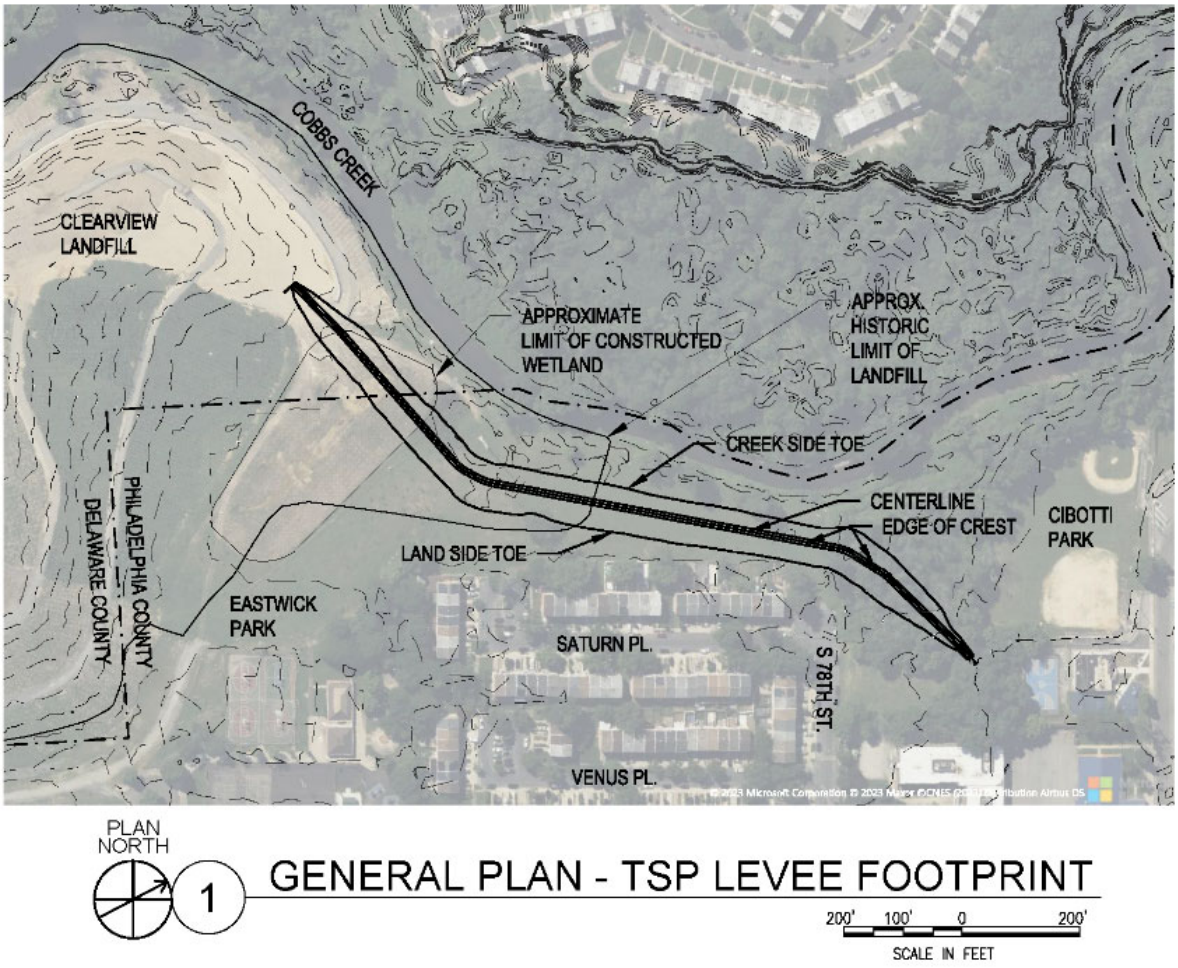
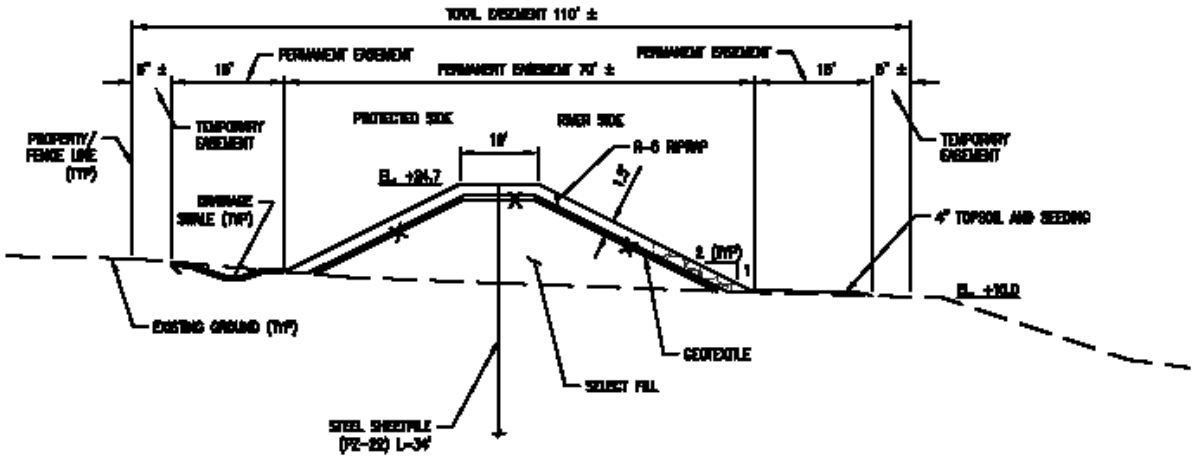
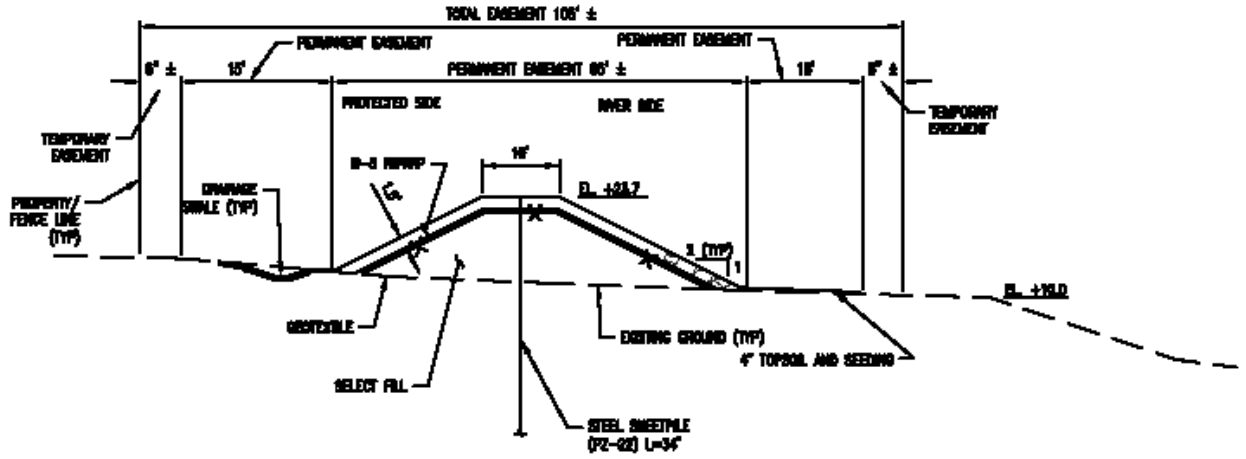


Figure 6-6: General Plan for Potential Levee



1 TYPICAL SECTION - LEVEE
NTS



2 TYPICAL SECTION - LEVEE OVERTOPPING SECTION
NTS

Figure 6-7: General Sections for Potential Levee

Table 6-7: Initial Quantity Calculations for Potential Levee

Item	QTY	UNIT	QTY/LF	COMMENTS
Sheetpile (PZ-22)	51623	SF	33.9	Calculated from Typical Sections
4" top soil and seeding	451	CY	0.3	From CAD
R5-RIPRAP	4148	CY	2.7	From CAD- Riprap quantities provided in both CY & Tons
R5-RIPRAP	6174	TN	4.1	Estimated from Volume
GEOTEXTILE Under R5-RIPRAP	86869	SF	57.1	From CAD
Select Fill	15216	CY	10.0	From CAD
R3-RIPRAP Ditch Lining	238	CY	0.2	Calculated from Typical Sections
R3-RIPRAP Ditch Lining	354	TN	0.2	Estimated from Volume-Riprap quantities provided in both CY & Tons
GEOTEXTILE Under R3-RIPRAP	13078	SF	8.6	Calculated from Typical Sections
Cut	884	CY	0.6	From CAD
24" Precast RCP Culvert Pile Supported	168.0	LF	N/A	2 Culverts
24" Precast RCP Culvert Cut and Cover	98.7	LF	N/A	1 Culvert
24" Concrete Headwall With Flap Gate	3	EA	N/A	
24" Concrete Headwall Without Flap Gate	3	EA	N/A	

Table 6-8: Initial Cost Calculations for Potential Levee

CIVIL WORKS BREAKDOWN STRUCTURE

Construction duration: XX months — Price Level: February 2022

ACCOUNT NUMBER	DESCRIPTION OF ITEM	QTY	UOM	UNIT PRICE	ESTIMATED AMOUNT	CONTINGENCY	TOTAL ESTIMATED AMOUNT
01.	LANDS AND DAMAGES				$115,000	$34,500.00	$149,500
02.	RELOCATIONS				$0	$0.00	$0
06.	FISH AND WILDLIFE FACILITIES				$200,000	$50,000	$250,000
11.	LEVEES AND FLOODWALLS	1	Job	LS	$5,728,961	$1,432,240	$7,161,201
06.03.74	ADAPTIVE MANAGEMENT @1.25 %	1.00	Job	LS	$71,612	$17,903	$89,515
29.	ENVIRONMENTAL MONITORING @ 0.50%	1.00	Job	LS	$286,448	$71,612	$358,060
30.	PLANNING, ENGINEERING, & DESIGN @ 12.00 %	1.00	Job	LS	$711,475	$177,869	$889,344
31.	CONSTRUCTION MANAGEMENT (S&A) @ 8.60 %	1.00	Job	LS	$509,891	$127,473	$637,363
		TOTAL PROJECT AMOUNT			$7,423,387	$1,861,597	$9,284,984
				ROUNDED	$7,423,000	$1,862,000	$9,285,000

Additional costs:

ADAPTIVE MANAGEMENT @1.25 % OF CONSTRUCTION (Year 1)	$89,515 includes contingency
ENVIRONMENTAL MONITORING @ 0.50% OF CONSTRUCTION (Years 1 thru 10)	$35,806 per year includes contingency

An estimate of annual costs was considered against the annual benefits for the alternatives (Table 6-9). This allowed for an initial screening of alternatives. Because costs are parametric at this stage, an initial screening BCR of 0.7 was set as the threshold for future USACE evaluation of alternatives. Alternatives with a BCR below 0.7 were dropped from further consideration. Alternatives with a BCR above 0.7 were compared to determine the alternative delivering the highest net benefits. This economic information then informed the consideration of efficiency of an alternative.

Table 6-9: Initial Economic Calculations for Potential Levee

Alternative	Levee	Acquisitions on Saturn Place	10% AEP Acquisitions	5% AEP Acquisitions	2% AEP Acquisitions
# of Acquisitions	0	21	36	63	366
FWOP AAD	$4,946,280	$4,946,280	$4,946,280	$4,946,280	$4,946,280
FWP AAD	$2,850,730	$4,936,700	$4,282,510	$3,816,650	$1,917,500
Reduced AAD	$2,095,550	$9,580	$663,770	$1,129,630	$3,028,780
Construction Cost	$9,285,000	$6,300,000	$10,800,000	$18,900,000	$109,800,000
AAC	$311,218	$211,166	$361,998	$633,497	$3,680,316
BCR	6.7	0.0	1.8	1.8	0.8
AANB	$1,784,332	-$201,586	$301,772	$496,133	-$651,536
Residual Damages	57.6%	99.8%	86.6%	77.2%	38.8%

Federal Discount Rate: 2.250%; Period of Analysis: 50 years; Capital Recovery Factor: 0.03352.
AAC = Average Annual Costs
AAD = Average Annual Damages
AANB = Average Annual Net Benefits
BCR = Benefit-Cost Ratio
FWOP = Future Without Project
FWP = Future With Project

At this initial stage of screening, the levee alternative had a greater Benefit-Cost Ratio (BCR) and provides much larger Average Annual Net Benefits (AANB). Benefits are calculated based on FFE of a structure in comparison with the expected stage level at different storm event frequencies. Within the study area some residents have converted former garages and basements into living space. These spaces are below the FFE and, thus, do not contribute significantly to benefit calculations. However, a levee could provide FRM for whole structures, including the converted spaces.

Note that the period of analysis for hydraulic (2025-2075) and economic (2030-2080) considerations differed for the analysis associated with this draft IFR/EA. This discrepancy in the periods of analyses timeframes will be modified prior to the release of the Final IFR/EA to use a consistent period of analysis of 2030-2080.

6.5.4 Secondary Screening of Alternatives

After the initial screening determined that there were economically viable alternatives, additional two-dimensional hydraulic modeling was conducted. This resulted in the selection of the levee

as the TSP rather than the acquisition alternatives. The hydraulic modeling provided refined input for the economics model so that benefits could be recalculated.

Revised cost and economics analyses taking into consideration interior drainage, induced flooding, and residual flooding have not been performed yet. These analyses will be performed to investigate the reduction of incremental flood risk in the FWP condition and will optimize levee height and potentially nonstructural solutions. These analyses will be performed based on the concurrent review of this IFR/EA and subsequent comments.

RED/OSE/EQ Evaluation

All USACE planning studies must evaluate and provide a complete accounting, consideration and documentation of the total benefits of alternative plans across all benefit categories. Total benefits involve a summation of monetized and/or quantified benefits, along with a complete accounting of qualitative benefits, for project alternatives across national and regional economic, environmental quality and social benefit categories. Identification of a plan that maximizes net total benefits across all benefit categories is required, although another plan may be recommended, if properly justified.

Nonstructural Evaluation

Regional Economic Development (RED), Other Social Effects (OSE), and Environmental Quality (EQ) evaluation of the nonstructural alternatives is handled qualitatively. Certain metrics, such as life safety risk, may be developed quantitatively if necessary for comparison and selection of the TSP.

As defined in IWR 2011-RPT-01 *Regional Economic Development (RED) Procedures Handbook* (March 2011), RED impacts are defined as the transfers of economic activity within a region or between regions in the FWOP condition and for each alternative plan. Spending in an area can spur economic activity, leading to increases in employment, income, and output of the regional economy, while chronic or catastrophic flooding can lead to regional losses in those same categories. As distinct from NED analysis, RED impacts and benefits are local and do not affect the net value of national output of goods and services.

RED impacts, and potential benefits, are unique to each study area based on population employment, labor income, tax base, and local business output. Table 6-10 provides a qualitative analysis for primary RED metrics across the four modeled nonstructural alternatives.

Among the four qualitatively assessed nonstructural alternatives, the 2% AEP floodplain acquisition plan has the most positive RED impact compared to the No-Action condition, but the benefits are still modest and the majority of the population continues to feel negative impacts to business output, income, employment, and tax base. Persistent flooding will negatively impact homes values in the area, while repetitive flooding causes missed employment hours and employment opportunities.

Table 6-10: Nonstructural Alternatives – RED Impacts

Metric	No-Action	10% AEP	5% AEP	2% AEP	Confluence
Impact on Regional Business Output	Business output will be lower due to displacement of facilities from repetitive inundation	No positive impact on regional business output	No positive impact on regional business output	No positive impact on regional business output. Some businesses acquired and relocated as part of alternative	No positive impact on regional business output
Impact on Income	Business closures within the study area will stunt the local economy. Impassable roadways from repetitive inundation will reduce total working days for population	Minimally improved. Persistent impact to majority of residents and businesses. Population relocated as part of acquisition will not experience lost workdays from flood delays	Minimally improved. Persistent impact to majority of residents and businesses. Population relocated as part of acquisition will not experience lost workdays from flood delays	Marginally improved. Persistent impact to majority of residents and businesses. Population and businesses relocated as part of acquisition will not experience lost workdays or business hours from flood delays	Minimally improved. Persistent impact to majority of residents and businesses. Population relocated as part of acquisition will not experience lost workdays from flood delays
Impact on Employment	Business closures within the study area will stunt the local economy. Local and regional employment threatened by closed businesses	Minimally improved. Persistent impact to majority of residents and businesses. Population relocated as part of acquisition will not experience lost employment opportunities	Minimally improved. Persistent impact to majority of residents and businesses. Population relocated as part of acquisition will not experience lost employment opportunities	Marginally improved. Persistent impact to majority of residents and businesses. Population and businesses relocated as part of acquisition will not experience lost employment or hiring opportunities	Minimally improved. Persistent impact to majority of residents and businesses. Population relocated as part of acquisition will not experience lost employment opportunities
Tax Base Changes	With continued flooding, tax values on homes and collected sales tax values will remain depressed	No improvement. Acquisition of residential structures removes tax base	No improvement. Acquisition of residential structures removes tax base	No improvement. Acquisition of residential and non-residential structures removes tax base	No improvement. Acquisition of residential structures removes tax base

As defined in IWR 09-R-4 *Handbook on Applying "Other Social Effects" Factors in Corps of Engineers Water Resources Planning"* (December 2009), and expanded in IWR 2013-R-03 *Applying Other Social Effects in Alternatives Analysis* (April 2013), other social effects refers to how the constituents of life that influence personal and group definitions of satisfaction, well-being, and happiness are affected by some condition or proposed intervention. Social effects is a broad term, but is generally narrowed to factors on Health and Safety, Economic Vitality, Social Connectedness, Identity, Social Vulnerability and Resiliency, Participation, and Leisure and Recreation.

Table 6-11 provides an overview of each social effect as defined in IWR 09-R-4.

