US Army Corps of Engineers®

# Papillion Creek and Tributaries Lakes, Nebraska

General Reevaluation Report

## Final Feasibility Report

**June 2021**

**Omaha District**
**Northwestern Division**

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# Executive Summary

**Study Information –** The purpose of the Papillion Creek and Tributaries Lakes, Nebraska General Reevaluation Report is to address flood risk issues in order to reduce flood and life safety risks in the Papillion Creek Basin. The report documents a Federal interest in implementation of structural and nonstructural measures. This report has been prepared in response to the authorization in the Energy and Water Development Appropriation Act, 1982 (Public Law 97-88) House Report No. 97-177 to conduct a General Reevaluation Study of the Papillion Creek and Tributaries Lakes, Nebraska Report. The Papillion Creek and Tributaries Lakes, Nebraska project was originally authorized by Public Law 90-483, the Flood Control Act (FCA) of 1968, in accordance with the recommendations of the Chief of Engineers in House Document No. 349. The authorized project consisted of a system of 21 dams and reservoirs, located on tributaries upstream from Metropolitan Omaha. In addition to flood control, the other purposes of the authorized project are recreation, fish and wildlife enhancement, and water quality. Of the 21 authorized dams, only four were built by USACE as a part of the Federal project. Since the completion of the Federal project, the Papio-Missouri River Natural Resources District (NRD) has continued to implement additional flood risk management through constructing four additional non-Federal dams, several detention basins, and nine additional non-Federal levee systems.

The report presents the flood risk management problems and opportunities within the Papillion Creek Basin as well as the measures and alternatives considered to reduce damages within the region. The economic analysis for each measure and alternative is documented and a Recommended Plan is presented. The study was conducted in conjunction with the NRD, serving as the non-Federal sponsor, and the U.S. Army Corps of Engineers (USACE). The study area encompasses the entire Papillion Creek watershed. The watershed covers most of Douglas County, and parts of Washington and Sarpy Counties in Nebraska. It drains an area of approximately 402 square miles. The three major streams draining the watershed are the Big Papillion Creek, Little Papillion Creek, and West Papillion Creek.

The study area has long been subject to damaging floods. Floods or threats of floods occur almost every year during the summer thunderstorm season which is when about 40 percent of the annual precipitation occurs. Flooding records are somewhat fragmented in nature prior to the installation of the initial USACE gaging station at Fort Crook in 1946. Major floods occurred June 3, 1943; June 20, 1960; June 16, 1964; and September 7, 1965. In addition, moderate floods or bank full stages are recorded for August 1932, July 1944, June 1946, June 1947, August 1950, June 1951, May 1957, and August 1959. The Big Papillion Creek drainage area sustained flood damage in all four years of major floods.

The Little Papillion Creek drainage area escaped the 1964 flood but sustained heavy flood damages in 1960 and 1965. The June 20, 1960 flood resulted in $671,000 in damages within the Papillion Creek basin. Little Papillion and West Papillion Creek were affected.

The 1964 flood, which was the basin's most damaging flood, centered over the West Papillion Creek drainage area. Seven lives were lost and millions of dollars in personal property losses resulted. 95 trailer homes were swept more than a half mile downstream by

torrential flooding in the Millard area. During that storm, eight inches of rain falling for three hours on Hell Creek flowing down from Boys Town into the West Branch Papillion Creek created a roaring torrent of water 50 feet wide with waves five feet high. Approximately 4,500 acres of farmland were flooded near Big Papillion Creek and south of Dodge Street on the Big Papillion Creek, 108 homes and 34 businesses were flooded and an estimated $6M in damages occurred (Papio-NRD, 2019).

A gaging station started on Papillion Creek in 1929 had recorded 11 floods through 1965 (NDNR, 2013). Several more recent flood events (1994, 1997, 1999, 2004, 2008, and 2014) continue to highlight that severe flood risks remain, and the 1999, 2004, and 2014 events resulted in one fatality each. The Papillion Creek has sustained damage from virtually every flood event because it receives flows from all three major tributaries. Continued urbanization of the Papillion Creek basin will cause increases in the damage potential.

**Problem** – There is significant risk to public health, safety, and property in the Papillion Creek Basin due to seasonal rainfall events combined with undersized bridges, culverts, and channels and extensive development in the floodplain that result in residential and commercial flooding in the Papillion Creek Basin. Based on updated floodplain mapping there are approximately 4,100 structures in the 0.2% annual exceedance probability (AEP) floodplain with an approximate total investment value of $4.5B and expected annual damages (EAD) of over $14M. In addition, there are several critical facilities that lie within the floodplain, including 3 correctional facilities, 13 emergency services facilities, 6 schools and 1 airport. The population at risk is approximately 25,000 people at night and 59,000 people during the day within the 0.2% AEP floodplain.

**Planning Objectives** – The Federal objective of water and related land resources project planning is to contribute to National Economic Development (NED) consistent with protecting the Nation's environment, pursuant to national environmental statutes, applicable executive orders, and other Federal planning requirements. Planning objectives represent desired positive changes to the future without-project conditions. All of the planning objectives focus on activity within the study area and within the 50-year period of analysis. These planning objectives are:

1) Reduce the likelihood and consequences of flooding on human life and safety in the Papillion Creek Basin.
2) Reduce the risk of flood damage to property, businesses, and infrastructure (including critical facilities) in the Papillion Creek Basin due to flooding.
3) Incorporate natural and nature-based systems, where possible, to preserve and increase the area and habitat function of the Papillion Creek and its tributaries consistent with Section 1184 of WRDA 2016.
4) A secondary objective of a justified flood risk management (FRM) plan is to improve recreational opportunities in the Papillion Creek watershed.

**Plans Considered** – The planning process went through several iterations and evaluated a large range of structural and nonstructural measures. The range of study alternatives was refined based on preliminary analyses of effectiveness and cost. Several alternatives were

screened from further consideration as they were found to be either economically unjustified or were less efficient at reducing flood damages than other alternatives. The Recommended Plan is highlighted in the final array of alternatives table below.

**Final Array of Alternatives:**

| Final Array | Alt 1 – No Action Alternative | Alt 2 – Dams/ Reservoirs | Alt 3 – Channel Modifications/ Levees/ Floodwalls | Alt 4 – Nonstructural | Alt 5 – Combined Plans |
|---|---|---|---|---|---|
| **West Papillion** | No Action | | Floodwall | Elevation, Dry Floodproofing, Basement Fill, Acquisition | Alt 3 + Alt 4 |
| **South Papillion** | No Action | Dam Site 19 | | Elevation, Dry Floodproofing, Basement Fill, Acquisition | |
| **Little Papillion** | No Action | Dam Site 10 | New Levee/ Floodwall | Elevation, Dry Floodproofing, Basement Fill, Acquisition | Alt 2 + Alt 3 + Alt 4 |
| **Big Papillion** | No Action | | - Channel Widening<br>- Levee Raise/ Floodwall | Elevation, Dry Floodproofing, Basement Fill, Acquisition | Alt 3 + Alt 4 |
| **Papillion Creek** | No Action | | | Dry Floodproofing, Acquisition | |
| **Saddle Creek** | No Action | | | Elevation, Dry Floodproofing, Basement Fill, Acquisition | |
| **Cole Creek** | No Action | | | Elevation, Dry Floodproofing, Basement Fill, Acquisition | |

Damage probability relationships for risk reduction reaches with the proposed alternatives in place were estimated. Construction, real estate, mitigation, operations, and maintenance cost estimates were prepared for each alternative. Alternatives were screened at risk reduction levels based on equivalent annual values of damages avoided over the period of analysis, as compared to the No Action alternative. From these assessments, net economic benefits and benefit-cost ratios were calculated.