Table 6-11: Other Social Effects (OSE) Description

Social Factor	Description
Health and Safety	Perceptions of personal and group safety and freedom from risks
Economic Vitality	Personal and group definitions of quality of life, which is influenced by the local economy's ability to provide a good standard of living
Social Connectedness	Community's social networks within which individuals interact; these networks provide significant meaning and structure to life
Identity	Community members' sense of self as a member of a group, in that they have a sense of definition and grounding
Social Vulnerability and Resiliency	Probability of a community being damaged or negatively affected by hazards and its ability to recover from a traumatic event
Participation	Ability of community members to interact with others to influence social outcomes
Leisure and Recreation	Amount of personal leisure time available and whether community members are able to spend it in preferred recreational pursuits

Table 6-12 qualitatively assesses how each nonstructural alternative may positively or negatively impact the defined social factors compared to the No-Action Plan.

Among the qualitatively assessed OSE contributors, few are improved by the potential nonstructural alternatives. The nonstructural measures do not keep water from repetitively and persistently flooding the community of Eastwick. Even with some reduction of flood damages to residential and non-residential structures through acquisition, the social community will continue to degrade and remain disadvantaged and underserviced. The acquisition of structures may actually exacerbate community connectiveness and community identity issues by actively reducing the population within the neighborhood.

The EQ account is defined in ER 1105-2-100 *Planning Guidance Notebook* as the displaying the non-monetary effects on ecological, cultural, and aesthetic resources including the positive and adverse effects of ecosystem. For the proposed nonstructural measure, impacts on EQ are negligible. There are no long-term improvements or degradations anticipated from these potential alternatives for water quality, air quality, noise pollution, endangered species, wetlands, aquatic habitats, or terrestrial habitats. Certain impacts from structure demolition, such as air quality and noise pollution, may be temporary, but would be expected to dissipate quickly after demolition and clean-up is completed. As the vacated lands are intended to be reverted to their natural condition, some marginal EQ benefits are possible.

Table 6-12: Nonstructural Alternatives – OSE Impacts

Social Factor	No-Action	10% AEP	5% AEP	2% AEP	Confluence
Health and Safety	Continued risks to health and safety. Repetitive and persistent flooding	Minimal improvement. Majority of population subject to continued flooding	Minimal improvement. Majority of population subject to continued flooding	Marginal improvement. Majority of population subject to continued flooding. Critical services continued to be disrupted.	Minimal improvement. Majority of population subject to continued flooding
Economic Vitality	Continued flooding depresses local economic health and opportunity	Minimal improvement. Local economic opportunities continue to worsen	Minimal improvement. Local economic opportunities continue to worsen	Marginal improvement. Local economic opportunities continue to worsen	Minimal improvement. Local economic opportunities continue to worsen
Social Connectedness	Continued risk forces residents to leave area and disrupt social connectivity	No improvement. Community cohesiveness continues to decline	No improvement. Community cohesiveness continues to decline	No improvement. Community cohesiveness continues to decline	No improvement. Community cohesiveness continues to decline
Identity	Continued risk forces residents to leave area and degrade community identity	No improvement. Community identity continues to degrade	No improvement. Community identity continues to degrade	No improvement. Community identity continues to degrade	No improvement. Community identity continues to degrade
Social Vulnerability and Resiliency	Continued flooding exacerbates existing social vulnerability and environmental injustice	Minimal improvement. Majority of population receives no increased resiliency nor decrease in environmental injustice	Minimal improvement. Majority of population receives no increased resiliency nor decrease in environmental injustice	Marginal improvement. Majority of population receives no increased resiliency nor decrease in environmental injustice	Minimal improvement. Majority of population receives no increased resiliency nor decrease in environmental injustice
Participation	Continued flooding worsens community members' trust in local and regional governance	Minimal improvement. Majority of population remains underserviced	Minimal improvement. Majority of population remains underserviced	Marginal improvement. Majority of population remains underserviced	Minimal improvement. Majority of population remains underserviced
Leisure and Recreation	Continued flooding degrades available leisure and recreation areas such as public parks	No improvement. Leisure and recreation areas continue to flood and degrade	No improvement. Leisure and recreation areas continue to flood and degrade	No improvement. Leisure and recreation areas continue to flood and degrade	No improvement. Leisure and recreation areas continue to flood and degrade

Structural Evaluation
Regional Economic Development (RED), Other Social Effects (OSE), and Environmental Quality (EQ) evaluation of the levee alternative is handled qualitatively. Certain metrics, such as life safety risk, may be developed quantitatively if necessary for comparison and selection of the TSP.

As with the nonstructural alternatives, RED impacts and potential benefits for the structural alternatives are unique to each study area based on population employment, labor income, tax base, and local business output. Table 6-13 provides a qualitative analysis for primary RED metrics across the four modeled nonstructural alternatives.

Table 6-13: Levee Alternative – RED Impacts

Metric	No-Action	Levee Alternative
Impact on Regional Business Output	Business output will decline due to displacement of facilities from repetitive and persistent inundation	Very positive impact on reducing impacts to business output. Successfully diverting flood water will allow businesses to avoid downtimes, avoid clean-up costs, and explore new opportunities
Impact on Income	Business closures within the study area will stunt the local economy. Impassable roadways from repetitive inundation will reduce total working days for population	Very positive impact. Avoided damaging flood events will reduce missed workdays and remove cleanup and repair costs from burdening the local community
Impact on Employment	Business closures within the study area will stunt the local economy. Local and regional employment threatened by closed businesses	Very positive impact. Avoiding damaging flood events will keep businesses open, roads passable, and strengthen regional and local employment opportunities and economic growth
Tax Base Changes	With continued flooding, tax values on homes and collected sales tax values will remain depressed	Very positive impact. Lowering flood risk will reduce downward pressure on home values and taxable sales

As the levee alternative will keep floodwaters from repetitively inundating the entire community of Eastwick, downward pressure on regional output, income, employment, and real estate tax base would be alleviated in the FWP condition. This is particularly beneficial for an economically disadvantaged and underserviced community where improvements to economic growth opportunities and vitality can materialize as significant enhancements to quality of life. For the OSE account, as with the modeled nonstructural alternatives, social effects of a structural alternative factors on Health and Safety, Economic Vitality, Social Connectedness, Identity, Social Vulnerability and Resiliency, Participation, and Leisure and Recreation. Table 6-14 qualitatively assesses how the levee alternative may positively or negatively impact social factors compared to the No-Action Plan.

Reducing flood risk to the community and decreasing the frequency of damaging flood events has significant positive impacts on community resiliency, continued access to critical services, and long-term community health and viability. As an economically disadvantaged and environmental justice community, positive impacts are particularly beneficial to the area and would positively contribute at every level of the community.

Table 6-14: Levee Alternative – OSE Impacts

Social Factor	No-Action	Levee Alternative
Health and Safety	Continued risks to health and safety. Repetitive and persistent flooding	Very positive impact. Reduced flooding mitigates critical service disruptions, such as potable water, electric, natural gas, sewage treatment, access to emergency services, and availability of medical services
Economic Vitality	Continued flooding depresses local economic health and opportunity	Very positive impact. Reduced flood risk allows for economic growth opportunities and higher investment in the community
Social Connectedness	Continued risk forces residents to leave area and disrupt social connectivity	Moderately positive impact. Reduced flood risk lessens pressure on residents to leave the area and disrupt social network
Identity	Continued risk forces residents to leave area and degrade community identity	Moderately positive impact. Reduced flood risk lessens pressure on residents to leave the area and abandon community identity
Social Vulnerability and Resiliency	Continued flooding exacerbates existing social vulnerability and environmental injustice	Very positive impact. Reduced flood risk improves community value, improves resiliency, and mitigates some environmental justice issues
Participation	Continued flooding worsens community members' trust in local and regional governance	Very positive impact. Community trust in regional and local government office improves, strengthened community can participate more fully in local and regional governance
Leisure and Recreation	Continued flooding degrades available leisure and recreation areas such as public parks	Moderately positive impact. Leisure and recreation areas are flooded less frequently and available for use more often

For the proposed levee alternative, impacts on EQ are negligible. There are no long-term improvements or degradations anticipated for water quality, air quality, noise pollution, endangered species, wetlands, aquatic habitats, or terrestrial habitats. Certain impacts from structure demolition, such as air quality and noise pollution, may be temporary, but would be expected to dissipate quickly after demolition and clean-up is completed. The levee is constructed near Cobbs Creek, but construction would follow all guidelines to limit impacts to riparian habitats. EQ benefit prospects are limited given the relatively short footprint of the levee. Habitat creation on the levee is possible, but the steepness of the slope may constrain opportunities and would not be expected to positively or negatively impact habitat for endangered species.

6.5.5 Life Safety Risk of Alternatives

A life safety risk analysis of alternatives is required per the–*Comprehensive Documentation of Benefits in Decision Document – 5 Jan 21 Policy Directive*. Specifically, flood and coastal storm risk management reports must include an assessment of potential mortality (life loss) for the future without project condition, as well as estimated changes in potential for and magnitude of mortality (life risk) for all alternatives in the final array. Where the change is anticipated to be the same across all alternatives or not play a significant role in the evaluation and selection of a recommended plan, a qualitative risk assessment will suffice.

Table 6-15 qualitatively assesses life safety risk for the two types of measures proposed: levees and acquisition.

Table 6-15: Qualitative Life Safety Risk Analysis

Risk	Description	Levee (Structural)	Acquisition (Nonstructural)
Residual flood damages within neighborhood of Eastwick	Future with-project damages expected due to capacity exceedance or unacquired structures	27.0%	10% AEP: 67.0% 5% AEP: 58.3% 2% AEP: 23.2% Confluence: 99.7%
Incremental Risk	Risk due to failed performance of measure (e.g., breach)	Yes, potential for incremental risk due to impounded water behind levee during flood events	No, acquisition of structures removes population from the floodplain without changing dynamics of flooding
Transformed Risk	Changing nature of flood risk (e.g., gradual to sudden)	Yes, levee would transform risk from observable and gradual to sudden in the scenario of a levee breach. Probability of risk would be expected to be low based on proper design and implementation of measure	No acquisition of structures removes population from the floodplain without changing dynamics of flooding
Transferred Risk	Changing location of risk upstream or downstream	Yes, levee may induce flooding upstream or downstream of levee location by preventing Eastwick as a channel “overflow” point.	No, acquisition of structures removes population from the floodplain without changing dynamics of flooding

The levee alternative would transform risk for the neighborhood of Eastwick, by lowering the risk of repetitive flooding, but increases the risk of catastrophic events by impounding water

behind the structural measure. The quantitative measurement of the transformed risk will depend on the probability of failure and the consequences of failure.

The levee alternative may also transfer risk upstream and downstream of the proposed levee location. As discussed previously, the levee alternative may transfer $348,000 AAD to neighboring reaches in the study area. While relatively minor compared to the total $15.4 million in total AAD, it is important to hydraulically track the change in flood characteristics in the entire area as well as investigate potential optimizations and complementary features that may reduce induced structure damage or life safety risk. Further analysis to reduce residual risk and transferred risk is expected in the next study phase.

6.5.6 Potential Cost-Sharing Responsibilities for Alternatives

Potential cost-sharing for the No action plan, the structural levee plan (0.01% AEP) and the 3) Nonstructural (10 AEP) alternatives (Table 6-16).

Table 6-16: Cost-Sharing for Alternatives

Alternative Plan	Federal Cost Share	Non-Federal Cost Share
1) No Action	$0	$0
2) Levee (0.01% AEP)	$8,665,800	$4,666,200
3) Nonstructural (10% AEP)	$5,471,050	$2,945,950

7.0 Tentatively Selected Plan

7.1 Plan Components

The USACE, in partnership with the Philadelphia Water Department, has identified the TSP which includes a levee along the left bank of Cobbs Creek within the city-owned Eastwick Regional Park and Clearview Landfill (Figure 7-1). The TSP consists of a levee constructed to a top elevation of 24.7' NAVD88 (the levee height above existing grade is approximately 15 ft). The preliminary levee design crest was sufficient to pass the 1% AEP (100-yr ARI) flood event without overtopping. For reference, at the highest point, the Clearview Landfill is 85 ft high, or 5 times higher than the potential levee. This levee runs through the Eastwick Regional Park, connecting to high ground at the eastern abutment near Cibotti Park, and the western abutment at the capped Clearview Landfill. This levee is 1370' long, has a 10' wide crest, with an interior slope of 3H:1V, and an exterior slope of 2H:1V. The interior slope is planted with grass, and the exterior slope is protected with riprap. There is a designed overtopping section at elevation 23.7' (NAVD88). Overtopping of the levee occurs at the 0.2% AEP (500-year event) for the main section of the levee and 0.5% AEP (200-year event) for the overtopping section. At the overtopping section of the levee, the slope values are the same as the rest of the levee, the only difference is that in the designed overtopping section is protected with riprap on both the interior and exterior slopes. Quantities for the TSP Levee alignment are included below in Table 7-1. The TSP levee typical cross section is demonstrated in Figure 7-2.

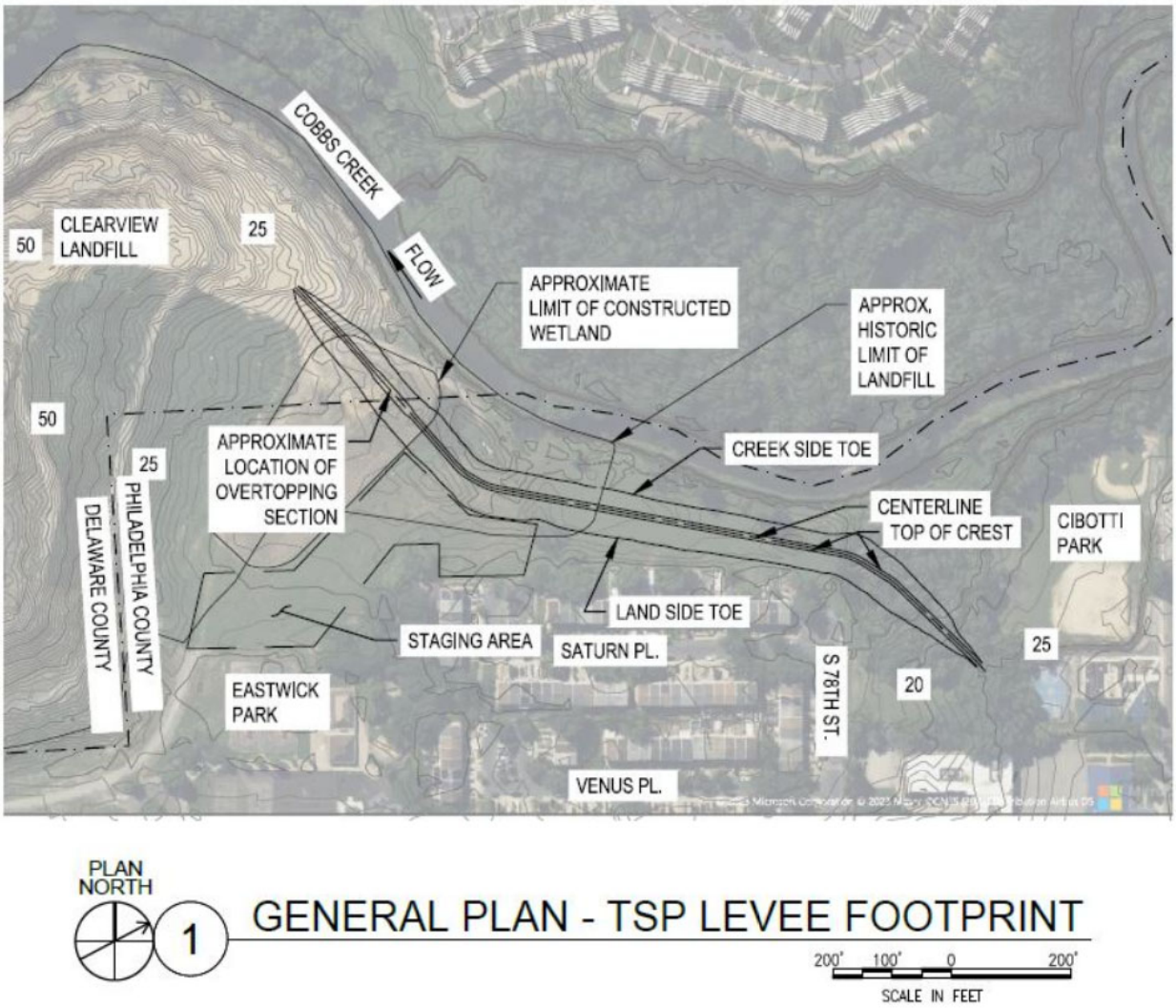
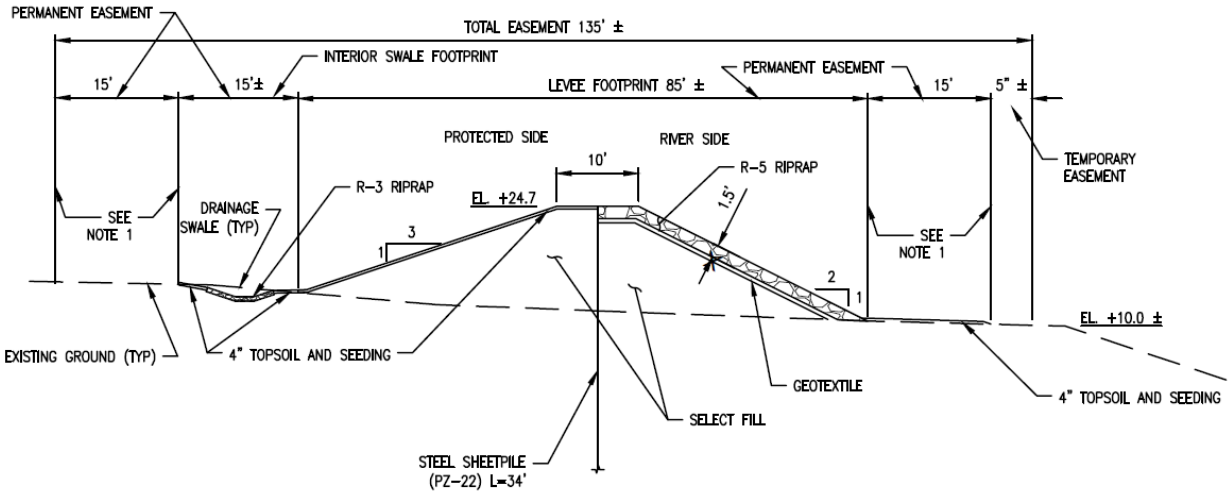


Figure 7-1. TSP Levee Alignment and Footprint

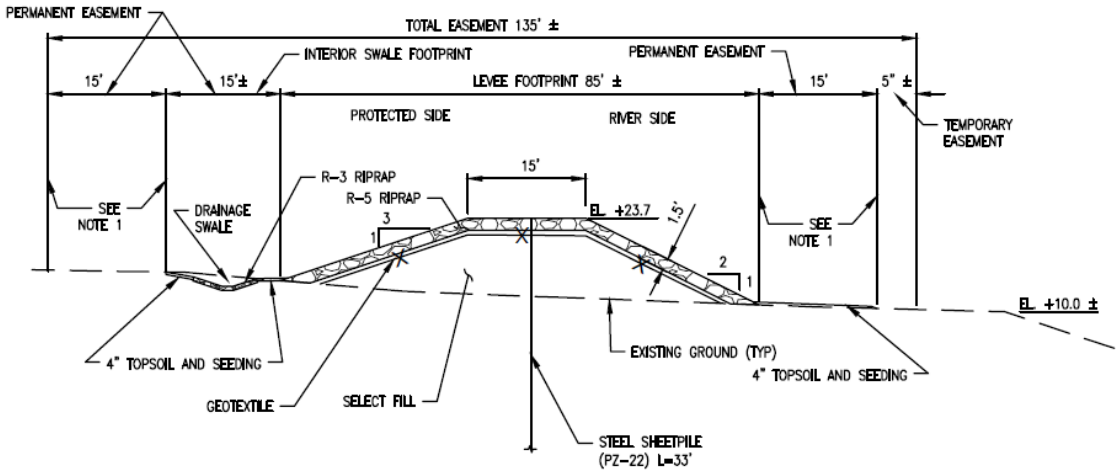
Table 7-1: TSP Levee Alignment Quantities

TSP Levee - 24.7'				
Item	**QTY**	**UNIT**	**QTY/LF**	**COMMENTS**
Sheetpile (PZ-22)	47148	SF	33.9	
4" top soil and seeding	1136	CY	0.8	
R5-RIPRAP	2602	CY	1.9	
GEOTEXTILE Under R5-RIPRAP	46840	SF	33.7	
Select Fill	24668	CY	17.8	
R3-RIPRAP Ditch Lining	217	CY	0.2	
GEOTEXTILE Under R3-RIPRAP	11488	SF	8.3	
Cut	5457	CY	3.9	

24" Precast RCP Culvert Pile Supported	168.0	LF	N/A	2 Culverts
24" Precast RCP Culvert Cut and Cover	98.7	LF	N/A	1 Culvert
24" Concrete Headwall With Flap Gate	3	EA	N/A	
24" Concrete Headwall Without Flap Gate	3	EA	N/A	



1 TYPICAL SECTION - LEVEE
NTS



2 TYPICAL SECTION - LEVEE OVERTOPPING SECTION
NTS

Figure 7-2: TSP Levee Typical Sections

The levee has three (3) 24" circular culverts with backflow prevention for the conveyance of interior drainage from Eastwick to Cobbs Creek. A swale along the inside toe of the levee

conveys interior drainage to these culverts. At this stage these culverts and swale represent minimum required drainage facilities based upon preliminary interior drainage analyses.

Additional levee specifics include a total permanent easement of 110 ft, sheet pile driven to an elevation of approximately -10.0 ft (NAVD88), 1' deep Stripping (90' wide), and a drainage swale behind the levee. The sheetpile wall in the center of the levee serves as a seepage cutoff wall. Interior drainage features, such as the swale shown at the interior toe, ponding areas, and/or a pump station, if needed, are yet to be designed.

The TSP levee alignment in Figure 7-1 considered the impact on community and open space. Specifically, the alignment of the levee closer to Cobbs Creek allowed for increased space for community functions in and around Eastwick Park. Additionally, potential alignments of the levee will be considered within the area generally bracketed by options detailed in Figure 7-3. An optimized alignment will be identified prior to the Final Feasibility Report based on comments upon this Draft Feasibility Report. An alternative levee alignment is provided in Figure 7-4. This alternative alignment will allow for increased space on the Cobbs Creek side of the levee at the detriment to open space on the community side of the levee, and will also involve less risk for contact with contaminated materials, less interference with wetlands and retain more of the floodplain. The TSP levee ties into the landfill near the retaining wall of Clearview Landfill and mimics the creek alignment.

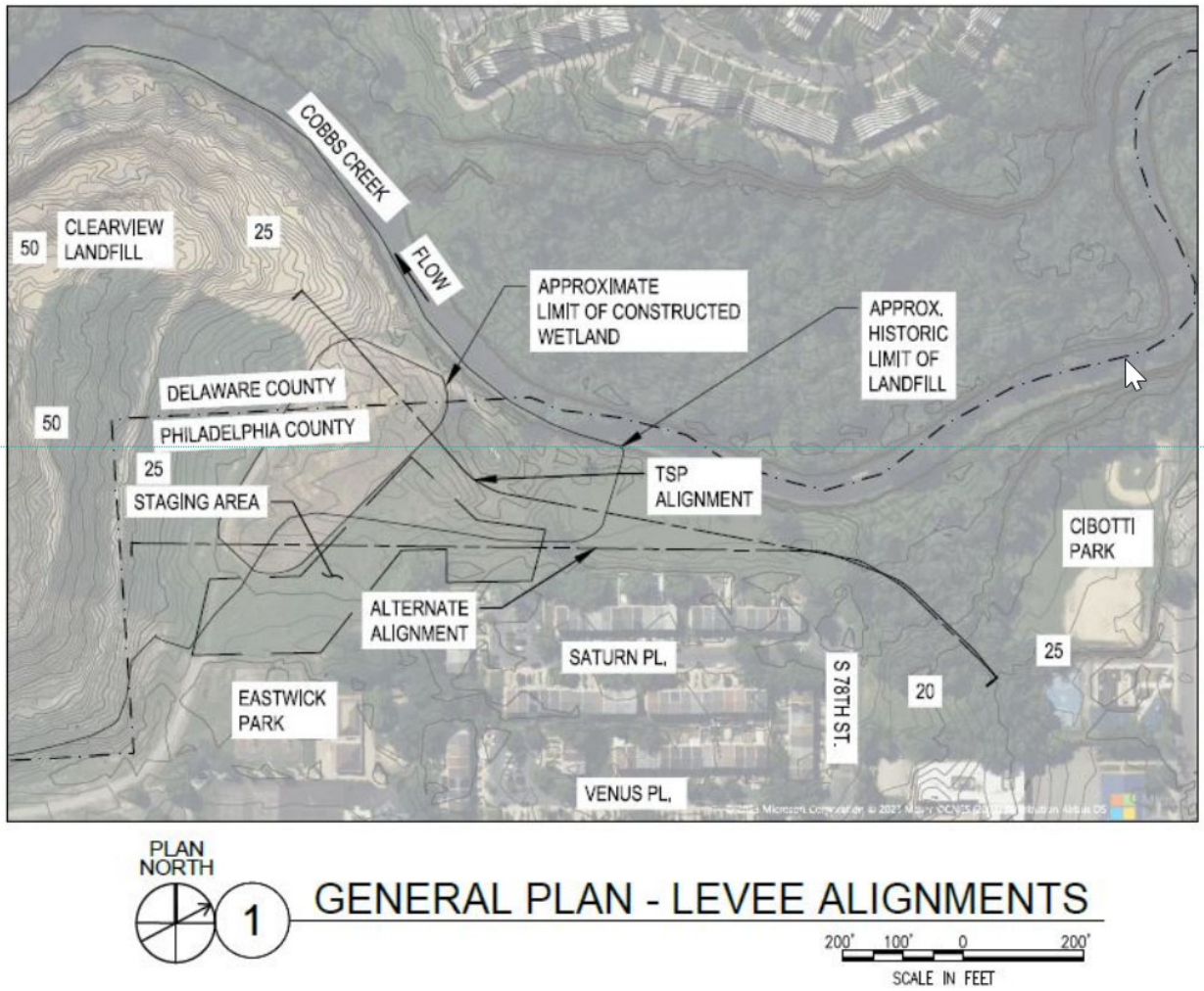


Figure 7-3: Potential Levee Alignments

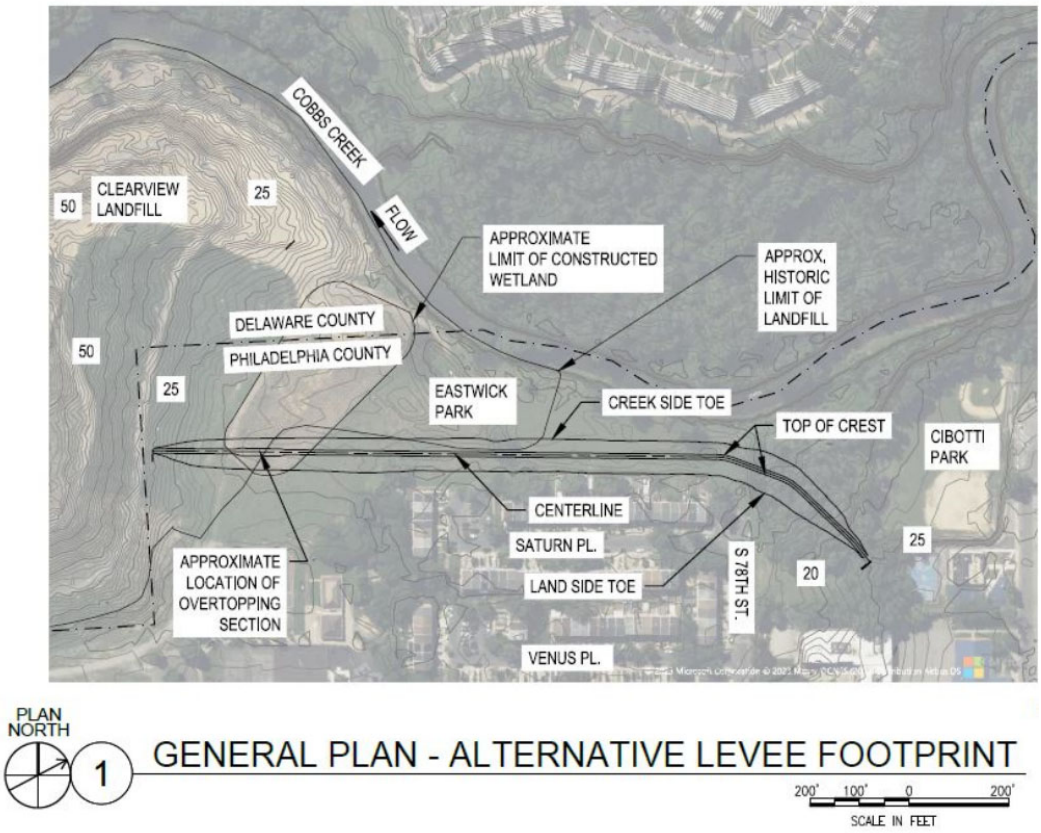


Figure 7-4: Alternative Levee Alignment Details

The second bracketing option, the alternative alignment, ties into the landfill further away from the creek and is 1,520 feet long. Alternative levee quantities are shown in Table 7-2.

Table 7-2: Alternative Levee Quantities

Item	QTY	UNIT	QTY/LF	COMMENTS
Sheetpile (PZ-22)	51623	SF	37.2	
4" top soil and seeding	1159	CY	0.8	
R5-RIPRAP	2748	CY	2.0	
GEOTEXTILE Under R5-RIPRAP	49470	SF	35.6	
Select Fill	23104	CY	16.6	
R3-RIPRAP Ditch Lining	237	CY	0.2	
GEOTEXTILE Under R3-RIPRAP	12576	SF	9.1	
Cut	5674	CY	4.1	
24" Precast RCP Culvert Pile Supported	168.0	LF	N/A	2 Culverts
24" Precast RCP Culvert Cut and Cover	98.7	LF	N/A	1 Culvert
24" Concrete Headwall With Flap Gate	3	EA	N/A	
24" Concrete Headwall Without Flap Gate	3	EA	N/A	

The project has the potential to fill up to 0.1 acres of forested wetlands and 0.4 acres of EPA constructed forested wetlands. Impacts on wetlands would be avoided and minimized to the maximum extent possible. Impacts that cannot be avoided would be mitigated using a mitigation bank (preferred) or onsite or as close to the study area as possible.

7.2 Future With Project Hydrology and Hydraulic Conditions

Current levee heights were determined from the Future With Project (FWP) conditions modeling to reduce risk for the 1% AEP event, with larger events beginning to overtop. These levee heights will be optimized in later phases. Stage frequency is summarized at the midpoint of the potential levee in Figure 4-5Table 7-3:

Table 7-3: Stage Frequency Relationships at Midpoint of Potential TSP Levee

Event	Scenario							
	Existing Conditions		FWOP Conditions		WP Conditions		FWP Conditions	
	Q Total	W.S. Elev	Q Total	W.S. Elev	Q Total	W.S. Elev	Q Total	W.S. Elev
	(cfs)	(ft)	(cfs)	(ft)	(cfs)	(ft)	(cfs)	(ft)
50pctAEP	2931.5	13.0	2911.7	13.0	2934.5	13.0	2907.0	13.0
20pctAEP	4448.2	15.3	4394.4	15.8	4525.5	15.4	4509.6	15.9
10pctAEP	5548.9	17.5	5569.5	17.6	5867.5	17.7	5877.2	17.7
5pctAEP	7060.3	19.0	7065.4	19.0	7180.4	19.3	7458.0	19.3
2pctAEP	9316.3	20.7	9316.6	20.7	9316.7	21.4	9725.6	21.4
1pctAEP	11825.3	21.9	11832.4	21.9	11837.5	23.0	11825.7	23.0
0.5pctAEP	13454.4	23.1	12953.7	23.1	13867.3	24.2	12285.2	24.0
0.2pctAEP	15228.2	24.8	15135.0	24.8	15829.5	25.7	15739.5	25.5
		indicates overtopping of current TSP levee height						

Current analysis of potential climate change impacts is ongoing. Analysis to date for climate change impacts to inland hydrology are detailed in the Hydrology & Hydraulics Sub-Appendix of the Engineering Appendix, with general summary of analysis tools provided below. Figure 7-5 details floodplain extents associated with FWP conditions.

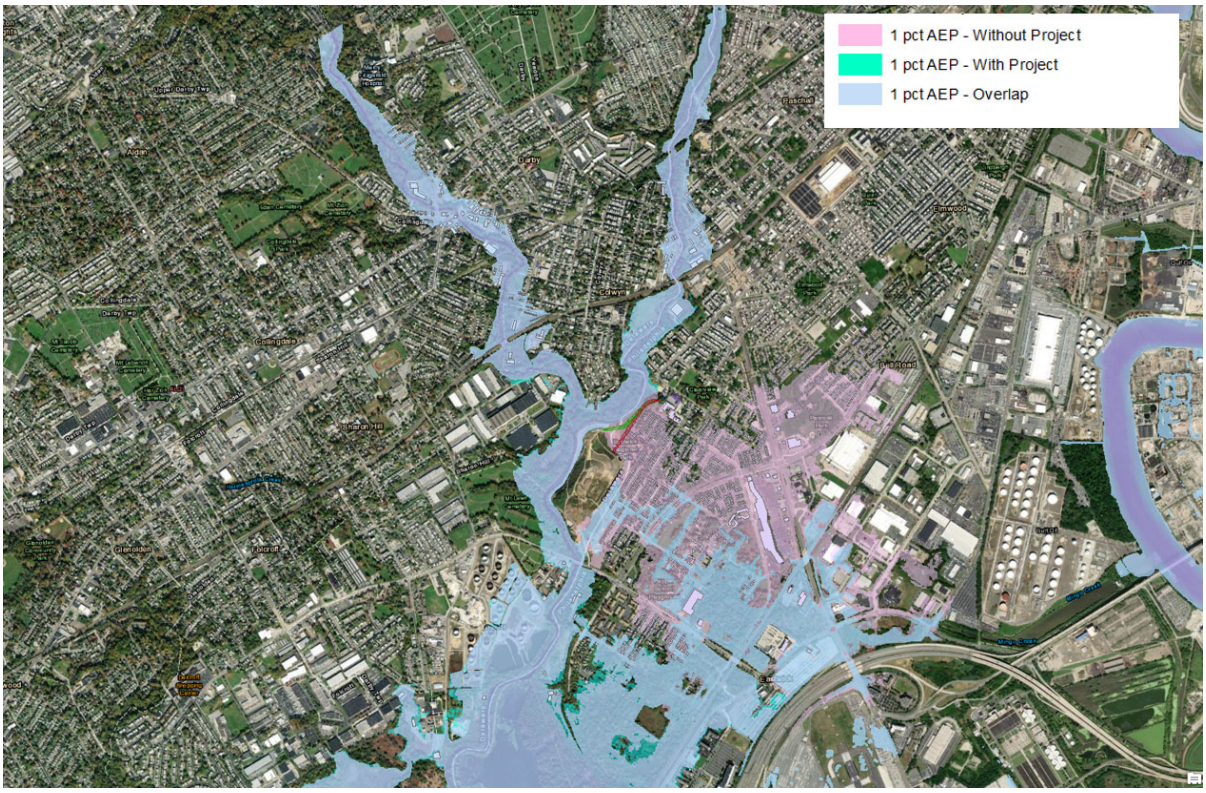


Figure 7-5: Modeled Floodplain Extents for 1% AEP Existing and FWOP Conditions (2025).