**Recommended Plan/NED Plan and Other Accounts** – Through several iterations of the planning process, the alternatives that maximize net benefits and reasonably maximize all benefits were selected. The Recommended Plan (RP) includes South Papillion Creek Dam

Site 19 (dam with 74-acre conservation pool and sediment detention) near Gretna, NE, Thomas Creek Dam Site 10 (dry dam) in rural Douglas County, NE and Little Papillion Creek new levee/floodwall (3.67 miles on right bank and 2.98 miles on left bank with 8 road and bridge closure structures) in Omaha, NE and nonstructural features including 71 basement fills, 59 elevations of residential structures and 256 dry floodproofing of commercial/industrial/municipal structures along Big Papillion Creek, Cole Creek, Papillion Creek, Saddle Creek, South Papillion Creek, and West Papillion Creek. The Dam Site 19 reservoir also includes associated recreational features consisting of a 2.5-mile trail, parking lots, restrooms, picnic shelter, boat access, and related features. Required mitigation of stream, wetland, and riparian forest impacts is also included. The Recommend Plan has substantial economic benefits and reduces study area expected annual flood damages by 51 percent overall, and by 69-78 percent across the South Papillion, Little Papillion, Thomas, and Saddle Creek portions of the watershed. It is important to note that the economic analysis completed as part of this study evaluated NED benefits from flood risk management only before adding recreation benefits. The NED benefits and costs are summarized below.

In addition to NED, the recommended plan provides further benefits and minimizes impacts in terms of Regional Economic Development (RED), Environmental Quality (EQ), and Other Social Effects (OSE). The implementation of the Recommended Plan would result in local economic activity which is accounted for within the RED account. The Recommended Plan is expected to result in approximately $107,170,094 in construction expenditures across the region. These construction expenditures are expected to support approximately 1,697 local jobs and approximately $114,061,171 in local value added within the local impact area. A summary of potential impacts on natural and cultural resources for each stream was identified based on the Recommended Plan to ensure that the EQ Account is not adversely impacted and required mitigation is included. With mitigation, the Recommended Plan is not anticipated to cumulatively degrade the habitat or current resources within the basin due to its present, altered condition. The Recommended Plan is not anticipated to adversely impact Cultural Resources, a Programmatic Agreement (PA) is finalized in consultation with the Nebraska State Historic Preservation Office, the Advisory Council on Historic Preservation, and Interested Parties to address potential impacts to unrecorded historic properties that may be discovered prior to, or during, the construction of levees, floodwalls, and reservoirs on undeveloped land as well as potential effects from nonstructural modifications to existing properties should the property owners choose to participate in the nonstructural part of the recommended plan. Adverse effects associated with the Recommended Plan are short-term and minor, primarily limited to construction activities. OSE was also considered including impacts to life safety. A risk assessment was conducted on the recommended Little Papillion Creek levee/floodwall, DS19, and DS10 to inform potential life safety risks associated with their construction. The DS19 and DS10 risk analysis show the structures fall well below USACE's societal tolerable risk limit and the structures would be constructed in a way that they would meet USACE's Tolerable Risk Guidelines as defined in ER 1110-2-1156 and expanded upon in Planning Bulletin 2019-04. For the Little Papillion Creek recommended plan levee/floodwall alternative will reduce potential life loss by 2 orders of magnitude over

the existing condition. Given irreducible uncertainties inherent in flood frequency analysis, the NED Plan will pass the 1 percent event with 76 percent assurance.

An Environmental Assessment has been prepared and included with this report. This assessment reviewed the existing environmental conditions of the study area and discusses the potential impacts of the various project alternatives considered and the Recommended Plan. No significant impacts have been identified; however, some environmental mitigation is required.

**Environmental Mitigation –** The Recommend Plan necessitates the removal of 23.5 acres of riparian forest habitat for dam construction, reservoir inundation and levee/floodwall construction and would require replacement. 31.8 acres of tree plantings would occur within the boundaries of the normal operating pool and maximum operating pool of DS19; 3 acres would be replaced at DS10. Estimated costs for mitigation of riparian forest habitat were calculated to be approximately $405,264. Additionally, 0.35 acres of palustrine emergent (PEM) wetlands would be directly filled from embankment construction of DS19, resulting in the restoration of 1.4 acres of PEM wetlands through the excavation of shallow areas connected to the edge of the normal pool area of DS19. Costs associated with PEM wetland mitigation are estimated at $54,100 for excavation and seeding. Impacts from converting a stream to a lacustrine system would also require mitigation; this would be accomplished by planting a 100-foot wide buffer of native prairie and wetland plants along each side of the Little Papillion Creek for 1,000 feet and planting a 100-foot wide buffer along both sides of South Papillion Creek for 1,200 feet. This would result in 10.1 mitigation acres for stream impacts at an estimated cost of $151,500. Mitigation requirements were determined through analysis utilizing the Nebraska Stream Condition Assessment Procedure and the Brown Thrasher Habitat Evaluation Procedure.

**Benefits and Costs –** The RP has a total project cost of $134,127,000 and average annual costs of $5,423,190, which includes operations, maintenance, repair, rehabilitation, and replacement costs (OMRR&R). Annual average net benefits are $2,790,510 with a benefit-to-cost ratio (BCR) of 1.51. These values were calculated at a discount rate of 2.5 percent over a 50-year period of analysis with an estimated three years for Pre-Construction Engineering and Design (PED) and five-year construction period. The fully funded cost share, including lands, easements, rights-of-way, relocations, and disposal areas (LERRDs) is expected to be $86,592,000 Federal, and $47,534,000 non-Federal. The sponsor is responsible for 100 percent of the OMRR&R cost.

**Public Involvement –** Public scoping meetings for the feasibility study and environmental assessment were held on December 3 and 5, 2018. An additional public meeting, which was requested by the public during the scoping meetings to discuss potential alternatives under evaluation, was held July 23, 2019. The draft report was available for public comments November 21, 2019 through January 3, 2020 and the draft report public meeting was held on December 3, 2019. The draft final feasibility report public meeting was held virtually on February 10, 2021 due to the COIVD pandemic. Invitations and announcements for the meetings were made in public websites, local City announcements, and through contacts in routine communication channels. Feedback from these meetings showed that the public and

officials in the local area recognized the need for effective flood risk management in the Omaha area. Issues and concerns raised by the public throughout the study process included:

- Implementation of DS10 and the need to acquire private land
- Long-term sedimentation of dams
- Inadequate enforcement of floodplain regulations
- Operations and Maintenance Costs
- Modeling Efforts

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## LIST OF ACRONYMS & ABBREVIATIONS

| | |
|---|---|
| AEP | Annual exceedance probability |
| APE | Area of Potential Effect |
| AQI | Air quality index |
| BCR | Benefit to cost ratio |
| BFE | Base flood elevation |
| BGEPA | Bald and Golden Eagle Protection Act |
| BMP | Best management practices |
| CAA | Clean Air Act |
| CERCLA | Comprehensive Environmental Response, Compensation, and Liability Act |
| CFR | Code of Federal Regulations |
| cfs | Cubic feet per second |
| CSRA | Cost and Schedule Risk Analysis |
| CWA | Clean Water Act |
| DFE | Design flood event |
| DS | Dam site |
| EA | Environmental Assessment |
| EAD | Expected annual damages |
| ECB | Engineering and Construction Bulletin |
| ECO-PCX | Ecosystem Planning Center of Expertise |
| EIS | Environmental Impact Statement |
| EM | Engineer Manual |
| EO | Executive Order |
| EPA | Environmental Protection Agency |
| EQ | Environmental Quality |
| ER | Engineer Regulation |
| ESA | Endangered Species Act |
| FCA | Flood Control Act |
| FCSA | Feasibility Cost Share Agreement |
| FEMA | Federal Emergency Management Agency |
| FIRM | Flood Insurance Rate Map |

| | |
|---|---|
| FIS | Flood Insurance Study |
| FRM | Flood risk management |
| FWCA | Fish and Wildlife Coordination Act |
| FWOP | Future without-project |
| H&H | Hydrology and hydraulics |
| HEC-FDA | Hydrologic Engineering Center – Flood Damage Reduction Analysis |
| HEC-RAS | Hydrologic Engineering Center – River Analysis System |
| HEP | Habitat Evaluation Procedure |
| HMP | Hazard Mitigation Plan |
| HIS | Habitat Suitability Index |
| HTRW | Hazardous, Toxic, or Radioactive Waste |
| HU | Habitat unit |
| HUC | Hydrologic Unit Code |
| IBI | Index of Biotic Integrity |
| IDC | Interest During Construction |
| IFB | Invitation for Bid |
| IPaC | Information, Planning, and Consultation System |
| LERRD | lands, easements, rights-of-way, relocations, and disposal areas |
| LRIP | Long-range implementation plan |
| LST | Levee Screening Tool |
| MAPA | Metropolitan Area Planning Agency |
| MBTA | Migratory Bird Treaty Act |
| msl | Mean sea level |
| MUD | Metropolitan Utilities District |
| NAAQS | National Ambient Air Quality Standards |
| NAVD88 | North American Vertical Datum of 1988 |
| NDEQ | Nebraska Department of Environmental Quality |
| NED | National Economic Development |
| NEPA | National Environmental Policy Act |
| NeSCAP | Nebraska Stream Condition Assessment Protocol |
| NFIP | National Flood Insurance Program |
| NGPC | Nebraska Game and Parks Commission |
| NHPA | National Historic Preservation Act |
| NISA | National Invasive Species Act |
| NLD | National Levee Database |
| NPDES | National Pollutant Discharge Elimination System |
| NRCS | Natural Resources Conservation Service |
| NRD | Natural Resources District |
| NRHP | National Register of Historic Places |
| O&M | Operations and maintenance |
| OMRR&R | Operations, maintenance, repair, rehabilitation, and replacement |
| OPPD | Omaha Public Power District |
| P&G | Principles and Guidelines |
| PA | Programmatic Agreement |
| PAR | Population at risk |
| PB | Planning Bulletin |

| | |
|---|---|
| PCWP | Papillion Creek Watershed Partnership |
| PDT | Project Delivery Team |
| PED | Pre-Construction Engineering and Design |
| PEM | Palustrine emergent |
| PL | Public Law |
| PM | Particulate matter |
| PMF | Probable Maximum Flood |
| PPA | Project Partnership Agreement |
| RP | Recommended Plan |
| SBMP | Stream Biological Monitoring Program |
| SCRB | Separable cost-remaining benefit |
| SHPO | State Historic Preservation Office |
| SQRA | Semi-Qualitative Risk Assessment |
| SWPPP | Stormwater Pollution Prevention Plan |
| TMDL | Total maximum daily load |
| TRG | Tolerable Risk Guideline |
| TSP | Tentatively selected plan |
| UDV | Unit Day Value |
| USACE | U.S. Army Corps of Engineers |
| USC | United States Code |
| USFWS | United States Fish and Wildlife Service |
| WRDA | Water Resources Development Act |
| WSE | Water surface elevation |

# 1 STUDY AUTHORITY

The Energy and Water Development Appropriation Act, 1982 (Public Law 97-88) House Report No. 97-177 authorized a General Reevaluation Study of the Papillion Creek and Tributaries Lakes, Nebraska Report. The Papillion Creek and Tributaries Lakes, Nebraska project was originally authorized by Public Law 90-483, the Flood Control Act of 1968, in accordance with the recommendations of the Chief of Engineers in House Document No. 349. The authorized project consisted of a system of 21 dams and reservoirs, located on tributaries upstream from Metropolitan Omaha. In addition to flood control, the other purposes of the authorized project are recreation, fish and wildlife enhancement, and water quality. The Papillion Creek and Tributaries Lakes, Nebraska General Reevaluation Report study began September 12, 2018, with the execution of a Feasibility Cost Sharing Agreement (FCSA) between the USACE and the Papio-Missouri River Natural Resources District, (Papio-NRD or NRD; local non-Federal sponsor).

# 2 STUDY PURPOSE AND SCOPE

The purpose of the Papillion Creek and Tributaries Lakes, Nebraska General Reevaluation Report study is to address flood risk in order to reduce flood and life safety risks in the Papillion Creek Basin. This feasibility report documents the existing conditions, evaluation of alternatives, and recommendations for Papillion Creek and its tributaries and lakes. These recommendations are intended for authorization and implementation following the approval of this final report.

Of the 21 dams authorized by the FCA of 1968, only four dams were constructed as part of the Federal project, and the plan was updated in the 1980s to substitute channel improvements and levees to address localized risks in specific reaches. There are four dams and six levee systems which comprise the completed Federal project. The Federal dams (Cunningham, Standing Bear, Wehrspann, and Zorinsky) are owned and operated by USACE and are leased to local sponsors who operate and maintain the upstream lands for public recreation. Since the completion of the Federal project, the local sponsors have continued to implement additional flood risk management through constructing four additional non-Federal dams, several detention basins, and nine additional non-Federal levee systems (see Figure 5 below).

Based on updated floodplain mapping at the time of the alternative measures development, there are approximately 4,700 structures in the 0.2 percent annual exceedance probability (AEP) floodplain with an approximate structure value of $1.9 billion. In addition, there are numerous critical facilities that lie within the floodplain, including three law enforcement facilities, 13 emergency services facilities, six schools and one airport. The population at risk is approximately 25,000 people at night and 59,000 people during the day within the 0.2 percent AEP floodplain.

The AEP is a measure of the probability of a flood occurring in any given year; therefore, a 0.2 percent AEP has a 0.2 percent chance of occurring in any given year (corresponds to a 500-year return interval). Table 1 shows AEP probabilities and corresponding recurrence intervals that may be used in this report.

**Table 1. AEP Probabilities and Corresponding Flood Return Intervals**

| AEP (%) | Return Interval (Yrs) |
|---|---|
| 0.2 | 500 |
| 1 | 100 |
| 2 | 50 |
| 4 | 25 |
| 10 | 10 |
| 20 | 5 |
| 50 | 2 |

This study is situated in a highly urbanized area prone to flash flooding. As a result, there is a threat to life safety in the communities of Omaha, Papillion, Ralston, Elkhorn, Bellevue, LaVista, Boys Town, Bennington, and Gretna along with a high risk of economic flood damage to associated urban infrastructure. The study is being formulated to reduce the risk of flooding to commercial, residential and public infrastructure along the various Papillion Creek tributaries, consistent with protecting the nation's environment, pursuant to national environmental statutes, with applicable executive orders and with other Federal planning requirements.

The study considers flood risk management alternatives in the Papillion Creek Basin, specifically along West Papillion Creek, Big Papillion Creek, Little Papillion Creek, South Papillion Creek, Saddle Creek, Papillion Creek, Cole Creek, and Thomas Creek. Future with- and without-project risks to life safety are considered in the study consistent with Planning Bulletin (PB) 2019-04. There are minimal risks to the environment expected if the recommended plan was approved and implemented.

The study area encompasses the entire Papillion Creek watershed. The watershed covers most of Douglas County, and parts of Washington and Sarpy Counties in Nebraska. It drains an area of approximately 402 square miles. The three major streams draining the watershed are the Big Papillion Creek, Little Papillion Creek, and West Papillion Creek. A study area map is shown in Figure 1. Detention in the upper parts of the basin, structural measures, and nonstructural measures in the lower part of the basin are all being considered in the alternatives analysis, therefore, the project area is consistent with the study area.