7.3 Economic Analysis

7.3.1 Structure Inventory

The following section outlines the structure inventory within the Eastwick study area as well as structures upstream and downstream of the study area that may be impacted by a potential levee proposal. Using the 0.2% AEP event as the maximum boundary of the inventory study area, the asset inventory contains 2,420 structures, primarily residential, with a further 328 structures upstream and downstream of a potential levee measure. For the structures upstream and downstream of the study area, a simulated 1% AEP floodplain with the levee in place was used to estimate the maximum floodplain extent. For storm events with a return frequency less frequent than the 1% AEP event (e.g., 0.2% AEP event), the levee would have reduced impact on flood stages, given overtopping during larger events.

In total, the 2,748 assets are entered into HEC-FDA version 1.4.3. to estimate flood risk in the area. Table 7-4 below provides a breakdown of the structure inventory categories by number, depreciated structure value, depreciated content value, and average depreciated value per structure. All values are in Price Level 2022 dollars.

Table 7-4: Structure Inventory - Category

Category	Notes	Count	Structure Value	Content Value	Average Total Value
RES	Residential	2629	$795,072,668	$350,457,642	$435,729
COM	Commercial	84	$135,200,480	$141,739,937	$3,296,910
PUB	Public	6	$26,871,873	$22,572,373	$8,240,708
REL	Religious	3	$5,298,337	$2,649,169	$2,649,169
CLOSED	Closed or No Value	6	$0	$0	$0
IND	Industrial	20	$26,595,682	$20,212,718	$2,340,420
TOTAL	**-**	**2748**	**$989,039,040**	**$537,631,838**	**$556,773**

Table 7-5 provides similar information to Table 7-4, however, assets are aggregated by occupancy types. This aggregation shows greater granularity of the inventory specifically in highlighting the various types of non-residential structures in the inventory. Among the 113 non-residential structures are fire stations, medical offices, and schools.

Table 7-5: Structure Inventory - Occupancy

Occupancy	Notes	Count	Structure Value	Content Value	Average Total Value
SFR1-BV	Single-Family 1Story Brick	109	$17,038,482	$7,411,740	$224,314
SFR1-WV	Single-Family 1Story Wood	5	$1,073,810	$467,107	$308,183
SFR2-BV	Single-Family 2Story Brick	2313	$687,258,593	$303,081,040	$428,162
SFR2-WV	Single-Family 2Story Wood	38	$13,318,140	$5,873,300	$505,038
SFR2-MS	Single-Family 2Story Masonry	2	$794,753	$350,486	$572,620
SFR2-BV-RB	Single-Family 2Story Brick w/ Refurbished Basement (Living Space)	146	$39,982,502	$17,632,283	$394,622
MFR1-WV	Multi-Family 1Story Wood	4	$10,121,900	$4,403,026	$3,631,231
MFR2-WV	Multi-Family 2Story Wood	1	$937,070	$413,248	$1,350,317
MFR2-BV	Multi-Family 2Story Brick	1	$935,942	$412,750	$1,348,692
REL	Religious Buildings	3	$5,298,337	$2,649,169	$2,649,169
FIRE	Fire Stations	2	$4,733,088	$3,975,794	$4,354,441
MEDOFFICE	Medical Offices	2	$7,976,669	$6,062,269	$7,019,469
EDU-1S	Schools 1Story	2	$9,221,916	$7,746,409	$8,484,163
EDU-3S	Schools 3Story	2	$12,916,869	$10,850,170	$11,883,520
WAREHOUSE	Warehouse	20	$26,595,682	$20,212,718	$2,340,420
BANK	Bank	1	$2,017,931	$1,533,628	$3,551,559
RENTAL	Rental Car Service Building	1	$3,108,315	$3,574,562	$6,682,877
EQUINE	Equestrian Building	2	$585,041	$292,520	$438,781
FASTFOOD	Fast Food Restaurant	11	$11,423,604	$5,597,566	$1,547,379
RETAIL	Retail Building	33	$53,362,778	$77,376,027	$3,961,782
OFFICE	Offices	22	$49,185,145	$37,380,710	$3,934,812
CLOSED	Closed or No Value	6	$0	$0	$0
GROCERY	Grocery / Supermarket	3	$2,315,754	$3,913,625	$2,076,460
SERVICE	Gas Service Station	1	$225,837	$259,713	$485,550
AUTOMOTIVE	Automotive Repair Shop	8	$4,999,406	$5,749,317	$1,343,590
APT	Apartment Building	3	$20,584,032	$9,077,558	$9,887,197
SFR3-BV	Single-Family 3Story Brick	7	$3,027,445	$1,335,103	$623,221
TOTAL	-	**2748**	**$989,039,040**	**$537,631,838**	**$556,773**

Figure 7-6 below provides an aerial image of the 2,420 structures located within Eastwick, PA. The primary source of flood risk for these structures comes from the confluence of Cobbs Creek and Darby Creek, though inundation can also occur from the south and the west.

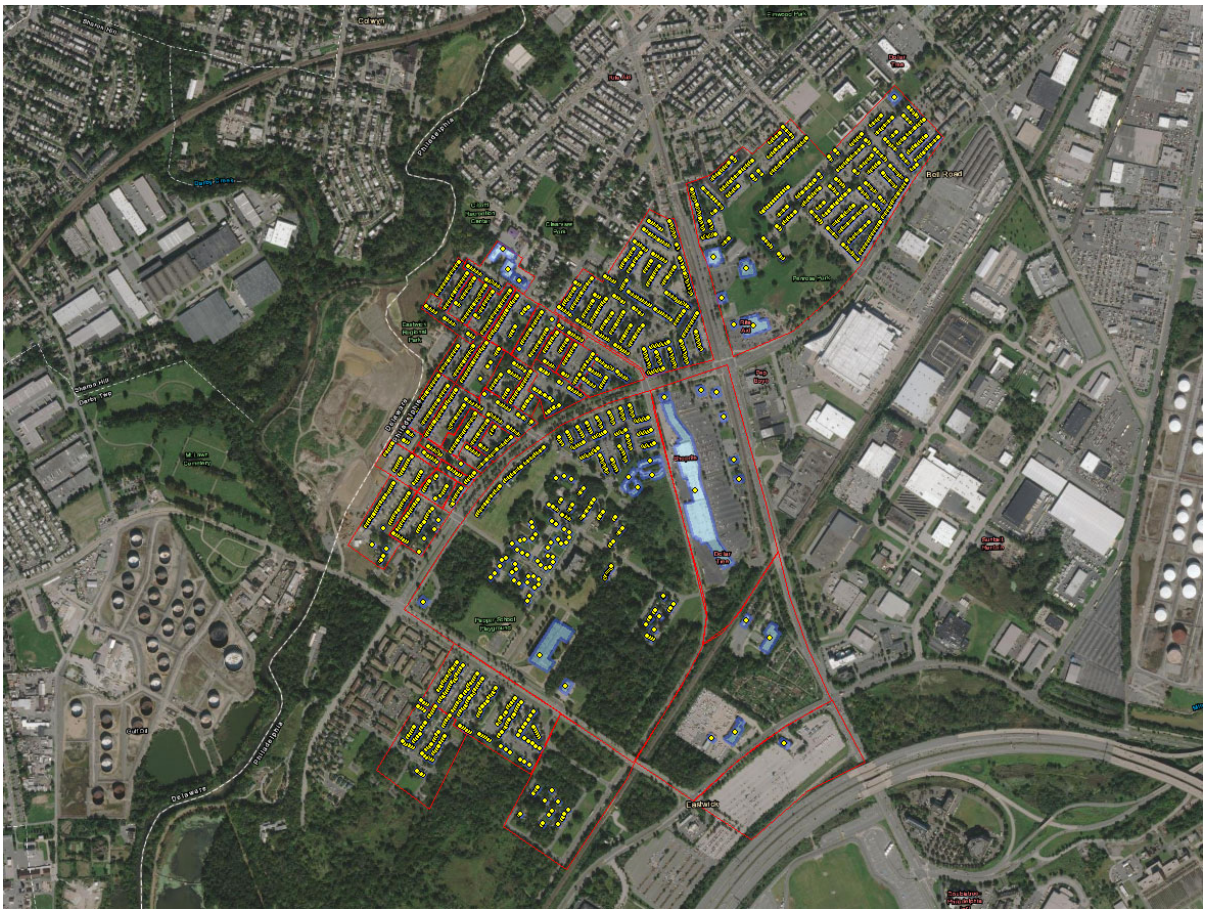


Figure 7-6 - Structure Inventory - Eastwick

Figure 7-7 below shows the 328 structures upstream and downstream (red markers) of a potential levee measure on the northwest side of the Eastwick study area. Including these structures is necessary to evaluate whether a levee measure may induce damages to assets outside the immediate study area. Also shown on the map are the 2,420 structures in Eastwick (yellow markers) and the simulated 1% AEP floodplain extent with the levee in place (approximate location shown with red line).

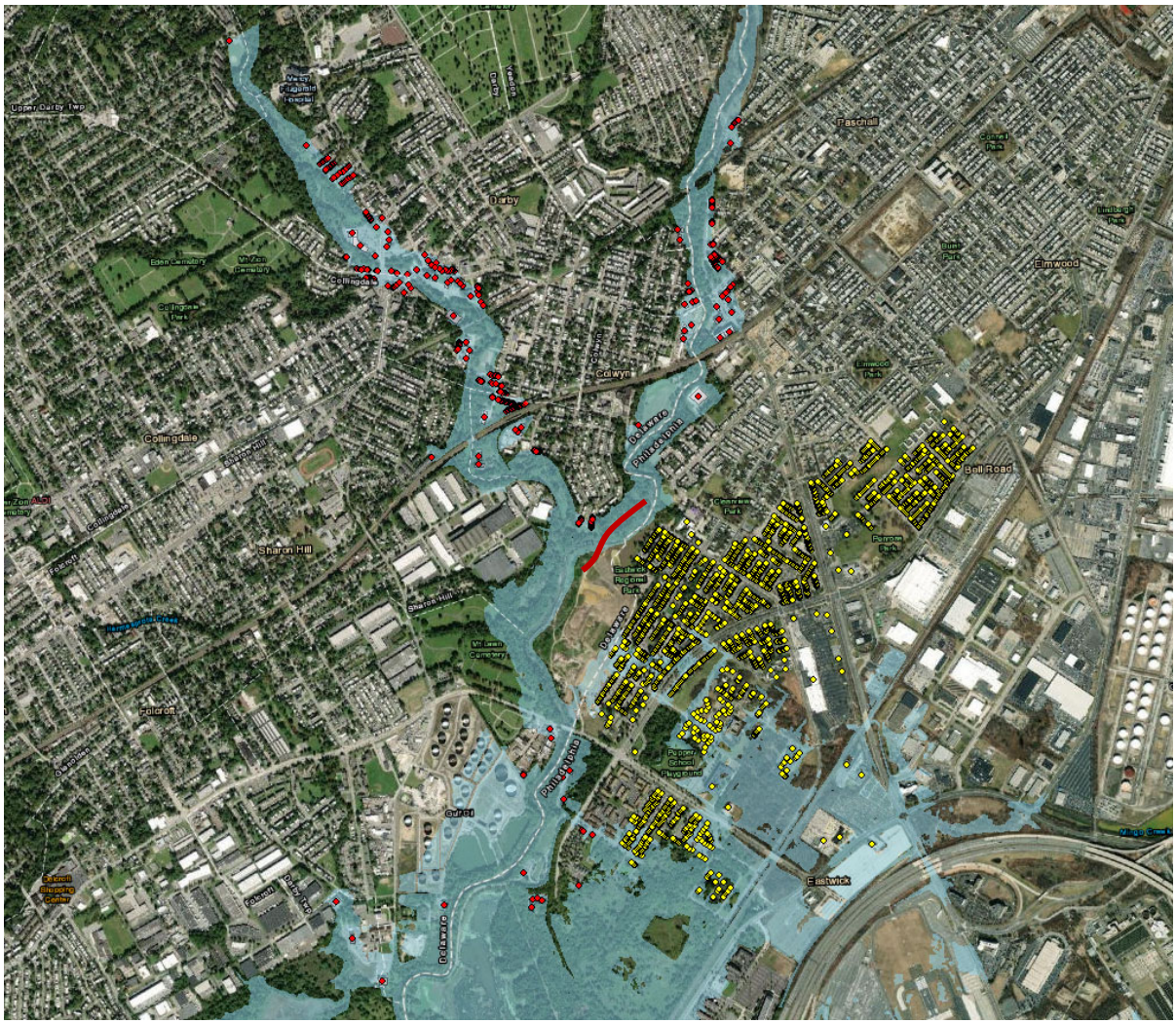


Figure 7-7: Structure Inventory - Upstream and Downstream

7.3.2 Benefit/Cost Analysis

Based on the 50-year period of analysis with the FY23 Project Evaluation and Formulation Rate (Federal Discount Rate) of 2.5%, the levee Plan provides $3,986,000 (rounded) in AANB with an 8.4 BCR as summarized in Table 7-6. As stated in Chapter 6. Plan Formulation, the levee plan is also the NED Plan.

Table 7-6 - Economic Summary

	Decision Metric	Levee Alternative (TSP)
NED	FWOP AAD	$15,432,000
	FWP AAD	$10,906,000
	Reduced AAD (AAB)	**$4,526,000**
	Initial Construction	$13,332,000
	AA OMRR&R	$67,000
	AAC	**$539,000**
	AANB	**$3,986,000**
	BCR	**8.4**
	Residual Risk*	27.0%

*Residual Risk accounts for residual damages within the community of Eastwick

7.4 Cost Estimate

The project cost estimate was developed in the MCACES MII cost estimating software and used the standard approaches for a feasibility estimate structure regarding labor, equipment, materials, crews, unit prices, quotes, sub-contractor markups and prime contractor markups. This philosophy was taken wherever practical within the time constraints. It was supplemented with estimating information from other sources where necessary such as from quotes, bid data, and Architect-Engineer (A-E) estimates. It is to be noted that after development of Abbreviated Risk Analysis (ARA), the costs withing the TSP were further refined so some minor inconsistencies between the Cost Sub-Appendix and the larger Engineering Appendix may be present.

Cost estimates for the TSP were developed at a Class 3 level of effort utilizing largely parametric unit prices from sources such as historical Government and Commercial bid data, A-E cost estimates available from design reports, the 2023 Gordian/RS Means Cost Data Books and other available historical cost data sources. For developing costs for the levee construction, the standard approaches for developing a feasibility cost regarding cost elements such as labor, equipment, materials, crews, unit prices, subcontractor and prime contractor markups were used.

The intent of the cost estimate was to provide or convey a “fair and reasonable” estimate and where cost detail was provided, it depicted the local market conditions. The construction work is common to the Philadelphia region. The construction site is only accessible via local and state roads, which are in close proximity to various interstate highways. The proposed staging area is also easily accessible through the same local and state roads in the Philadelphia area. No water access is available.

Table 7-7 shows the project first cost for the TSP. All costs are at June 2023 price levels.

Table 7-7: TSP Levee Cost Summary

Feature	Cost	Contingency	Total
01 Lands and Damages	$129,000	$32,000	$161,000
02 Relocations	-	-	-
06 Fish and Wildlife Facilities	$183,000	$79,000	$262,000
11 Levees and Floodwalls	$6,055,000	$2,616,000	$8,671,000
ALL Composite Index (Weighted Average)	$330,000	$143,000	$473,000
30 Planning, Engineering & Design	$1,644,000	$710,000	$2,354,000
31 Construction Management	$985,000	$426,000	$1,411,000
TOTAL	**$9,327,000**	**$4,005,000**	**$13,332,000**

The total baseline project cost for the comprehensive TSP is $13,332,000.

7.5 Consideration of Additional Hydraulic Information

In addition to the recommended plan information discussed above, an interior drainage, induced flooding and residual risk analysis was conducted to augment the TSP as well as to mitigate flooding risk.

7.5.1 Interior Drainage

At this stage in the study the interior drainage features of the levee alternatives represent minimum required facilities. This is because interior drainage analysis has not yet been completed as part of the current phase of study. Currently, the potential levee has three (3) 24" circular culverts through the levee with backflow prevention in the form of flap-gates or duckbills. Along the inside toe of the levee is a drainage swale intended to convey interior drainage to these three culverts.

As interior drainage analysis progresses there is the possibility that additional interior drainage features will be needed. These potential features could include, larger culverts, a pump station, or a constructed interior ponding area, for example.

7.5.2 Induced Flooding

For the With Project conditions levee plan (TSP), both downstream and upstream impacts were evaluated. Placement of a levee along Cobbs Creek is efficient in eliminating modeled flows through the Eastwick neighborhood. This has the effect of pushing more flow downstream, because that flow is no longer leaving Cobbs Creek. More flow downstream leads to marginal WSEL increases. Additionally, placement of a levee cuts off a portion of the adjacent floodplain, where floodwaters cannot spread out. This constriction leads to marginal WSEL increases upstream. Generally, WSEL increases dissipate with distance from the potential levee. Moving downstream from Cobbs Creek into Darby Creek, and through the Hook Road bridge, flows spread out through the larger, wider floodplain, and attenuate slightly, leading to WSEL

increases that decrease moving downstream toward the Delaware River. Similarly, largest upstream WSEL increases are generally limited to reaches on both Darby and Cobbs between the confluence and the upstream B&O railroad bridges. These bridges both have limited capacity to pass large floods, leading to backup at the upstream faces of each. This elevated WSEL leads to upstream WSEL increases dissipating to less than 0.5 feet upstream of the railroad. Examples of potential induced WSEL impacts are provided below. The below bulleted list summarizes the assumptions associated with the current level of analysis with respect to induced flooding:

- Induced WSEL impacts estimated for a range of events
- Base TSP levee in place, no complementary features included for results shown
- 50% AEP through 0.2% AEP riverine flooding events
- Downstream boundary conditions set to mean higher high water (MHHW, high tide) with 2075 sea level change (SLC) conditions
- Currently not coupled with coastal storm surge event(s), planned to assess in future phase

Figure 7-8: WSEL Differences - Darby Creek 10%, 1%, and 0.2% AEP FWOP and FWPFigure 7-8 and Figure 7-9 show the difference in water surface elevation with the levee in place for the 10%, 1% and 0.2% AEP events. Additional discussion of potential induced flooding is provided in the Hydrology & Hydraulics Sub-Appendix of the Engineering Appendix.