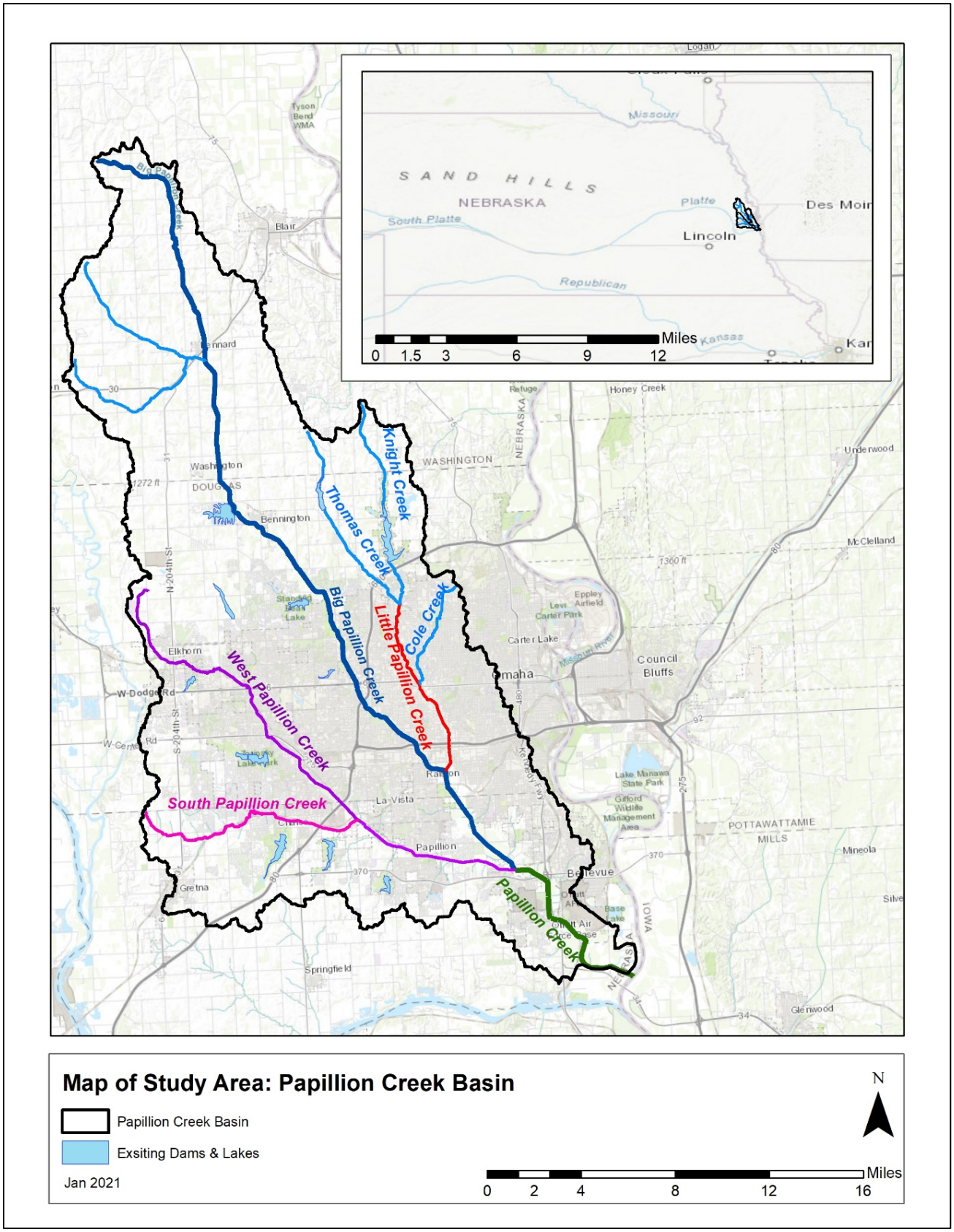



**Figure 1. Map of Study Area**

# 3 PRIOR STUDIES

On July 23, 1946, Congress initiated interest in determining the need for flood control within the Papillion Creek basin and on November 30, 1949, the first survey was authorized for Big Papillion Creek and its tributaries. Since the early 1960s, the Papillion Creek basin has been extensively studied. The existing project was authorized by specific legislation, as documented in reports of Congress, and was implemented through a series of design memorandums, and operations and maintenance (O&M) manuals. Following the partial implementation of the original project, various reevaluation reports and studies associated with the project or the basin have been published. A select listing of documents follows which are considered important to the current feasibility study.

**April 1961: Survey Report on Flood Control Papillion Creek & Tributaries -** Initial investigation into recommending a project along Little Papillion Creek.

**February 1967: Review Report Papillion Creek & Tributaries -** Comprehensive multi-volume report that came about as a result of the devastating June 1964 flood. Report recommends construction of 21 dams and reservoirs at a cost of $26.8 million, at a benefit to cost ratio (BCR) of 2.0.

**November 1967: Papillion, Big Papillion Creek, West Papillion Creek, Omaha Metro NE -** First of three volumes looking at floodplain information for the Omaha Metro in the Papillion Creek watershed.

**April 1968: Little Papillion Creek, South Branch, Omaha Metro NE -** Second of three volumes looking at floodplain information for the Omaha Metro in the Papillion Creek watershed.

**May 1969: Thomas Creek, Cole Creek, Hell Creek, Big Papillion Creeks -** Third of three volumes looking at floodplain information for the Omaha Metro in the Papillion Creek watershed.

**August 1971: Papillion Creek & Tributaries -** Similar to the February 1967 report, except Site 17 was dropped due to not being cost effective (Note - Site 17, Candlewood Lake, was built by a private developer).

**September 1975: Papillion Creek Plan Evaluation** - Details changes to previously authorized project.

**March 1985: Reevaluation Report & Final Supplement to Final Environmental Impact Statement (EIS) -** Comprehensive reevaluation report that recommended a combination of structural and nonstructural measures within the basin.

**January 1992: Union Pacific Railroad Bridge at Papillion Creek Model Study** - Results of physical model study on concrete flume, integral part of Big Papillion Creek channel improvement project.

**December 1997: HEC-1 Model of West Papillion Creek Omaha NE** - Report prepared by HDR for USACE as a part of a Section 22 study.

**November 1999: West Papillion Creek Section 22 -** Section 22 report prepared for Papio-Missouri River NRD that incorporates USACE hydraulics and HDR hydrology from 1997.

**September 2004: Multi-Reservoir Analysis, Papillion Creek Watershed -** Report by HDR prepared for the Papio-Missouri River NRD to assess the feasibility of several dam sites.

**September 2007: West Papillion Creek Section 22 -** Hydrology portion of Phase II Section 22 report.

**April 2009: Papillion Creek Watershed Management Plan -** Report by HDR prepared for the Papio-Missouri River NRD and the Papillion Creek Watershed Partnership to develop a watershed management plan for the basin.

**August 2011: Papillion Creek Watershed Nebraska Hydrologic Analysis -** Report by USACE to update previous floodplain mapping for watershed to reflect current land use conditions, development, and stream characteristics. Includes a 2008-2010 modeling effort.

**March 2014: Papillion Creek Watershed Management Plan, 2014 Update -** Report by HDR prepared for the Papio-Missouri River NRD and the Papillion Creek Watershed Partnership to update the 2009 Plan.

**October 2014: Hydrologic Engineering Branch Technical Report, Lower Papillion Creek** - Unsteady flow hydraulic routing analyses for Douglas and Sarpy counties, Nebraska.

**March 2015: Papillion Creek Watershed, Douglas and Sarpy Counties, NE** - Development of hydraulic models necessary to determine water surface profiles and inundations for selected flood frequencies for the Papillion Creek Watershed in Douglas and Sarpy counties, Nebraska, and incorporated areas.

# 4 PLAN FORMULATION

The USACE uses a six-step planning process to guide project studies, as detailed in Engineer Regulation (ER) 1105-2-100 “Planning Guidance Notebook.” This process is a structured approach to problem solving which provides a rational framework for Federal project decision making. The six steps are (Figure 2):

1) Specify water and related land resource problems and opportunities (relevant to the planning setting) associated with the Federal objective and specific state and local concerns
2) Inventory, forecast, and analyze water and related land resource conditions within the planning area relevant to the identified problems and opportunities
3) Formulate alternative plans
4) Evaluate effects of the alternative plans
5) Compare alternative plans
6) Select recommended plan based upon the comparison of alternative plans

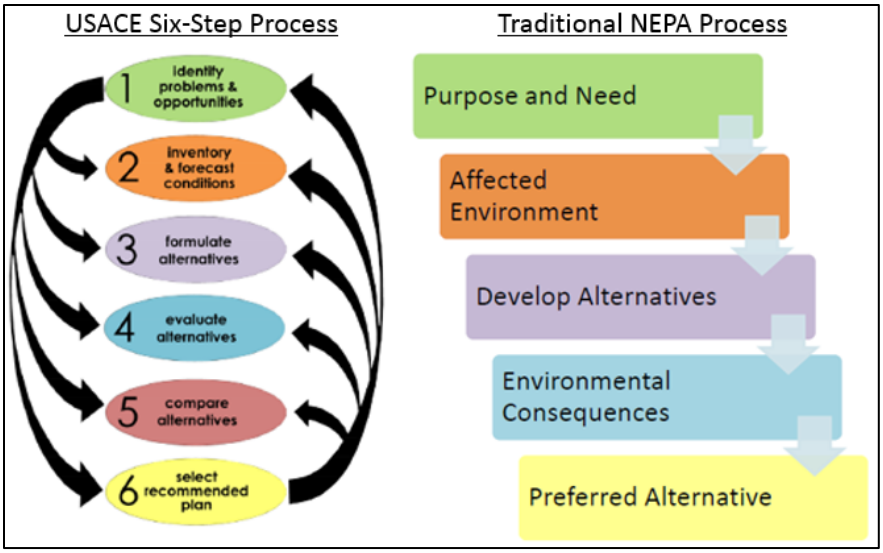



**Figure 2. USACE Six-Step Process**

Plan formulation is the process of evaluating existing conditions and building alternative plans that meet planning objectives and avoid planning constraints. This study examines and addresses the Federal criteria of completeness, efficiency, effectiveness, and acceptability. To adequately address these criteria, the development and early screening of potential alternatives considered a number of evaluation factors. Primary among those factors are the following:

- Engineering and flood risk management adequacy (effectiveness/completeness)
- Ability to contribute to meeting the planning objectives (effectiveness/completeness)
- Consistency with planning constraints and authorities
- Acceptability (includes law and policy, sponsor, environmental, cultural and public aspects)
- Early cost indicators (early efficiency indicators for screening purposes)
- Construction site constraints and real estate requirements (topography, location conflicts, adjacent development, etc.)

Alternative plans are a set of one or more flood risk management measures functioning together to address one or more planning objectives. A measure is a feature or activity that can be implemented at a specific geographic site to address one or more planning objectives. Throughout this study, iterations of alternative plans throughout the watershed have been performed, outlined later in Section 4. The first iteration was conducted at the start of the study using readily available data and existing knowledge to consider, evaluate, and screen potential measures without generating new information. The second iteration, completed approximately three months later (Section 4.4), included data collected by others and some very preliminary evidence gathering and evaluations using rough estimates. The third iteration (Section 4.5) was completed prior to identification of the tentatively selected plan (TSP) shown in Section 5.0. It relied on a more detailed analysis and reduces uncertainty to the extent practicable. Following public review of the draft report, optimization of the TSP was conducted to further reduce uncertainties and to determine the plan that maximizes net benefits and reasonably maximizes all benefits (Section 4.10).

A separate Environmental Assessment (EA) and Finding of No Significant Impact (FONSI) has been prepared and published in conjunction with this feasibility report in accordance with 40 Code of Federal Regulations (CFR) 1500 Parts 1500-1508, 1 July 1986. Details of the existing and future environmental conditions and appropriate considerations are found in the EA accompanying this Feasibility Report (Appendix H).

Economic and Environmental Principals (Principals & Guidelines colloquially "P&Gs") for Water and Related Land Resources Implementation Studies were established pursuant to the Water Resources Planning Act of 1965 (PL 89-80), as amended (42 U.S.C. 1962a-2 and d-1) with the intent to ensure consistent planning by Federal agencies for plan formulation. In accordance with the P&Gs, four accounts were established to facilitate evaluation and display of impact from alternative plans. The four accounts are 1) National Economic Development (NED); 2) Environmental Quality (EQ); 3) Regional Economic Development; and 4) Other Social Effects (OSE).

The NED displays changes in economic value of national output of goods and services while the EQ displays non-monetary effects on significant natural and cultural resources. The RED account notes change in distribution of regional economic activity and OSE registers plan effects from perspectives relevant to plan formulation, but not reflected in the other three accounts. The four accounts were considered during alternative formulation and ultimately selection of the Recommended Plan.

## 4.1 Existing and Future Without-Project Conditions

The Papillion Creek basin is about 41 miles long, has a maximum width of about 17 miles, and drains an area of approximately 402 square miles (Figure 1). The Omaha metropolitan area is near the center of the basin, of which about 40 percent is urbanized (Omaha/Douglas County & Sarpy County, 2021). The Omaha area lies on a loess-mantled upland till surface dissected by deep major stream valleys and smaller tributaries. The climate of the area is continental sub-humid with about 30 inches of average annual rainfall, which is normally adequate for dry land farming. The stream channels are well entrenched with moderately to steeply sloping banks. The area has a deficiency of land- and water-based recreation in relation to population.

Extensive alteration within the Papillion Creek Basin had been occurring since the early 1900s. To reduce the risk of flooding in Omaha, drainage districts were formed between 1910 and 1928 and significant channelization of the Big Papillion Creek and its contributing tributaries began. Additionally, the Nebraska Department of Roads and Irrigation have historical accounts that indicate the majority of Papillion Creek, Big Papillion Creek and West Papillion Creek were straightened between 1910 and 1913 (Rus et al., 2003).

Establishing a consistent basis for the comparison of various potential solutions to flood risk management problems involves the analysis and forecasting of the most likely future without-project condition. The future without-project condition for this study describes the prevailing significant water and related land resource conditions and their impacts if no major action is taken towards reducing the flood risk in the Omaha area. The without-project conditions considered for this study includes existing conditions and future without-project conditions (FWOP). Future project conditions could be significantly impacted by climate change sometime

in the future based on regional evidence which predicts an increasing frequency of large runoff events (Appendix A).

### 4.1.1 Flood History

Floods or threats of floods occur almost every year during the summer thunderstorm season which is when about 40 percent of the annual precipitation occurs. Flooding records are somewhat fragmented prior to the installation of the initial USACE gaging station at Fort Crook in 1946. Major floods occurred June 3, 1943; June 20, 1960; June 16, 1964; and September 7, 1965. In addition, moderate floods or bank full stages are recorded for August 1932, July 1944, June 1946, June 1947, August 1950, June 1951, May 1957, and August 1959. The Big Papillion Creek drainage area sustained flood damage in all four years of major floods.

The economic damages from the 1943 flood are unknown. The Little Papillion Creek drainage area escaped the 1964 flood but sustained heavy flood damages in 1960 and 1965. The June 20, 1960 flood resulted in $671,000 in damages within the Papillion Creek basin. Little Papillion and West Papillion Creek were affected.

The 1964 flood, which was the basin's most damaging flood, centered over the West Papillion Creek drainage area. Seven lives were lost and millions of dollars in personal property losses resulted (Figure 3) including 95 trailer homes that were swept more than a half mile downstream by torrential flooding in the Millard area. During that storm, eight inches of rain falling for three hours on Hell Creek flowing down from Boys Town into the West Branch Papillion Creek created a roaring torrent of water 50 feet wide with waves five feet high. Approximately 4,500 acres of farmland were flooded near Big Papillion Creek and south of Dodge Street on the Big Papillion Creek, 108 homes and 34 businesses were flooded and an estimated $6M in damages occurred (Papio-NRD, 2019).

**Figure 3. June 1964 Flooding. Left photo: vehicles swept downstream (source Papio-NRD); Right photo: submerged car on 84th Street near I-80 (source Omaha World Herald)**

The September 6, 1965 flood was one of the most damaging floods in the Papillion Creek watershed. Total damages within the basin were estimated at $529,000. Almost the entire business district of Papillion was covered by water.

The four Corps of Engineers dams were constructed in 1970s and 1980s. However, additional damaging floods have occurred since their construction. These include the July 22, 1993; the September 2, 1997; the August 6, 1999; the June 11, 2008; and the June 21, 2014 floods.

The June 1993 flood is credited as the worst event since the 1964 event. Flood damages were recorded in the Big Papillion Creek watershed from consistent, heavy downpours, with many homeowners reporting bowing and collapsed foundations (City of Omaha, n.d.). Most damage was to the south bank of the West Papillion Creek. Flood waters spilled across 84th and 72nd Streets and were closed by officials (Omaha World-Herald, 2017).

The August 1999 flood caused flash flooding along Big Papillion Creek resulting in one fatality and overburdening of sewers. Some basements filled with chest-deep water and flooding damaged more than 1,000 homes. Flooding from this event was estimated to result in approximately $11 million in property damages.

The June 2008 flood resulted in an estimated $320,000 in flood damages. This value is estimated from the USACE annual flood damage prevented estimate (Note: USACE annual flood damages prevented provides a damage estimate based on best available USACE data and has not been verified with actual damages reported).

The June 2014 torrential downpour led to flooding on Big Papillion Creek. This resulted in one fatality in Bellevue when rushing water swept away a 29-year-old man who left his vehicle after it went into a drainage ditch. Up to 5 feet of flooding was reported at Fun-Plex amusement park near 70th Street and Q Street.

A gaging station started on Papillion Creek in 1929 had recorded 11 floods through 1965 (NDNR, 2013). Several more recent flood events (1994, 1997, 1999, 2004, 2008, and 2014) continue to highlight that severe flood risks remain, and the 1999, 2004, and 2014 events resulted in one fatality each. The Papillion Creek has sustained damage from virtually every flood event because of the discharge concentration from the three major tributaries that converge on this stream. Continued urbanization of the Papillion Creek basin will cause increases in the damage potential.