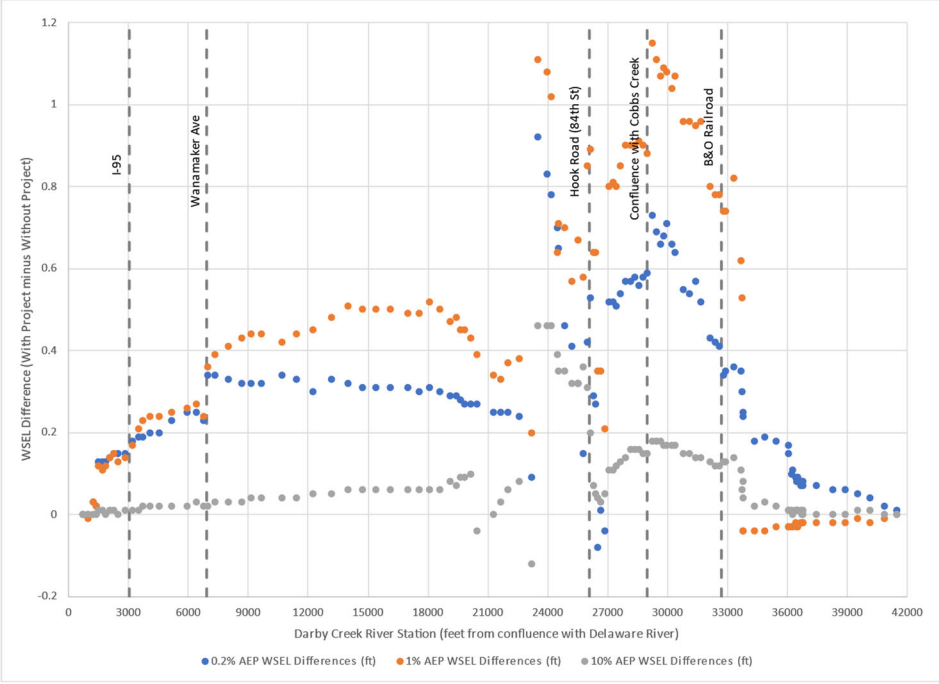


Figure 7-8: WSEL Differences - Darby Creek 10%, 1%, and 0.2% AEP FWOP and FWP

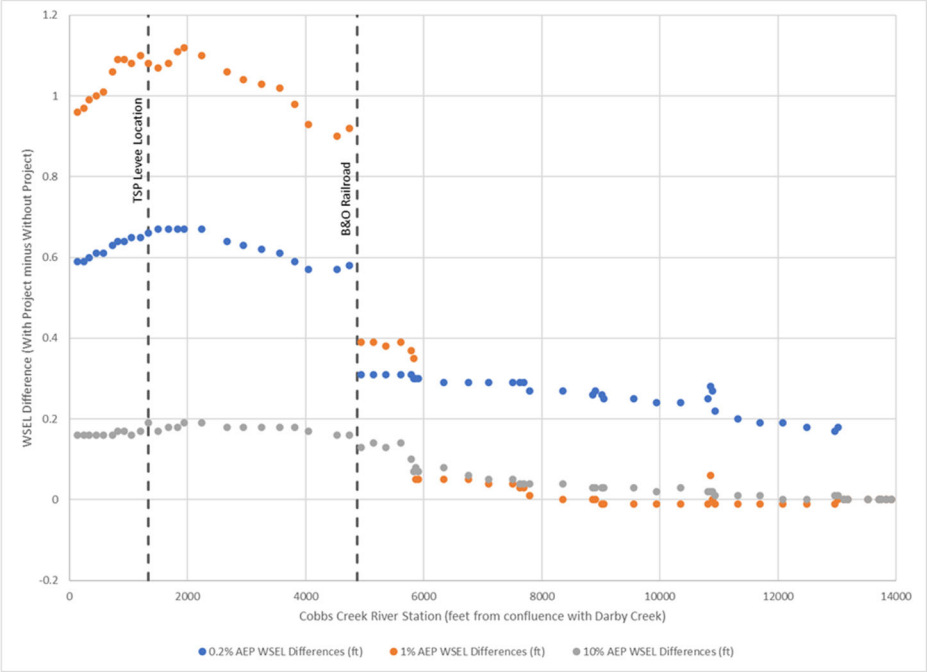


Figure 7-9: WSEL Differences - Cobbs Creek 10%, 1%, and 0.2% AEP FWOP and FWP

Induced flooding impacts are currently included in the economic analysis as negative benefits. Induced flooding also have negative impacts from an OSE and EQ perspective as discussed in the Economics Appendix and the Environmental Appendix, respectively. Full understanding of induced flooding impacts is ongoing. Analysis of complementary measures to offset induced flooding is in progress, as discussed in below sections, and will continue into next phases, including coordination with Federal and Non-federal partners.

7.5.3 Residual Flooding

Residual Risk is defined as the flood risk that remains if a proposed FRM project is implemented. Residual risk also includes the consequence of capacity exceedance as well (ER 1105-2-101). While the TSP levee plan is highly effective, the focus of the plan is to reduce associated with Cobbs Creek overflow into Eastwick, up to a specific frequency event. As discussed throughout this document, Eastwick is subject to additional impacts from other flooding sources. These include stormwater runoff in excess of storm sewer capacity, and tidal impacts from the Delaware River. Future study phases will further quantify impacts of residual flooding due to these other flooding sources, for potential investigation of additional complementary measures, in conjunction with other Federal and Non-Federal partners. Figure 7-10 below shows residual flooding with the current TSP levee in place for the 1% AEP event. Economic discussion of residual flooding is included in previous sections. Additional discussion of residual flooding is included in the Hydrology & Hydraulics Sub-Appendix of the Engineering Appendix.

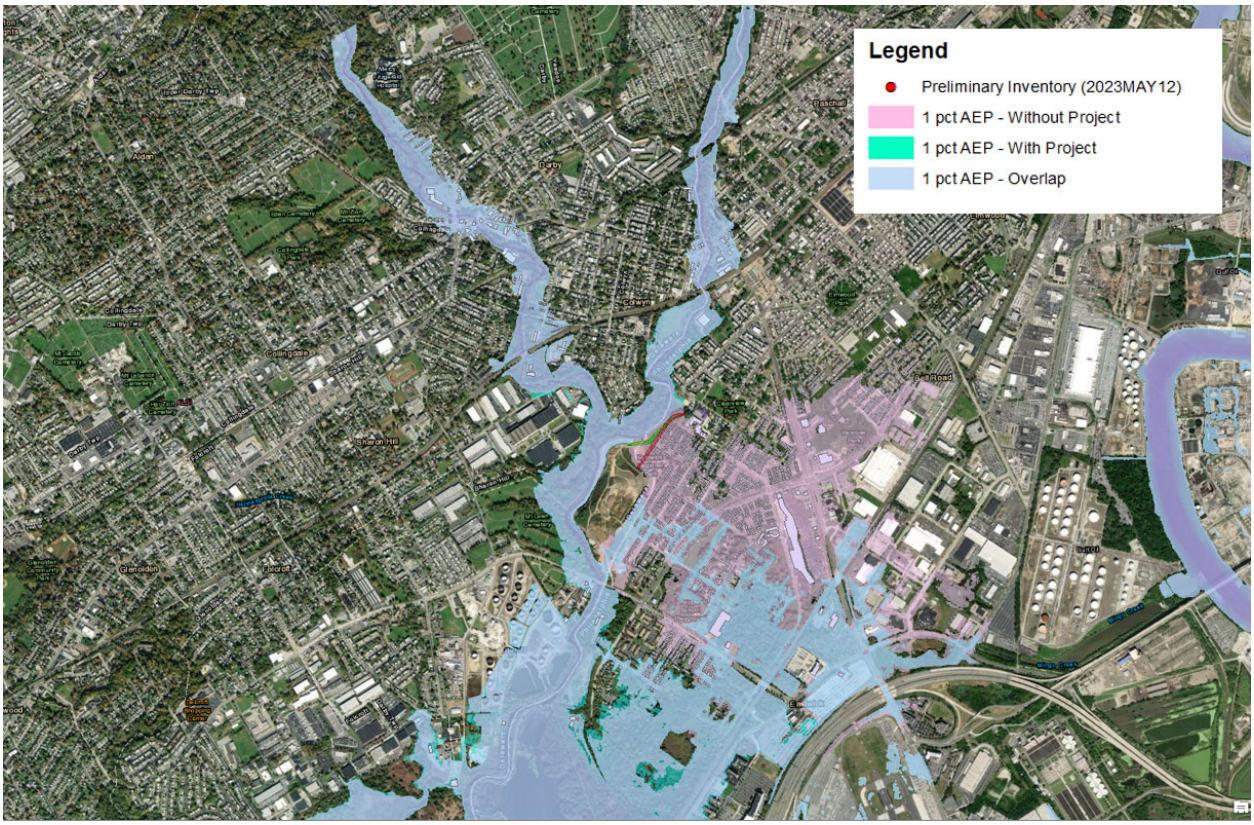


Figure 7-10: Depiction of Residual Flooding for 1% AEP FWP Event

Given the residual flooding risk from flooding sources other than Darby and Cobbs Creeks overbank flooding which is the focus of this IFR/EA, additional analyses to address flooding in Eastwick overall may be warranted. Responsibility for sources of this larger scale residual flooding could possibly be investigated, but that may require a different study mechanism and responsibility may lie with an entity besides the USACE (e.g., USEPA or the owner of the railroad tracks). Residual flooding may be able to be addressed through efforts by the City of Philadelphia or others. Residual flooding from all sources may affect the economic analysis associated with a levee and will be an important topic due to potential impacts of future sea level rise.

7.6 Complementary Measures

Complementary measures are measures in addition to the TSP that manage the risk of frequent or induced flooding to provide a more comprehensive, integrated FRM solution. The complementary measures discussed herein are not considered part of the TSP and will be developed in greater detail in the future. Further refinement with respect to induced flooding and complementary measures is needed in order to formulate a complete plan. While sufficient to move forward with TSP and draft IFR/EA, these updates are insufficient to answer all issues unequivocally. Additional analysis is identified in previous sections moving forward to reduce uncertainty and finalize the feasibility level analysis.

Several complementary measures were assessed to determine potential associated WSEL reduction benefits and subsequently mitigate induced flooding. Generally, no complementary measures were fully efficient to completely offset induced flooding, however multiple features were effective in reducing residual flooding within Eastwick during the largest events. These features include lowering banks/floodplain upstream of Hook Road, downstream of Hook Road, increasing natural high ground elevations at multiple locations, and realignment of high ground near the southeast corner of Eastwick to prevent interaction with Darby Creek and the John Heinz NWR. The location of modeled measures is provided in Figure 7-11, Figure 7-12 and Figure 7-13. Figure 7-11 depicts Floodplain benching on both the right bank above Hook Road as well as the left bank below Hook Rd. Figure 9-12 depicts the small berm area at downstream end of Landfill. Figure 9-13 depicts the small berm area at 86th Street. Additional complementary measures are being considered for these following situations:

- Slight modifications (earthwork only) at Hook Rd. Bridge
- John Heinz NWR Marsh backflow/SEPTA overflow
- Re-alignment of the berm separating the John Heinz NWR marsh to the south and Eastwick to the north

A more detailed discussion of complementary measures is provided in the Hydrology and Hydrology & Hydraulics Sub-Appendix of the Engineering Appendix.

These complementary measures were only preliminarily modeled, not fully designed. Additional complementary measures including structure specific potential measures (e.g., local FRM features, non-structural solutions, etc.) particularly with involvement from Federal Agency partners USFWS and USEPA as well as possibly with Engineering With Nature will be further assessed in the future. Due to the limited capacity, scope and funding levels associated with the USACE CAP Section 205 Program, additional complementary measure analyses will need to be performed through subsequent or separate study phases, programs or authorities either from the Federal or non-Federal entities.

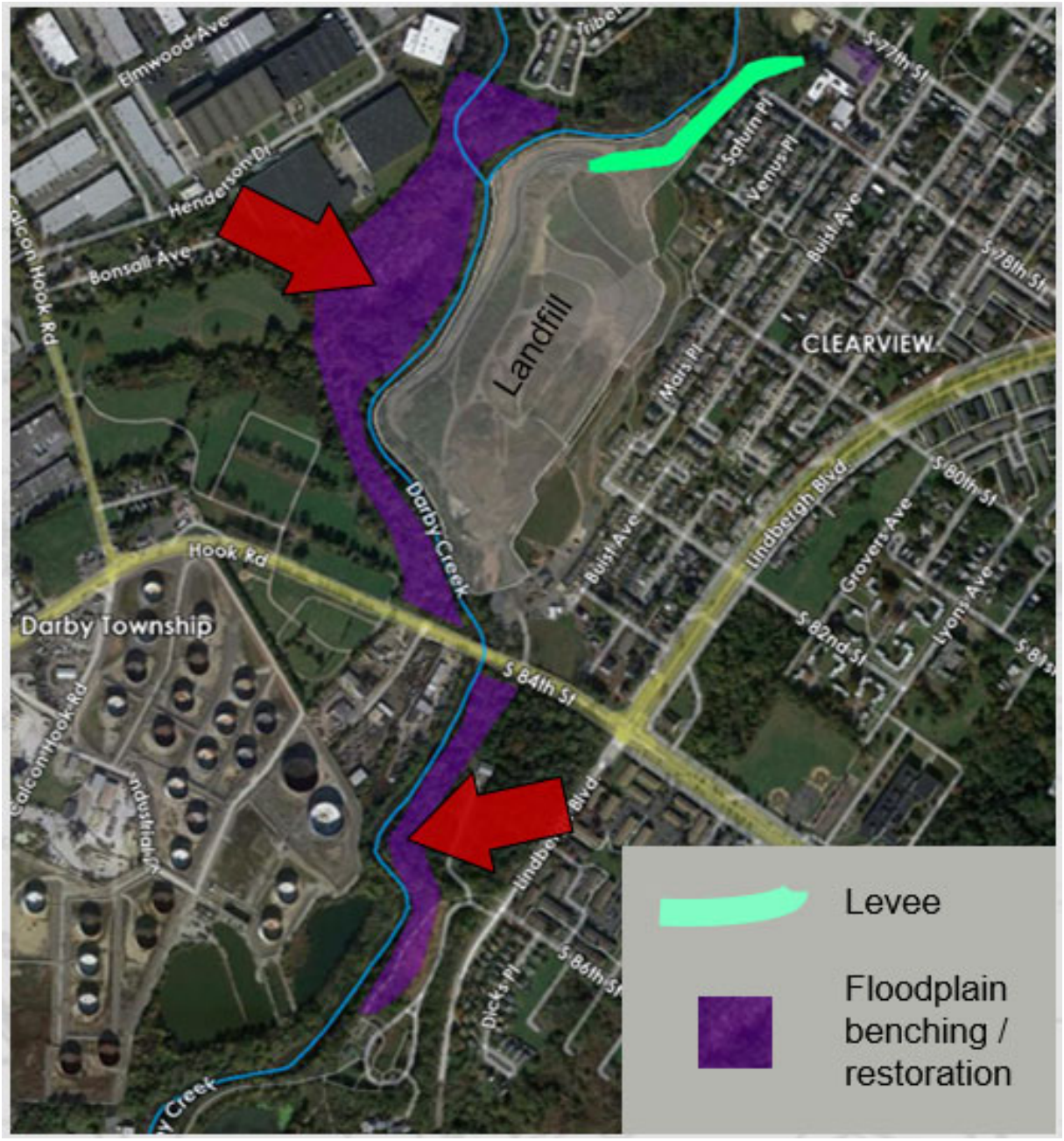


Figure 7-11: Alternatives for Complementary measures Near Hook Road

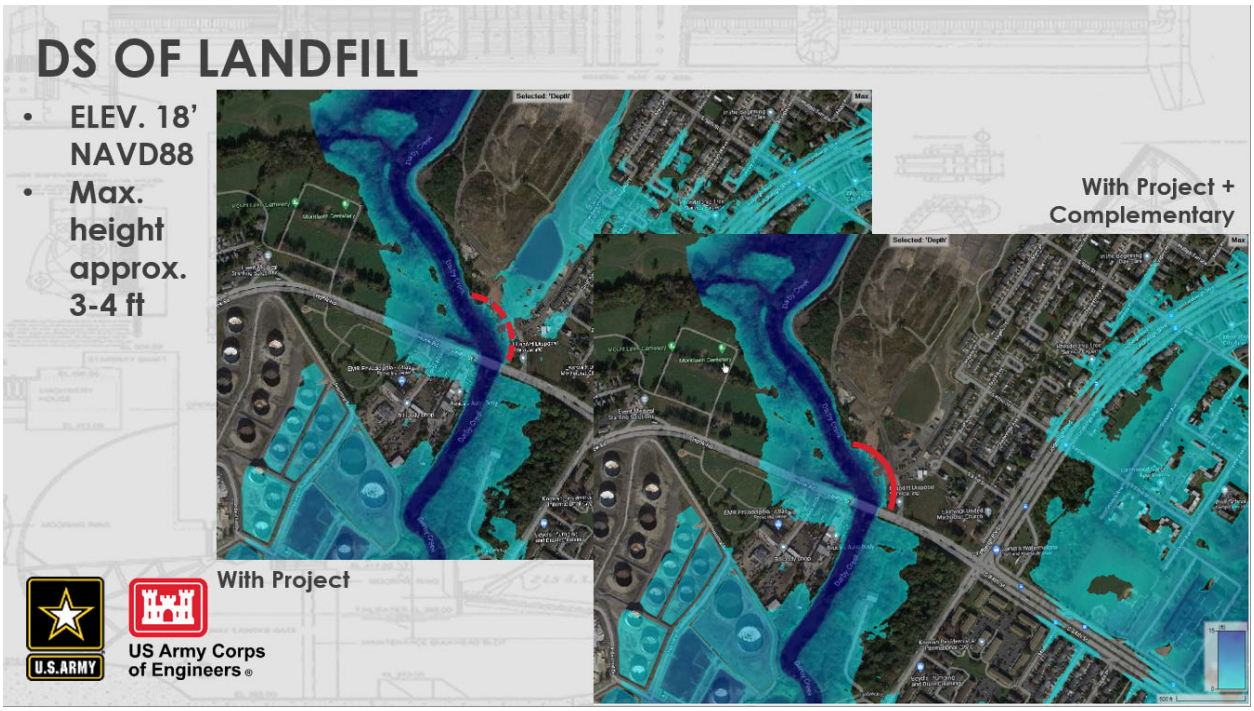


Figure 7-12: Downstream End of Landfill Increased Berm Height to Prevent Backwater