As significant urban development has progressed across the Papillion Creek basin, the damage potential due to flooding has increased. Aerial imagery from 1941 shows that development in the basin was primarily concentrated between the Missouri River and 72nd Street. By 1980, aerial imagery shows that most development had extended as far west as 144th Street and by 2019 development had extended west of 204th Street (Figure 3). Basin wide full build-out is expected by 2040 for Douglas, Sarpy, and Washington counties, even though some areas in Washington County are designated as agricultural in the county's master plan. This continued urbanization of the Papillion Creek basin will continue to increase runoff damage potential. Increases in urbanization result in larger runoff peaks and volumes due to increased impervious surface and reductions in soil infiltration. Damage potential will increase because residences and businesses are replacing agriculture. Although the construction of several flood risk management features does provide some relief from events, significant potential still exists in the basin due to increased urbanization along once largely agricultural streams. See Appendix A Hydrology for

additional information of these flooding events and their sources. Some of the historic events are described in more detail below.

**June 1943:** During the night of June 2, 1943, approximately 9 to 10 inches of rain fell in the vicinity of Irvington. Flooding began in the upper reaches of the Little Papillion Creek about 12:45 a.m. and by morning the stream was back in its banks. Flooding occurred throughout the length of the creek with a maximum width of approximately 3,600 feet at the junction of the Big and Little Papillion Creeks. Water averaged about 3 to 4 feet deep on the floodplain. The estimated peak discharge on the Little Papillion Creek at Irvington was 12,500 cubic feet per second (cfs) and at the mouth was 9,000 cfs. Total damages within the basin were estimated at $200,000 and were mostly agricultural.

**August 1959:** Thunderstorms that caused the flood of August 2-3, 1959 stalled in eastern Nebraska producing torrential rains that measured 12 inches in some places. In the Papillion Creek basin, 6.4 inches was reported at Bennington. Omaha Eppley Airfield reported 3.35 inches. Parts of the western sections of Omaha received more than six inches. Flooding began at Irvington around 9:00 a.m. when water flowed over a bridge. A one-square mile area located near the junction of the Little and Big Papillion Creeks and the area around Fort Crook were hit the hardest. Water flowed five feet deep on 66th Street for two blocks south of Q Street. Six business establishments were flooded Sunday morning in the town of Papillion. A motel area west of the Big Papillion Creek on Dodge Street was also hit hard. At Fort Crook, a recently constructed levee broke, flooding a farm area. Some peak discharges during this flood were 5,900 cfs at Irvington on the Little Papillion Creek, 22,500 cfs on the West Papillion Creek near Papillion, 10,900 cfs at 80th and F Streets on the Big Papillion, and 14,600 cfs at Fort Crook on the Papillion Creek. On Big Papillion Creek on August 3rd at Irvington, discharges were noted as three feet above flood stage and at Fort Crook, six feet above flood stage. West Papillion Creek had a discharge of 22,500 cfs (NDNR, 2013). Total damages within the basin were estimated at $1,090,000.

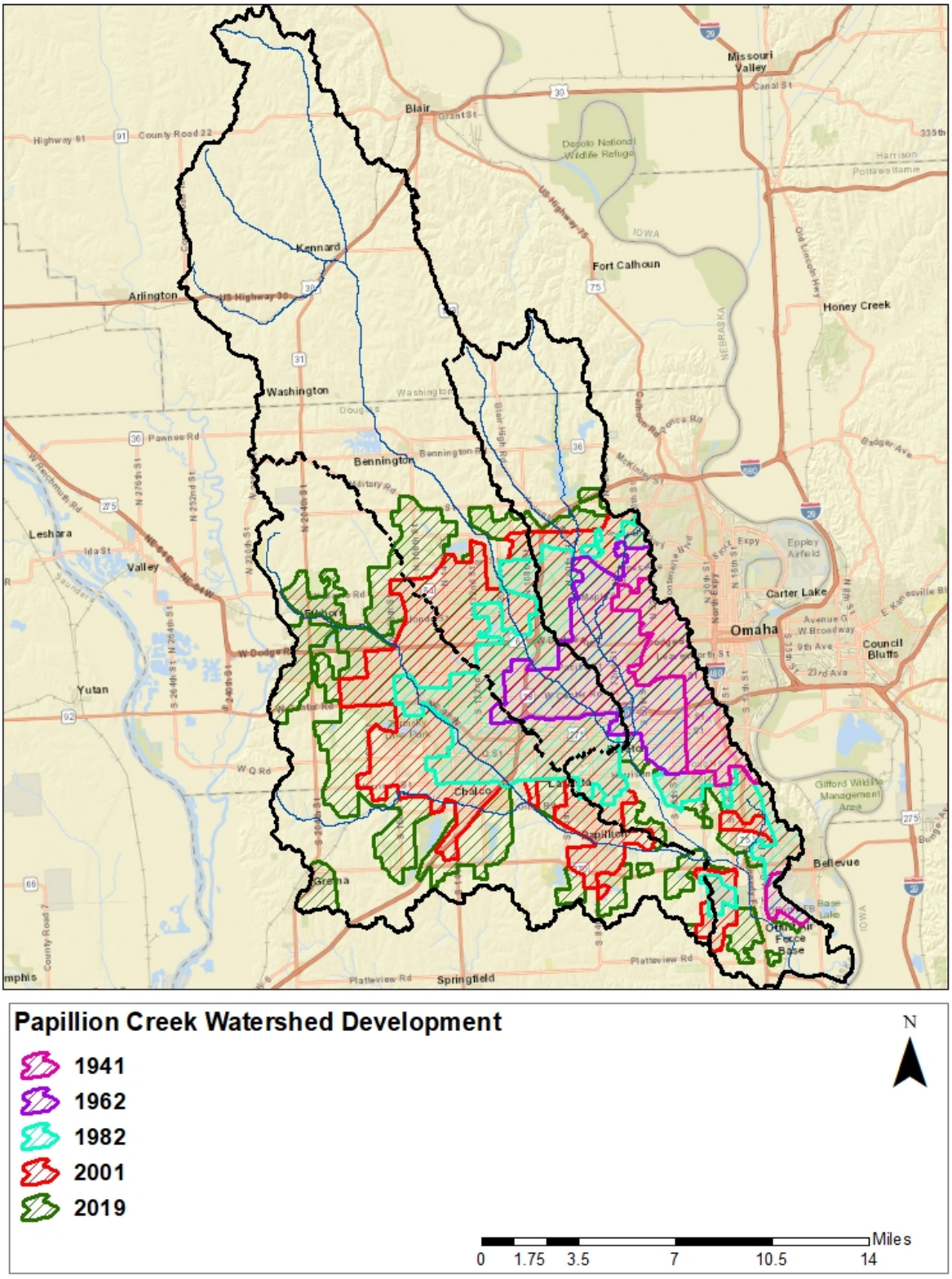



**Figure 4. Papillion Creek Watershed Development**

**June 1960:** Local heavy rains fell in the vicinity of Omaha on June 20, 1960. The North Omaha Weather Station reported 4.32 inches, of which 3.70 inches fell between the hours of 3:00 a.m. and 5:00 a.m. Omaha Eppley Airfield reported 2.42 inches. The Little Papillion Creek crested at L Street at 9:00 a.m. and was back in its banks by 2:30 p.m. Some peak discharges during this flood were 15,300 cfs at Irvington on the Little Papillion Creek, 12,000 cfs near Papillion on the West Papillion Creek, 9,500 cfs at 80th and F Streets on the Big Papillion Creek, and 9,200 cfs at Fort Crook on Papillion Creek. Total damages within the basin were estimated at $671,000.

**June 1964:** On June 16 and 17, 1964, seven people lost their lives and millions of dollars in personal property losses occurred (Figure 4). 95 trailer homes were swept more than a half mile downstream by torrential flooding in the Millard area. During that storm, eight inches of rain falling for three hours on Hell Creek flowing down from Boys Town into the West Branch Papillion Creek created a roaring torrent of water 50 feet wide with waves five feet high. Approximately 4,500 acres of farmland were flooded near Big Papillion Creek and south of Dodge Street on the Big Papillion Creek, 108 homes and 34 businesses were flooded and an estimated $6M in damages occurred (Papio-NRD, 2019).