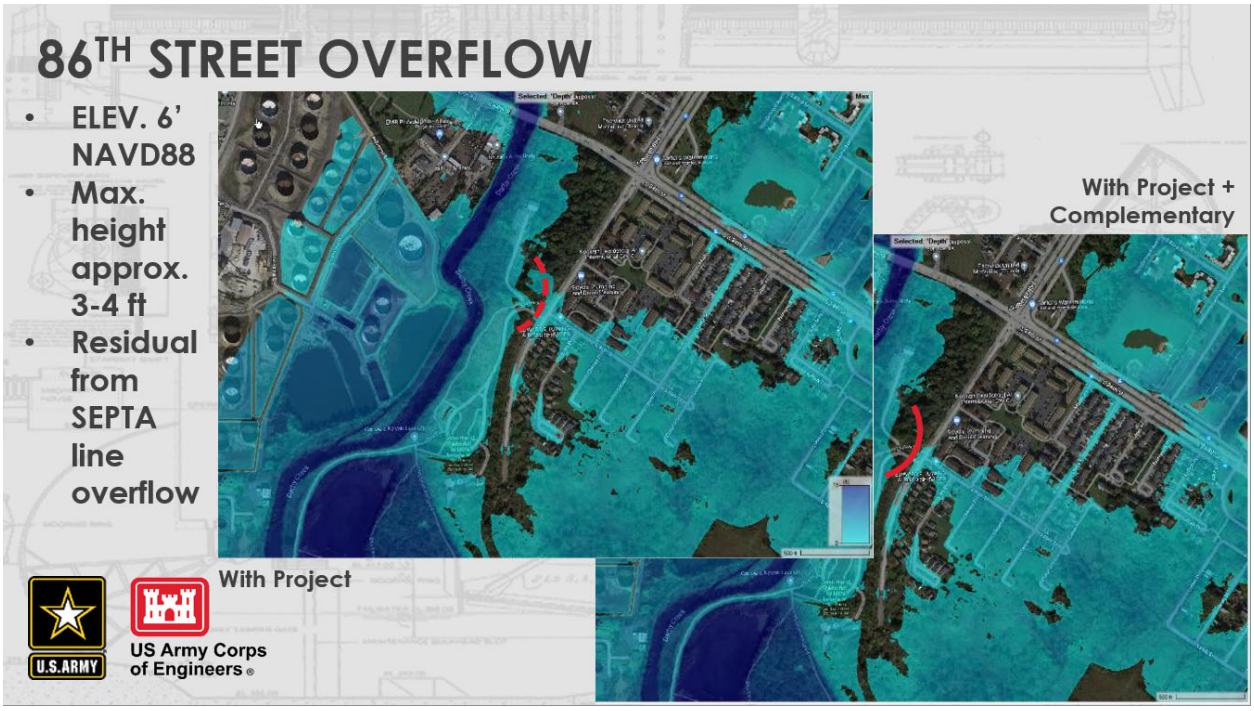


Figure 7-13: Increased berm height near USFWS Entrance (86th street)

7.7 Natural and Nature-Based Features

Natural and nature-based features (NNBFs) as complementary measures to the TSP have been identified to increase the ecological, social, and aesthetic value of the system and will be further evaluated in later phases. FRM projects that implement nature-based components could experience higher levels of preparedness, greater resistance, quicker recovery, and ability to adapt to flooding events. A holistic approach to traditional levee design can be invaluable to a community experiencing recurring and intensifying flooding events such as Eastwick, while increasing the ecological and social value of the project.

*S*ome of the NNBFs identified in Appendix E: Natural and Nature-Based Features as Complementary Features to the TSP include trails with seating, levee ramps and stairs, outdoor classrooms/ amphitheater, bioswales, managed riparian habitat, tree screens, and levee overlooks. These complementary approaches to the standard levee design are presented, each focused on increasing one of these primary benefits to encourage and prioritize different values in the decision-making process. These plans are not designed to be comprehensive or independent but, rather, components to be considered and implemented where feasible in the final design. Figure 7-14 and Figure 7-15 detail the suite of potential complementary measures locational to the TSP levee.

NNBFs are not included in the TSP. Additional NNBF analyses will need to be performed through subsequent or separate Federal or non-Federal study phases, programs or authorities due to the limited capacity, scope and funding levels associated with the USACE CAP Section 205 Program.

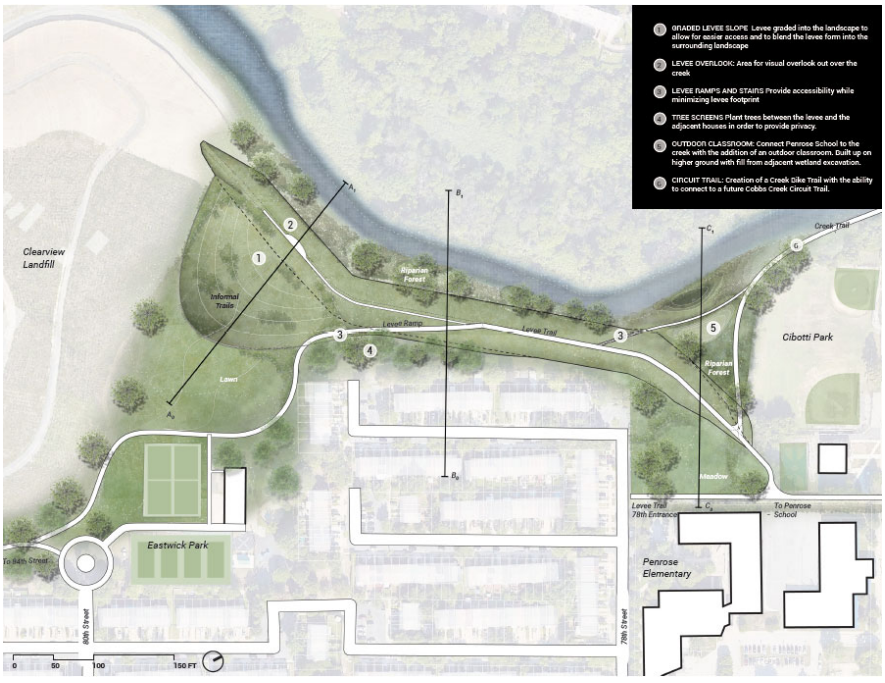


Figure 7-14: TSP Levee NNBF Complementary Measures

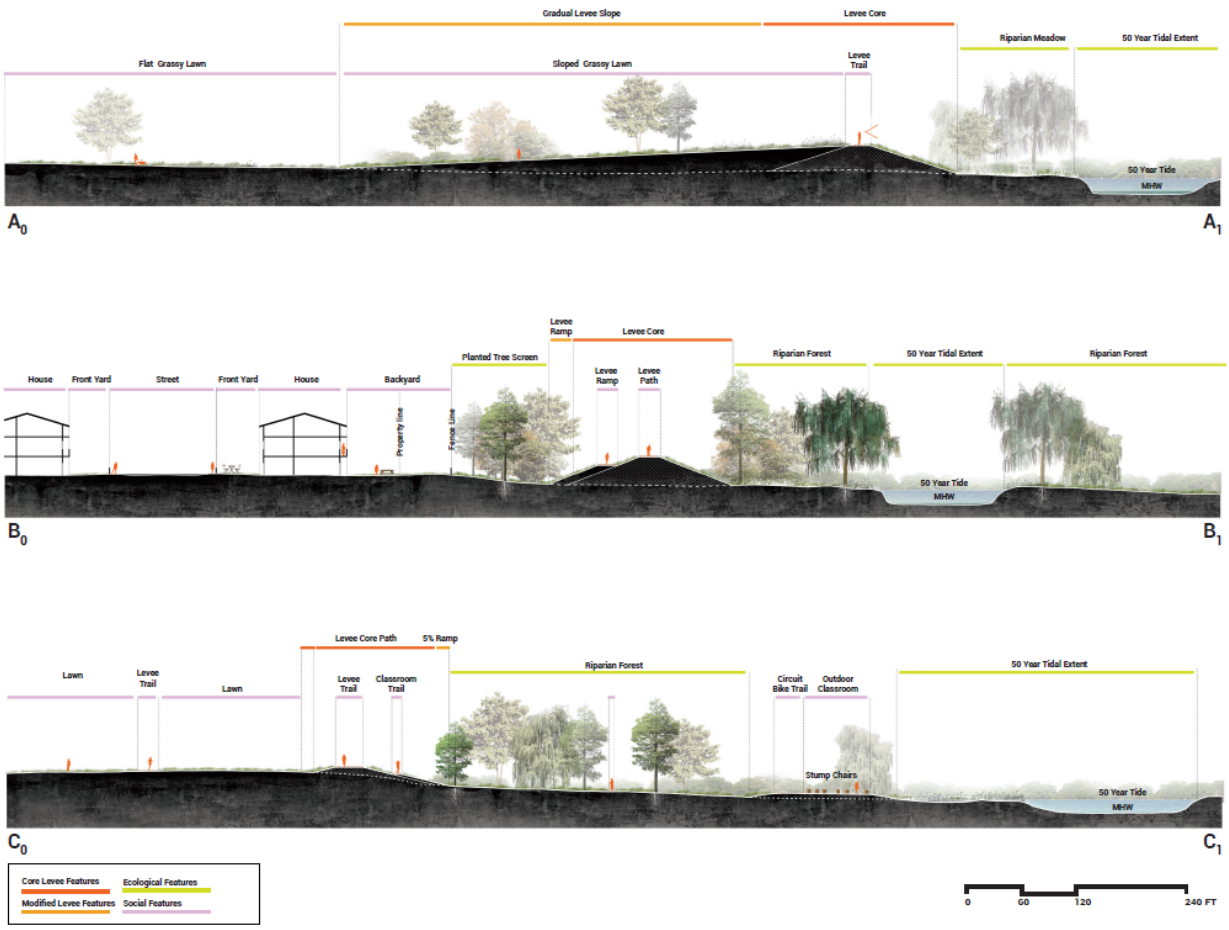


Figure 7-15: TSP Levee NNBF Sections

7.8 Life Safety Risk Assessment

In compliance with ER 1105-2-100 and ER 1105-2-101 *Risk Assessment For Flood Risk Management Studies*, a comprehensive life safety risk assessment of the Recommended Plan is scheduled to occur during the Design and Implementation phase of the study. The assessment will run concurrently with enhancements to the level of design, as well as improvements to the level of certainty in construction cost estimates. The scope and detail of data collection and model assessment (analytical rigor) in the study are scalable, including assessments of the potential for life loss. The level of detail will depend on the decision being made, what is necessary to address uncertainty in the results, complexity of the problem, and cost of addressing the risks.

An abbreviated qualitative life safety risk assessment of the most likely alternatives is detailed in this section. This risk assessment includes a description of the various types of safety risks, a qualitative assessment of key life safety metrics, and an outline of the Tolerable Risk Guidelines (TRGs) as recommended by USACE Planning Bulletin (PB) 2019-04 *Incorporating Life Safety into Flood and Coastal Storm Risk Management Studies*.

A Tolerability of Risk Framework focusing on life safety and feasibility-level design considerations was established for the recommended plan. The Framework applied Tolerable Risk Guidelines (TRGs), as defined by PB 2019-04, to inform the degree and priority of federal investments and actions; to make recommendations on non-federal investment to others on the same basis; and to determine if the risk is tolerable. The TRGs included the following:

1. TRG 1 – Understanding the Risk
2. TRG 2 – Building Risk Awareness
3. TRG 3 – Fulfilling Daily Responsibilities
4. TRG 4 – Actions to Reduce Risk

In summary, this qualitative assessment considering life loss and population at risk for the various types of risk including residual risk, transferred risk, transformed risk, and incremental risk has assisted in informing if the future with-project condition provides a tolerable level of safety for the study area. Overall, this area has a low Transformed Risk and loss of life potential, which is evident in the non-breach and incremental life loss. The Transferred Risk is shown to increase for some properties, and may require further evaluation as the project layout is optimized.

While qualitative assessments of the With Project Plan suggest the levee alignment has a low life safety risk, complete assessment of the With Project Plan will only be reached once the quantitative risk assessment is completed. Further, while the current qualitative life safety risk assessment only considered structural measures, a quantitative risk assessment will also consider both structural and nonstructural alternatives.

This qualitative assessment considering life loss and population at risk for the various types of risk including residual risk, transferred risk, transformed risk, and incremental risk has assisted in informing if the future with-project condition provides a tolerable level of safety for the study area. Overall, this assessment indicates that life safety risk is low for this project and does not need to a decision driver. Water depths, while damaging, are not reaching the point where life safety risk is impacted during breach and non-breach scenarios at the 0.01 ACE water level (tentative level of protection). As the project continues, further life loss assessment will likely be needed at a full range of ACE events, including overtopping. Additional information can be found in the Life Safety Analysis Sub-Appendix of the Engineering Appendix.

8.0 Environmental Impacts*

8.1 No Action

The No Action Alternative (future without project condition) is required to be evaluated as prescribed by the NEPA and Council of Environmental Quality (CEQ). The No Action Alternative serves as a baseline against which the Proposed Action and alternatives are are evaluated. Evaluation of the No Action Alternative involves assessing the environmental effects that would result if the proposed action did not take place.

Under the no action alternative, the TSP would not be constructed. It is likely that other local, state and federal entities would continue to address flooding associated with Cobbs Creek. While there would be no direct impacts associated with the no action alternative, other pre-existing impacts as well as impacts from flood risk management measures employed by other sponsors would continue to occur.

8.2 Climate, Weather, and Climate Change

The adoption of the TSP revision would have no expected effect on the climate in the region. The air quality analysis shows that construction of TSP would have a de minimis impact on air quality.

8.3 Air Quality

As stated previously, the project is located in Philadelphia, Pennsylvania, which is located in the Philadelphia-Wilmington-Atlantic City Area 8-hour ozone Marginal Nonattainment Area, as well as a "maintenance area" for previous violations of the 2006 $PM_{2.5}$ NAAQS.

Construction of the TSP would result in temporary effects on local ambient air quality due to emissions and fugitive dust generated by construction equipment. These temporary effects would not have a significant effect on the long-term air quality of the surrounding area.

General Conformity Review and Emission Inventory

In 1993, the EPA promulgated the General Conformity Regulations, which ensure that Federal Actions comply with NAAQS. To meet this requirement, federal agencies must demonstrate that actions it takes conform to a nonattainment area's State Implementation Plan (SIP). In the case of the Eastwick Flood Risk Management Study, the Federal Action includes the construction of a levee. USACE will be responsible for construction.

The General Conformity Rule (GC) applies to this project. However, a conformity determination is not required if the total of direct and indirect emissions of the criteria pollutant caused by a Federal action will not equal or exceed any of the rates set forth in 40 CFR 93.153. Therefore, the total direct and indirect emissions associated with the proposed action were compared to the levels set forth at 40 CFR 93.153 ("GC trigger levels") to determine if a conformity determination is necessary. Table 8-1 provides the GC trigger levels.

Table 8-1: General Conformity Trigger Levels

Pollutant	Trigger Level (tons per year)	Project Emissions (tons per year)
NOx	100	9.52
VOC	50	1.50
$PM_{2.5}$	100	0.49

The Clean Air Act assessment/GC review and emission inventory is provided in Sub-Appendix A4 of the Environmental & Cultural Appendix.

The total estimated emissions that would result from the TSP is 9.52 tons of NOx, 1.50 tons of VOC, and 0.49 ton of $PM_{2.5}$ (Sub-Appendix A4 of the Environmental & Cultural Appendix). Construction of the project will be completed in approximately 8 months. These emissions are well below the General Conformity trigger levels of 100 tons of NOx and $PM_{2.5}$ and 50 tons of VOC per year.

The direct and indirect emissions associated with the project were evaluated according to the requirements of 40 CFR Part 93, Subpart B. A conformity determination is not required because the total direct and indirect emissions from the project are below the conformity threshold values established at 40 CFR 93.153 (b) for ozone (NOx and VOC) in a Marginal Nonattainment Area (100 tons and 50 tons of each pollutant per year) and $PM_{2.5}$ in a maintenance area (100 tons). A Record of Non-Applicability (RONA) can be found in Section 17.0. The project is not considered regionally significant under 40 CFR 93.153 (i).

8.4 Water Quality

The TSP would not require in water construction or discharges; therefore, no direct effects on water quality would be expected. Indirect effects runoff, such as erosion and sedimentation would be managed through Best Management Practices (BMPs), in accordance with all applicable requirements and permits. These include a CWA Section 401 water quality certification and an Erosion and Sediment Control permit.

No impacts on water quality are expected from induced flooding.

8.5 Biological Resources

8.5.1 Vegetation

The proposed action will result in the trampling and removal of vegetation. Most of the vegetation impacts will be grass fields in a park. Approximately, 0.2 acres of EPA restored habitat associated with the Clearview Landfill mitigation program would be removed and would require mitigation. Using a ratio of 1:1 for restored forest habitat, it is estimated that 0.2 acres of forest habitat would be required for mitigation. See Sub-Appendix A1 of the Environmental & Cultural Appendix. While some native trees would be removed, the project is being designed to avoid impacts to trees to the maximum extent practicable. BMPs are being developed to avoid the unnecessary removal of woody vegetation during construction. All areas outside the levee footprint would be restored to existing conditions.

Induced flooding (described in Section 7.4.2) would result from the proposed action. Induced flooding would only occur during storm events and would be temporary. Most of the induced flooding would mean an increase in water surface elevation in already flooded areas. Therefore, only negligible impacts to vegetation would occur from induced flooding.

Invasive species are prevalent near the north end of the levee. The project maintenance plan will recommend that the non-Federal interest conduct annual inspections to manage invasive species.

8.5.2 Wetlands

The project has the potential to fill up to 0.1 acres of forested wetlands and 0.4 acres of EPA constructed forested wetlands. See Appendix A-1 for a copy of the wetland delineation summary. Impacts on wetlands would be avoided and minimized to the maximum extent possible. Impacts that cannot be avoided would be mitigated using a mitigation bank (preferred) or onsite or as close to the study area as possible. Using a ratio of 1:2 for forested wetlands, it is estimated that 1 acre of forested wetlands would be required for mitigation. See Sub-Appendix A1 of the Environmental & Cultural Appendix for the Mitigation Plan.

Induced flooding (described in Section 7.4.2) would result from the proposed action. Induced flooding would only occur during storm events and would be temporary. Most of the induced flooding would mean an increase in water surface elevation in already flooded areas. No impacts on wetlands are expected as a result of induced flooding.

8.5.3 Fisheries and Aquatic Species

No inwater work is proposed, therefore, no direct effects on aquatic species are expected. BMPs would be used to minimize indirect effects on fisheries and aquatic habitat. Because no inwater work is proposed for the TSP, the implementation of erosion and sediment control BMPs and sound construction practices would avoid and minimize impacts to aquatic species, including the Pennsylvania State Protected Species in Section 8.4.4.

No impacts on fisheries are expected as a result of induced flooding.

8.5.4 Wildlife

Construction activities would result in minor disturbance on the urban adapted wildlife that occur iin the study area. These impacts would be temporary. No impacts on wildlife are expected as a result of induced flooding.

8.5.5 Protected Species

Federally Protected Species

Federally Threatened and Endangered Species

Construction of the levee under the TSP would require the removal of several large trees which could serve as northern longeared bat habitat. Approximately 1 acre of potential habitat would be impacted. To avoid direct impacts on northern longeared bats, tree removal would be conducted during the bat inactive season from November 15 through March 31. Additionally,

construction would occur during daylight hours, which would help to avoid impacts on nighttime foraging. Tricolored bats are not expected to occur in the southeast corner of Pennsylvania (PGC 2023). No impacts on threatened and endangered species are expected as a result of induced flooding. USACE has determined that construction of the levee may affect, but would not likely adversely affect northern longeared bat. This has been documented using the appropriate IPAC determination key. The Pennsylvania Natural Diversity Inventory (PNDI) (PNDI-786856, dated August 14, 2023 indicates that no further review with USFWS is required. See Sub-Appendix A2 of the Environmental & Cultural Appendix for the IPAC and PNDI reports.

Bald and Golden Eagle Protection Act
No direct or indirect impacts on bald eagles are expected as a result of the TSP. A bald eagle's nest is known to occur downstream of the study area, in the area where the TSP would induce minor temporary increases in water surface elevations during extreme storm events. This would have no effect on the bald eagle or its nest which is in an area that already experiences flooding during storm events. Additionally, this species is adapted to fluctuating water levels.

Migratory Bird Treaty Act
Vegetation removal has the potential to result in unintentional take of migratory birds. To avoid take of migratory birds, vegetation removal would be avoided during peak breeding season, approximately May 1 through August 31, to the maximum extent practicable. If vegetation removal cannot avoid this time period, surveys would be conducted prior to vegetation clearing activities, to determine if active nests are present within the area of impact. All active nests would be marked with a buffer to avoid disturbing the nest. No impacts on migratory birds are expected as a result of induced flooding.

Pennsylvania State Protected Species
Pennsylvania Fish and Boat Commission Aquatic species of Concern
No inwater work is proposed, therefore, no direct effects on fisheries and aquatic species are expected. Therefore, no time of year construction restrictions would be required to avoid impacts on sensitive diadromous fish. No impacts on aquatic species are expected as a result of induced flooding. If necessary, surveys will be conducted to confirm the presence of northern red-bellied cooter. If it is determined that this turtle species occurs in the study area, USACE will coordinate with PAFBC to avoid impacts on this species. Erosion and sediment control BMPs and sound construction practices would be used avoid indirect effects on aquatic species, including the PAFBC fish species of concern. *Pennsylvania State-listed Threatened and Endangered Species*
No direct or indirect impacts on least bittern and marsh wren are expected as a result of the construction of the TSP. Both birds nest in the grasses and reeds of marsh habitat, which does not occur within the TSP impact footprint. This habitat occurs downstream, in the area where the TSP would induce minor temporary increases water surface elevations during extreme storm events. This would have no effect on these species which are adapted to fluctuating water levels and nest which is in an area that already experiences flooding during storm events.

No impacts on waterhemp ragweed are expected as a result of the TSP.

8.6 Cultural Resources

On October 6, 2020, the USACE coordinated the proposed undertaking with the following Tribes: the Delaware Nation, the Delaware Tribe of Indians, the Eastern Shawnee Tribe of Oklahoma, the Oneida Indian Nation, the Saint Regis Mohawk Tribe, the Seneca Nation of Indians, and the Stockbridge-Munsee Community of Mohicans.

The Delaware Nation responded recommending the project to continue as planned but requested that if any artifacts are inadvertently discovered, all construction and ground disturbing activities should cease until the appropriate state agencies, as well as their office are notified within 24 hours if any artifacts are inadvertently discovered. No other Tribe provided comments.

The levee/floodwall portion of the APE has been so extensively modified that little likelihood exists for the proposed project to impact a historic property. The USACE has determined that the proposed undertaking will have No Effect on historic properties eligible for or listed on the National Register of Historic Places in compliance with 36 CFR 800.4(d)(1). The PASHPO, in their correspondence dated November 2, 2020, are in concurrence with this determination (see Appendix A3).

8.7 Executive Order 11988

Executive Order (EO) 11988 requires that federal agencies avoid to the extent possible the long and short-term adverse impacts associated with the occupancy and modification of floodplains and to avoid direct and indirect support of floodplain development wherever there is a practicable alternative. In accomplishing this objective, "each agency shall provide leadership and shall take action to reduce the risk of flood loss, to minimize the impact of floods on human safety, health, and welfare, and to restore and preserve the natural and beneficial values served by flood plains in carrying out its responsibilities."

Further, ER 1165-2-26 states that this Executive Order has as an objective the avoidance, to the extent possible, of long-and short-term adverse impacts associated with the occupancy and modification of the base flood plain and the avoidance of direct and indirect support of development in the base flood plain wherever there is a practicable alternative.

The Water Resources Council Floodplain Management Guidelines for implementation of EO 11988, as referenced in Corps ER 1165-2-26, require an eight-step process that agencies should carry out as part of their decision-making on projects that have potential impacts to, or are within the floodplain. The eight steps and project-specific responses to them are summarized below.

1. Determine if a proposed action is in the base floodplain (that area which has a one percent or greater chance of flooding in any given year).

The proposed action is within the base floodplain. However, the project is designed to reduce damages to existing infrastructure located landward of the proposed project.

2. If the action is in the base flood plain, identify and evaluate practicable alternatives to the action or to location of the action in the base flood plain.

Chapter 6: Plan Formulation of this document presents an analysis of potential alternatives. Practicable measures and alternatives were formulated and evaluated against the Corps of Engineers guidance, including non-structural measures such as elevation and land acquisition. However, there are no practicable alternatives to the location of the action.

3. If the action must be in the flood plain, advise the general public in the affected area and obtain their views and comments.

Meetings and field trips were conducted throughout the study period to discuss flood risk management options with local representatives and other agencies. Regular meetings have been held with municipal officials throughout the study period to present work to date, including conceptual options for flood risk management. Attendee's views and comments were documented and addressed. Most recently, a public meeting was held associated with the release of this Draft Feasibility Report and Integrated Environmental Assessment in 2023 to present the same information to the general public.

A Public Notice was sent to all Federal, State and local agencies prior to agency review of the Draft Feasibility Report and Integrated Environmental Assessment. The public was also notified of the public review period and a public meeting was held. The electronic versions of the report were made available on compact disc and online.

4. Identify beneficial and adverse impacts due to the action and any expected losses of natural and beneficial flood plain values. Where actions proposed to be located outside the base flood plain will affect the base flood plain, impacts resulting from these actions should also be identified.

The anticipated impacts and related mitigation associated with the TSP are summarized in Chapter 8: Environmental Impacts of the Main Report, and in the Environmental & Cultural Appendix, respectively. The primary benefit of the action is to reduce flooding in the Eastwick neighborhood in Philadelphia.

As discussed in Chapter 7: Tentatively Selected Plan, induced flooding at some locations will result from the TSP. The risk from induced flooding may be managed by complementary measures. The development of these complementary measures has not been evaluated as part of this current draft study, but is planned for later phases. There is potential that complementary features may have to be implemented under separate study authority.

5. If the action is likely to induce development in the base flood plain, determine if a practicable non-flood plain alternative for the development exists.

The TSP is not envisioned to directly induce development in the base floodplain as much of the area in vicinity of the TSP highly developed or currently owned by a Government entity.

6. As part of the planning process under the Principles and Guidelines, determine viable methods to minimize any adverse impacts of the action including any likely induced development

for which there is no practicable alternative and methods to restore and preserve the natural and beneficial flood plain values. This should include reevaluation of the "no action" alternative.

The action might result in minor impacts to habitat and wetlands. These impacts will be avoided and minimized throughout the planning and design process. Any unavoidable environmental impacts will be mitigated for appropriately.

The project will not induce development in the flood plain. Chapter 6: Plan Formulation of this report summarizes the alternative identification, screening and selection process. The "no action" alternative was included in the plan formulation phase.

7. If the final determination is made that no practicable alternative exists to locating the action in the flood plain, advise the general public in the affected area of the findings.

The Draft Feasibility Report and Integrated Environmental Assessment was provided for public review and a public meeting was held during the public review period.

8. Recommend the plan most responsive to the planning objectives established by the study and consistent with the requirements of the Executive Order.

The Recommended Plan is the most responsive to all of the study objectives and the most consistent with the EO.

8.8 Parks and Recreation

The TSP levee alignments transit the city-owned Eastwick Regional Park and terminate near the Eastwick Recreation Center. As a result, the TSP would have impacts on parks and recreation particularly on the creek side of the levee but the recreation side of the levee would offer some recreational opportunities. Specifically, USACE is working with our EWN partners including University of Pennsylvania to consider NNBF measures to tie the levee into surrounding recreational uses; for example, adding a bike path on the top of the levee to tie into the bike path planned at the Clearview Landfill. Concept designs are provided in the Civil Design Sub-Appendix of the Engineering Appendix. Recreational features will continue be considered throughout plan optimization.

Induced flooding (described in Section 7.4.2) would result from the proposed action. Induced flooding would only occur during storm events and would be temporary. Most of the induced flooding would mean an increase in water surface elevation in already flooded areas. Therefore, only negligible impacts to vegetation would occur from induced flooding.

8.9 Noise

Temporary impacts due to increased construction noise may be experienced by nearby homeowners during the project construction. Construction activities will require the use of heavy construction equipment. An increase in road traffic and possibly traffic interruption can also be anticipated. Construction activities are temporary in nature and would last for

approximately 8 months. Under normal circumstances, noise will only be generated Monday through Friday during normal working hours. There will be no long-term adverse noise impacts associated with the proposed completed project.

8.10 Hazardous, Toxic and Radioactive Waste (HTRW)

Soils were not investigated as the study area is known to contain soils contaminated with hazardous materials. Part of the TSP footprint overlaps with the Clearview Landfill. Outside of the landfill, it is suspected the area was historically used as some form of landfill or waste disposal area. Additionally, surface evidence of more recent dumping was observed (e.g., bricks and other debris). The design of the levee uses a sheet pile wall which will minimize the need for soil excavation and will not intrude into the Clearview landfill subsurface cap into the HTRW. All excavated soil if necessary would take place during the Design and Implementation Phase and would require testing for proper disposal or use, in accordance with all applicable regulations.

8.11 Visual and Aesthetic Values

The TSP levee alignments may obstruct some views of Cobbs Creek. As a result, the TSP would have impacts on visual and aesthetic values. USACE is working with our EWN partners including University of Pennsylvania to consider NNBF measures to tie the levee into the existing landscape and to make the levee visually pleasing. Concept designs are provided in the Civil Design Sub-Appendix of the Engineering Appendix. Aesthetic features will continue be considered throughout plan optimization.

No impacts on visual and aesthetic resources are expected as a result of induced flooding.

8.12 Cumulative Impacts

According to CEQ NEPA regulations (40 CFR 1508.7), the cumulative effect is defined as the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of who undertakes these actions. The proposed action must be evaluated with the additive effects of other actions in the project area to determine whether all the actions will result in a significant cumulative impact on the natural and human environment of the area.

Multiple state and federal agencies are addressing the flood problems in the Eastwick neighborhood of Philadelphia. Other present federal activities in the area include the ongoing management of the John Heinz NWR and EPA clean up of the Clearview Landfill Superfund Site. While these activities would result in temporary minor effects, overall, they are generally expected to cumulatively benefit the environment in Eastwick. Most negative effects associated with this project are short-term and minor. Wetland impacts would be avoided to the maximum extent practicable. If wetland effects can not be avoided, they would be mitigated.

9.0 Environmental Justice

In accordance with Executive Order (Environmental Justice in Minority Populations) 12989 dated February 11, 1994, a review was conducted of the populations within the affected area. The U.S. Environmental Protection Agency definition for Environmental Justice is: “the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies.”

The TSP presents an opportunity to provide Federal benefits in a disadvantaged community as Eastwick classifies as an environmental justice community per the USACE Climate and Economic Justice Screening Tool (CEJST) and the Environmental Justice and Screening and Mapping Tool (EJScreen).

Based on the criteria outlined in the CEJST, all four Census tracts used to represent the neighborhood of Eastwick for this study are classified as disadvantaged. This classification is based on numerous criteria, but higher than national average poverty rates, proximity to superfund sites, asthma-afflicted adults, vulnerability to flood risk, and history of underinvestment highlight some of the climate and economic factors used to make this determination.

To meet the directive of Justice40 (Executive Order 14008), a Federal goal to provide 40% of overall benefits of certain Federal investments to marginalized, underserved, and overburdened communities, Eastwick serves as a prime opportunity to manage flood risk in a vulnerable and disadvantaged area.

Additional information on this analysis is provided in the Economics Appendix.

10.0 Compliance with Environmental Statutes*

Compliance with applicable Federal Statutes, Executive Orders, and Executive Memoranda is presented in Table 10-1. This is a complete listing of compliance status relative to environmental quality protection statutes and other environmental review requirements.

Table 10-1: Compliance with Env. Quality Protection Statutes and Other Requirements

FEDERAL STATUTES	COMPLIANCE W/PROPOSED PLAN
Archeological - Resources Protection Act of 1979, as amended	Full
Clean Air Act, as amended	Partial
Clean Water Act of 1977	Partial
Coastal Zone Management Act of 1972, as amended	Partial
Endangered Species Act of 1973, as amended	Partial
Fish and Wildlife Coordination Act	Partial
Magnuson-Stevens Fishery Conservation and Management Act	N/A
National Historic Preservation Act of 1966, as amended	Full
National Environmental Policy Act, as amended	Partial
Rivers and Harbors Act	Partial
Watershed Protection and Flood Prevention Act	Full
Wild and Scenic River Act	N/A
Executive Orders, Memorandums, etc.	
EO 11988, Floodplain Management	Partial
EO 11990, Protection of Wetlands	Partial
EO 12989, Environmental Justice in Minority Populations and Low-Income Populations	Full
EO 14008-Tackling the Climate Crisis at Home and Abroad	Partial
EO 14072-Strengthening the Nation's Forests	Full
EO 13990 - Restoring Science to Tackle the Climate Crisis	Partial
County Land Use Plan	Full

Full Compliance - Requirements of the statute, EO, or other environmental requirements are met for the current stage of review.
Partial Compliance - Some requirements and permits of the statute, E.O., or other policy and related regulations remain to be met.
Noncompliance - None of the requirements of the statute, E.O., or other policy and related regulations have been met.
N/A - Statute, E.O. or other policy and related regulations are not applicable.

11.0 Risk and Uncertainty

11.1 Project Performance and Residual Risk

The levee alternative was identified as the Recommended Plan during this feasibility study. Consequently, a risk assessment was performed with the Project Delivery Team (PDT) to identify all possible project risks. The qualitative information derived from the risk meeting with the PDT provided the framework for the risk analysis. The risk assessment conducted for this alternative yielded a contingency of approximately 40 percent.

The TSP will be more fully analyzed and assessed prior to being considered as the Recommended Plan in the Final Integrated Feasibility Report and Environmental Assessment. Comments from the public, stakeholders and Federal and non-Federal agencies during the Draft Report comment review period will be considered and addressed towards the development of the Recommended Plan.