**September 1965:** During the late evening of September 6, 1965 and the early morning of the 7th, intense rain fell over the Papillion Creek basin. Bennington reported six inches of rain in a little over two hours, with a storm total of 8.90 inches. The North Omaha Weather Station reported 7.84 inches. Eppley Airfield reported 6.45 inches of which 3.13 inches fell in one hour and 5.18 inches fell in three hours. Waterloo reported 6.71 inches. The Little Papillion Creek crested between 5:00 a.m. and 7:00 a.m. and dropped below flood stage at L Street by noon. Some peak discharges were 6,500 cfs at Irvington on the Little Papillion Creek, 20,400 cfs near Papillion on the West Papillion Creek, 15,500 cfs at 80th and “F” Streets on the Big Papillion Creek, and 15,600 cfs at Fort Crook on the Papillion Creek. Total damages within the basin were estimated at $529,000. As a result of the serious flooding in 1964 and 1965, the USACE completed a study in 1967 calling for comprehensive flood risk management for the Metropolitan area that included the construction of reservoirs throughout the Papillion Creek Watershed.

Major floods and damages that occurred after the four main flood control reservoirs were constructed are not reported in the USACE Water Control Manual. Standing Bear Reservoir on the Big Papillion Creek was completed in 1974; Cunningham Reservoir on the Little Papillion Creek was completed in 1976; Wehrspann Reservoir on the South Papillion Creek in the West Papillion watershed was completed in 1982; and Zorinsky Reservoir on the West Papillion Creek was completed in 1989. After the four reservoirs were constructed, the largest stream flows occurred in 1993, 1997, 1999, and 2008.

**July 1993:** Some peak discharges from July 22, 1993 were 800 cfs at Irvington on Little Papillion Creek, 4,100 cfs at 125th & Fort Streets on Big Papillion Creek, and 10,800 cfs at Fort Crook on Papillion Creek. Flood damages were recorded in the Big Papillion Creek watershed from consistent, heavy downpours, with many homeowners reporting bowing and collapsed foundations (City of Omaha, n.d.).

**September 1997:** Some peak discharges from September 2, 1997 were 1,500 cfs at Irvington on Little Papillion Creek, 7,300 cfs at 125th & Fort Streets on Big Papillion Creek, and 13,000 cfs at Fort Crook on Papillion Creek.

**August 1999:** 10.5 inches of rain fell within the two-day span of August 6-7, 1999, causing flash flooding along Big Papillion Creek resulting in one fatality and overburdening of the sewers. Some peak discharges from August 6, 1999 were 8,400 cfs at Irvington on Little Papillion Creek, 17,700 cfs at 125th & Fort Streets on Big Papillion Creek, and 23,200 cfs at Fort Crook on Papillion Creek. Flooding from this event was estimated to result in approximately $11 million in property damages.

**June 2008:** Some peak discharges from June 11-12, 2008 were 3,600 cfs at Irvington on Little Papillion Creek, 4,300 cfs at 125th & Fort Streets on Big Papillion Creek, and 24,800 cfs at Fort Crook on Papillion Creek. According to the USACE annual flood damage prevented estimate, there were an estimated $238,000 in flood damages. (USACE annual flood damages prevented provides a damage estimate based on best available USACE data and has not been verified with actual damages reported.)

**June 21, 2014:** A torrential downpour resulted in flooding on the Big Papillion Creek, causing one fatality in Bellevue when rushing water swept away a 29-year-old man who left his vehicle after it went into a drainage ditch (Omaha World-Herald, 2014). Channels in parts of the basin were at capacity. Up to 5-feet of flooding was reported at Fun-Plex amusement park near 70$^{th}$ and Q Streets. Millard Airport near 132$^{nd}$ and Q Street recorded 6.83 inches in 24 hours and Offutt Airforce Base recorded 3.95 inches (Omaha World-Herald, 2014). According to the USACE annual flood damage prevented estimate, there were an estimated $320,000 in flood damages. (USACE annual flood damages prevented provides a damage estimate based on best available USACE data and has not been verified with actual damages reported.)

### 4.1.2 Existing Dam and Levee Features

There are existing dams (Figure 5) and levees (Figure 6) in the Papillion Creek watershed constructed to reduce flood risk.