Risks identified for this project include the following:

- Induced flooding associated with the TSP in areas adjacent to the levee has been identified. While complementary measures have been identified associated with the Study to mitigate the impacts associated with this flooding, continued more detailed assessment and outreach with municipalities affected by induced flooding will have to be performed to formulate complementary alternative plans.
- Complementary measures are not included in the TSP. Construction costs do not consider costs associated with complementary measures. The addition of these costs may exceed the USACE CAP Authority limit of $10M. This may require additional Federal partnership or Study authority with greater cost limits to consider the inclusion of the complementary measures.
- A portion of the project is on property outside of Philadelphia County that cannot be acquired by the current NFS for the Feasibility Phase of the project. If the NFS is unable to acquire all the property interests necessary for the project, then the project will be unable to be constructed as the NFS cannot meet the real estate terms of the PPA. One resolution is to work with the adjacent jurisdiction where the project resides to sign on the PPA as a co-sponsor and that it can acquire real estate interests in it's respective jurisdiction. Note that the design may be modified during the feasibility phase which could potentially result in the project only being on property the current NFS is authorized and able to acquire.
- The alignment of the levee and of the interior swale and non-vegetative/maintenance zone offset will likely be adjusted during optimization prior to the Final Report to avoid the residential property parcels. This adjustment is based on the addition of an interior swale which may be needed to monitor seepage flows.
- Earthwork estimates and site grading.
- Further engineering of design requiring changes in quantities and cost.
- Unidentified, abandoned or improperly located utilities.
- Contamination within the project site
- Potential alternative plans were formulated with less level of detail leading to uncertainty in economics, design and costs.
- Incomplete accounting of existing infrastructure, pipelines, utilities which resulted in increased uncertainty for the baseline potential damage and cost estimates.

- Residual risk of high frequency, induced and residual flooding events associated with the TSP.
- Sea Level Change (SLC) - Given the potential impacts of global climate change and associated SLC, a rise in water surface elevation through SLC may exacerbate erosion rates and storm-related flood damages over the 50-year period of analysis.
- Climate change impacts consider that the timing of benefits and impacts are sensitive to the rate of rise. As a result, identification of the accurate impact will be in the timing of future adaptive responses and the costs.
- Availability of funding for construction of levee
- Relocations - Availability of replacement housing for displaced persons associated with a nonstructural plan, if applicable.

12.0 Plan Implementation

12.1 Institutional Requirements

The Eastwick FRM Feasibility Study was cost-shared 50%-50% between the Federal Government (USACE) and the City of Philadelphia. The deliverable for this study will be a feasibility report and a NEPA compliant Environmental Assessment. Submission of this report by the District Engineer would constitute the first step in a series of events which must take place before the project is constructed. It may be modified at any stage of review, and only if it successfully passes all stages of review would it ultimately be constructed. Upon the USACE North Atlantic Division approval of the final feasibility report, the project will proceed into the Design and Implementation Phase pending execution of a Project Partnership Agreement (PPA) with the non-Federal sponsor.

The initial project cost of the CAP Section 205 Eastwick FRM Project will be cost shared, with 65 percent of initial cost paid by the Federal Government and 35 percent paid by the non-federal sponsor. A PPA package will be coordinated and executed subsequent to the feasibility phase. The PPA will reflect the recommendations of this Feasibility Report.

12.2 Cost Apportionment

The total project cost would be shared between the USACE and the City of Philadelphia, with 65 percent of the cost from Federal funds and 35 percent non-Federal. Section 205 projects have a federal expenditure limit of $10,000,000. Table 12-1 presents the fully funded cost estimate for the proposed project which includes the Federal and non-Federal cost shares. The fully funded cost estimate assumes a single construction season in fiscal year 2023. Feasibility costs include those costs spent to date on the study. It should be noted that the first $100,000 of the project study costs are 100 percent Federally funded and not included in the estimated Total Project Cost shown in Table 12-1.

Table 12-1: Project Cost Apportionment Table

	Total Project Costs
Feasibility Study Costs	**$960,000**
FED Share	$530,000
Non-FED	$430,000
Design and Implementation Costs	**13,332,000**
Monitoring[1]	$35,800
LERRDs[3]	$107,600
FED Share	$8,665,800
Non-FED Share	$4,666,200
Non-FED Cash	$4,666,200
Non-FED LERRD credit	$116,211
TOTAL PROJECT COST[2]	**$14,292,000**
FED Share	$9,195,800
Non-FED	$5,096,200

Notes:

1 Monitoring Costs are incurred after the project is constructed.
2 Total Project Costs do not include operations and maintenance costs.
3 LERRDs are a 100% non-Federal responsibility for which the sponsor gets cost sharing credit.

As the non-Federal project partner, the City of Philadelphia must comply with all applicable Federal laws and policies and other requirements, including but not limited to:

1 Provide all lands, easements, rights-of-way and relocations (LERRD) necessary for the construction, operation and maintenance of the proposed project, and perform or ensure performance of any relocations determined by the Federal Government to be necessary for the initial construction, operation, and maintenance of this project.

2 Perform, or cause to be performed, any investigations for hazardous substances as are determined necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Public Law (PL) 96-510, as amended, 42 U.S.C. 9601-9675, that may exist in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be required for the construction, operation, and maintenance of the Project. However, for lands that the Federal Government determines to be subject to the navigational servitude, only the Federal Government shall perform such investigations unless the Federal Government provides the non-Federal project partner with prior specific written direction, in which case the non-Federal project partner shall perform such investigations in accordance with such written direction.

3 Coordinate 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 to be necessary for the construction, operation, or maintenance of the Project.

12.3 Permits and Authorizations

Permits and authorizations required to implement the TSP include the following:

- USFWS Endangered Species Act concurrence with the determination that the proposed action may affect but not likely to impact threatened and endangered species under their jurisdiction. This approval should be obtained prior to signing the FONSI.
- USACE and PWD will coordinate with PADEP to determine the most appropriate coverage for Section 401 Clean Water Act Certification and any other permits required.
- While a USACE Clean Water Act Section 404 permit is not required, impacts on wetlands would require mitigation.
- Pennsylvania Bureau of Clean Water National Pollutant Discharge Elimination System (NPDES) for Discharges of Stormwater Associated with Construction Activities. Depending on the extent of the construction footprint a General Permit (GP-01 for disturbances less than 5 acres or GP-02 for disturbances greater than 5 acres) or an Individual Permit will be required. Pennsylvania State concurrence with the USACE determination that the proposed action is consistent with the applicable enforceable policies of the that Coastal Resources Management (CRM) Program, as required under the CZMA (in Sub-Appendix A5 of the Environmental & Cultural Appendix).
- Clean Air Act Draft RONA (attached)
- Sedimentation plan

12.4 Views of the Non-Federal Sponsor

The Philadelphia Water Department (PWD), acting as the non-Federal Sponsor on the behalf of the City of Philadelphia (City), is unable to commit to signing the PPA for the design and implementation of the TSP. The City is working to determine the most applicable agency/department, other than PWD now that a levee has been approved by USACE Leadership as the tentatively selected plan. The City of Philadelphia has reservations in signing the PPA due to language in the agreement for acquiring all real estate interests which are outside of the jurisdiction of Philadelphia County. The City of Philadelphia is also assessing its liability if hazardous substances are encountered during construction. The City of Philadelphia hasn't identified the appropriate agency/department in operating and maintaining the levee in perpetuity. Finally, the City needs to ensure that there is community and stakeholder support, including neighboring townships and counties, before signing the PPA.

12.5 Real Estate Requirements

The TSP requires two parcels within the City of Philadelphia. One parcel is privately owned parcel and the other is owned by the NFS. The minimum estates required for these parcels are a Temporary Work Area Easement and Perpetual Flood Protection Levee/Floodwall Easement. There are no proposed non-standard estates for these parcels.

In addition, the proposed levee is partially located in Delaware County. Because a portion of the project is on property outside of Philadelphia County, it cannot be acquired by the current

NFS. If the NFS is unable to acquire all the property interests necessary for the project, then the project will not be able to be constructed as the NFS cannot meet the real estate terms of the PPA. One resolution is to work with the adjacent jurisdiction where the project resides to sign on the PPA as a co-sponsor. Note that the design may be modified during the feasibility phase which could potentially result in the project only being on property the current NFS is authorized and able to acquire.

The Federal Government currently owns no lands in the project area. The PWD is the Non-Federal Sponsor (NFS).

12.6 Operation, Maintenance, Repair, Replacement & Rehabilitation

The purpose of Operations, Maintenance, Repair, Replacement, and Rehabilitation (OMRR&R) is a broad category meant to capture the ongoing costs to the non-Federal sponsor after initial construction of the project is completed. OMRR&R is estimated based on the type of measure proposed and the initial construction cost of that measure, in this case the levee. OMRR&R for levees typically include a variety of activities. These can be broken into a few categories. The first, wildlife and vegetation control, includes activities such as mowing of the levee embankment and clearzone on both sides, repair/refilling of holes from burrowing animals on the levee embankment, and the spraying of herbicides, and weeding to keep vegetation from growing in riprap armored portions of the levee. A second category, routine inspection and preventative maintenance, involves activities such as conduit inspections, inspection and painting of flap gates, and other metal features, inspection and repair of concrete features (headwalls), regular inspection and testing of pump station if present. A third category, flood fighting, involves the operation of the levee during high-water events. This generally, includes more frequent inspections of the levee, looking for signs of failure, and the operation of the pump station, if present. The last category, post-storm inspection and maintenance, includes the cleanup and removal of detritus that has built up around, and on the levee, and inspecting the levee for potential damage caused by the high-water event. Annual OMRR&R costs were estimated to be approximately 0.5% of the construction cost for this project. This estimated cost will be updated in the future.

13.0 Coordination, Public Views, and Comments*

This EA was developed in accordance with the applicable regulations, policies, and procedures, including USACE's NEPA regulations at Engineers Regulations (ER) 200-2-2 and the CEQ's NEPA regulations at 40 CFR Part 1500 (NEPA Implementing Regulations).

The project was developed by USACE in partnership with Philadelphia Water Department. The project is being coordinated with local stakeholders. The USACE Eastwick Study PDT has participated in a series of regularly scheduled meetings inclusive of Federal and non-federal, environmental resource agencies, stakeholders, and public throughout the course of Study since 2018. These meetings include Federal Leadership meetings (Monthly), Interagency Meetings (Monthly), Federal/City Leadership Meetings (Occasional), Model Coordination Workshop Meetings (Occasional), Community Days (as needed), and Town Halls (Quarterly). Additionally, public meetings/open houses were held in the Summer of 2023 associated with the release of the draft IFR/EA. Scoping was conducted in September 2020. Some initial considerations that were raised include the following:

- Mitigation may be needed for impact to wetlands. There is potential that there are forested wetlands at northern levee tie-in location. EPA is constructing wetlands at/near the southern levee tie-in location.
- The City of Philadelphia does not currently have an entity or agency that handles and maintains levees – this is a new territory for the City. An entity will need to be identified within the City of Philadelphia to sign an agreement with Army Corps for project design and construction.
- This levee would be unique because it ties into a landfill. The City of Philadelphia will be responsible for addressing any contaminated material encountered during construction.
- Acquisition of real estate instruments will be the responsibility of the City of Philadelphia. The levee is partially located in Delaware County, so the levee tie-ins into the landfill will require the acquisition of real estate instruments by Delaware county and/or associated municipalities.

Public review of the draft IFR/EA is occurring in 2023. Public notice of the availability of draft IFR/EA will be distributed in the following methods:

1) Distribution to the USACE Philadelphia District Subscriber's List (approximately 300 contacts).
2) Coordination with the Philadelphia Office of Sustainability to send an email of availability to their Eastwick stakeholders list which includes various agencies and stakeholders and of course members of the public.
3) A reduced agency list comprising attendees of the FEMA monthly interagency conference call. Some of these participants include FEMA, HUD, EPA, USFWS, PEMA, PADEP, and Philadelphia Office of Sustainability among others.
4) Engagement with Congresswoman Mary Gay Scanlon's office which has offered to include a narrative in some of their various communications.

Consultation is being conducted in accordance with all applicable requirements. Pertinent correspondences are provided in in Sub-Appendix A6 and A7 of the Environmental & Cultural

Appendix. Responses received to comments provided during public review will be provided in Sub-Appendix A7.

14.0 Recommendations (DRAFT)*

As a result of this Draft Integrated Feasibility Report and Environmental Assessment, USACE recommends that the least cost alternative with the highest average annual net benefits proceed to a final design in the Design and Implementation Phase of the project. Further, this Draft Report consists of all planning and design activities that demonstrate that Federal participation is warranted at this time. A Final Integrated Feasibility Study and Environmental Assessment is required and will be developed in the future. During the Design and Implementation Phase, other actions such as completing plans and specifications and obtaining necessary permits will be conducted leading to a construction contract award. Additional funding is required to scope the PMP and execute the Project Partnership Agreement (PPA) to construct the least cost alternative plan with the highest average annual benefits.

This Draft Integrated Feasibility Report and Environmental Assessment has been prepared to evaluate flood risk management alternatives for the Eastwick neighborhood in Philadelphia County in regard to their relative completeness, effectiveness, efficiency and acceptability and potential impact to existing ecological, cultural and socio-economic resources. The levee alternative has the highest average annual net benefits and was the only alternative that met all planning criteria. This recommended alternative includes a 1,370-foot levee in the vicinity of Darby Creek at elevation +24.7 feet (NAVD88). The levee would tie into the USEPA Clearview landfill on the south side.

This Draft Integrated Feasibility Report and Environmental Assessment has given consideration to aspects in the overall public interest, including environmental, social, and economic impacts; feasibility; and the ability and interests of the non-Federal sponsor. The sponsor, the City of Philadelphia, will enter a Project Partnership Agreement to perform the required items of cooperation, including provision of all needed real estate interests, provision of cash as needed beyond real estate values to constitute 35 percent of total costs, and post-construction operation and maintenance of the project.

I recommend that the proposed plan for flood risk management be approved and implemented. This recommendation reflects the information available at this time and with respect to current departmental policies.

(Signed in Final Feasibility Report after Public Review)

_____ Date

_____
Jeffrey M. Beeman
Lieutenant Colonel, Corps of Engineers
District Commander

15.0 List of Preparers*

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Scott Sanderson – Project Development Branch Chief
Chris Carnes –Design Manager
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Valerie Whalon – Environmental Resources
Nicole Minnichbach – Cultural Resources
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Jeffrey Sklencar – Cost Engineering
Jake Helminiak – Hydrology and Hydraulics
Christopher Bomba – Civil Design
Conor McCafferty – Geotechnical Engineering
Steven Langseder – Geo-Environmental
Janay Dixon – Real Estate
Steve Long – Geographic Information System Support

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17.0 Record of Non-Applicability (RONA)

Project Name: Eastwick, Philadelphia County, Pennsylvania Flood Risk Management Study

Reference: Eastwick, Philadelphia County, Pennsylvania, Flood Risk Management Continuing Authorities Program Section 205, Integrated Feasibility Report & Environmental Assessment

Project/Action Point of Contact: Valerie Whalon, CENAP-PL-E

Begin Date (tentative): December 2025

End Date (tentative): August 2025

Project Description: The Eastwick neighborhood of Philadelphia has a problem with flooding of structures, primarily residential, from Cobbs Creek during high streamflow events. Flooding especially occurs between 78th and 82nd Streets, from the creek to Chelwynde Avenue. The purpose of the feasibility study is to investigate potential flood risk management (FRM) solutions for Eastwick. The Tentatively Selected Plan (TSP) is a 1300-linear foot levee within Eastwick Park. The levee typical section includes a crest elevation of +24.7 ft (NAVD88) with a 10-ft wide crest and 2H:1V riprap side slope on the creek slide and 3H:1V grass side slope on the community side. The levee was laid out such that the inner toe is at least 50 feet away from the nearest structure. The plan also assumes that the levee is grass lined and that the distance from the outer toe of the levee to the left bank of Cobbs Creek was also grassed. The preliminary levee design crest was sufficient to pass the 1% AEP (100-year ARI) flood event without overtopping..

1. An emissions estimate was completed to determine the Nitrogen Oxides (NOx) and Volatile Organic Carbon (VOC) emissions (precursors to ozone formation) and Particulate Matter (specifically $PM_{2.5}$) associated with the Eastwick FRM Study. The total estimated emissions from the construction of the TSP is is 9.52 tons of NOx, 1.50 tons of VOC, and 0.49 ton of $PM_{2.5}$ (Table 1 – Sub-Appendix A1 of the Environmental & Cultural Appendix). Construction of the project will be completed in approximately 8 months. These emissions are well below the de minimis levels established by the EPA of 100 tons of NOx and $PM_{2.5}$ and 50 tons of VOC per year. A conformity determination is not required for this project because the total direct and indirect emissions from the project are below the de minimis levels set forth at 40 CFR 93.153 (b) for ozone (NOx and VOC) in a Marginal Nonattainment Area (100 tons and 50 tons of each pollutant per year) and $PM_{2.5}$ in a maintenance area. The project is not considered regionally significant under 40 CFR 93.153 (i).

2. The project described above has been evaluated for Section 176 of the Clean Air Act. Project related emissions associated with the Federal action were estimated to evaluate whether a conformity determination is required in accordance with General Conformity

regulations (40CFR Part 93, Subpart B).

3. The project is located in Philadelphia, PA, which has the following nonattainment-related designations with respect to the National Ambient Air Quality Standards (40 CFR §81.133): Marginal Nonattainment for the 2015 8-hour Ozone Standard (primary and secondary), and Maintenance Area for the 2006 $PM_{2.5}$ Standard.

4. A conformity determination is not required because the total direct and indirect emissions from this project are less than the 100 tons de minimis level for NO_x and $PM_{2.5}$ for each project year and significantly below the 50 tons de minimis level for VOC (40 CFR §93.153(b)(1) & (2)), as VOCs, are typically a fraction of total NOx emissions. The estimated emissions for the project for each pollutant are provided below.

CALENDAR YEAR	MONTHS	TONS NOx	TONS VOC	TONS PM2.5
2025-2026	8	9.52	1.50	0.49

5. The project conforms with the General Conformity requirements (40 CFR §93.153(c)(1)), and is exempted from the requirements of 40 CFR §93 Subpart B.

Peter R. Blum, P.E.
Chief, Planning Division

Date