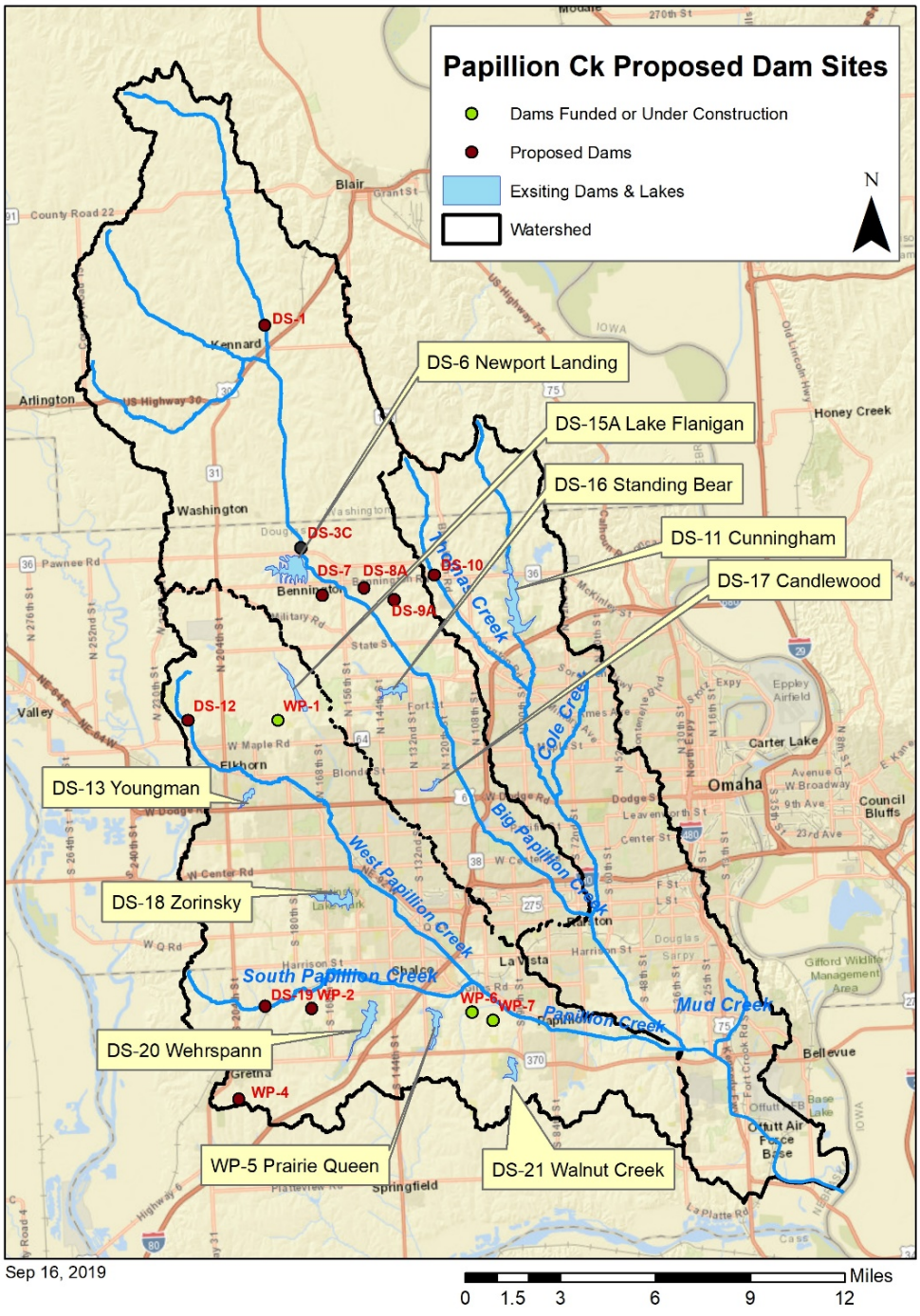



**Figure 5. Existing Dams and Potential Dam Sites**

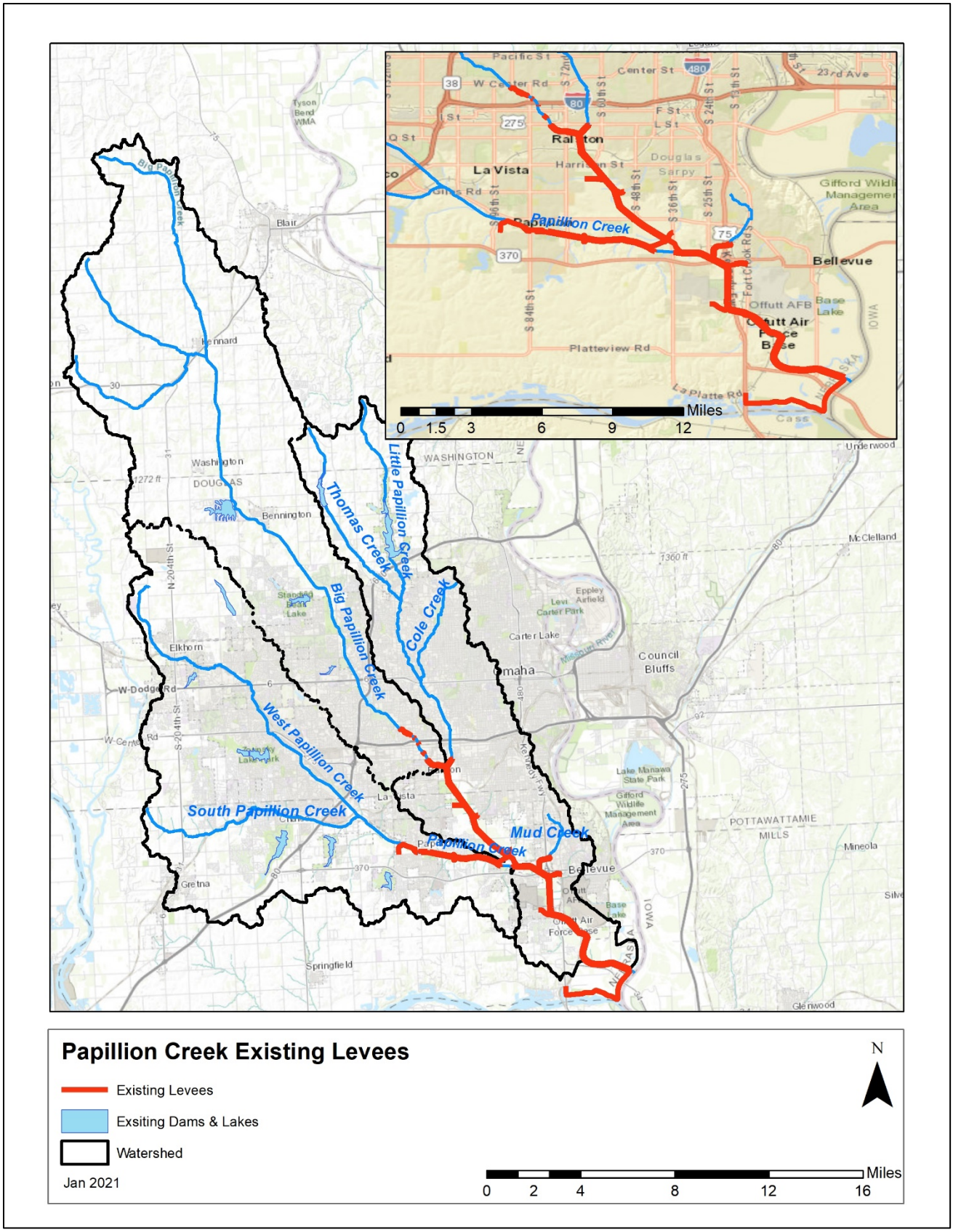



**Figure 6. Papillion Creek Watershed Existing Levees**

Little Papillion Creek flows through the agricultural area upstream from Irvington, Nebraska and through a highly developed area downstream from Irvington (Figure 7). Railroads, several State highways, Interstate 80, and numerous paved streets are located in the basin. Dam Site 11, Glenn Cunningham Lake, was completed in 1976, and a 6.5-mile channel straightening project along the Little Papillion Creek was completed in 1970.

**Figure 7. Little Papillion Creek at Maple Street and Keystone Drive**

Big Papillion Creek extends from its headwaters west of Blair, Nebraska to its junction with West Papillion Creek (Figure 8). The upstream reaches of the floodplain are primarily rural in character. Kennard, Bennington, Omaha, and Ralston lie within the floodplain. Highways, railroads, and numerous streets are in the basin. The Omaha District, in partnership with the Papio-Missouri River NRD, constructed a flood risk management channel on Big Papillion Creek from West Center Road to L Street. The NRD extended this project upstream by improving the section from West Center Street north to Blondo Street. The Papio-Missouri River NRD constructed and currently maintains approximately 21 miles of levees and channel improvements from 72nd Street downstream to Capehart Road and a section of channel improvement from L Street downstream to 72nd Street. In 2018, Omaha District completed a levee inspection on the Big Papillion levee that included adjacent ground surfaces, top of levee elevation along the entire existing levee unit, and the location of associated features of the levee (i.e., appurtenances). The levee has experienced loading and based on embankment, floodwall, and foundation materials, performed as designed. Further, there has been no significant change to the levee itself in the intervening years, and the project is well maintained by the project sponsor. Standing Bear Lake (Dam Site 16) is located on a tributary of Big Papillion Creek and was completed in 1974. Lake Candlewood (Dam Site 17), was constructed by a private developer on a tributary to the Big Papillion Creek. Newport Landing (Dam Site 6) was built on a tributary to the Big Papillion Creek by the Papio-Missouri River NRD and a private developer in 2002. Even

with these features, significant flood damage is caused by floods larger than the 10% AEP event on Big Papillion Creek.

**Figure 8. Big Papillion Creek. Left Photo is at 86th and Frederick; Right Photo is at 108th and West Dodge Road**

The West Papillion Creek basin is a mix of agriculture and urban uses, with the urban uses concentrated in the lower and middle portions of the basin (Figure 9). The drainage area of the basin is approximately 134 square miles, with a length of approximately 22 miles and a width of approximately 10.2 miles. The basin topography ranges from nearly level to moderately steep sloping hills. Soils in the uplands are generally deep, well-drained silt loam to silty clay loam formed in loess. These soils are moderately permeable and have high water capacity. The bottom land soils are generally poorly drained silty clay to loamy fine sand.

The West Papillion Creek rises in the vicinity of the Elkhorn area of Omaha, Nebraska and flows in southeasterly direction to its confluence with the Papillion Creek just downstream from 36th Street. The Millard and Elkhorn areas of Omaha and the town of Papillion extend into the West Papillion floodplain. The basin currently has five flood risk management structures. Lake Zorinsky (Dam Site 18) controls about 16½ square miles of Box Elder Creek, Wehrspann Lake (Dam Site 20) controls slightly over 13 square miles of a right bank tributary to the South Branch, Walnut Creek Lake (Dam Site 21) controls 3.4 square miles of Walnut Creek, Lake Flanagan (Dam Site 15A) controls 11.1 square miles of North Branch West Papillion Creek, and Prairie Queen Lake (Dam Site WP5) controls 2.1 square miles of an unnamed tributary to West Papillion Creek. Both Zorinsky and Wehrspann were built by the USACE under the originally authorized project. Walnut Creek (Dam Site 21) was built in 1999 by the Papio-Missouri River NRD in cooperation with Nebraska Game and Parks Commission and Nebraska Natural Resource Conservation and Development. Dam WP6 and WP7 flood risk management reservoirs are currently under construction by the NRD. Site WP1, located west of Lake Flanagan (DS-15A) on a tributary to West Papillion Creek has been designed and funding has been secured. It is expected to be constructed in the next five years and is therefore included in both the existing and future without-project scenarios. In addition to these reservoirs, the Papio-Missouri River NRD has constructed a levee/channelization project along West Papillion Creek from the

confluence of Walnut Creek to 36th Street. Even considering these efforts, significant flood damage is caused by floods larger than the 10% AEP event on West Papillion Creek.

**Figure 9. West Papillion Creek at 143rd Street and L Street**

An important aspect of assessing the existing condition of the levee on West Papillion creek was identifying previous existing levee performance in past flooding events. In 2018, Omaha District completed a levee inspection that included adjacent ground surfaces, top of levee elevation along the entire existing levee unit, and the location of levee appurtenances. The levee has experienced loading and based on embankment, floodwall, and foundation materials, performed as designed. Further, there has been no significant change to the levee itself in the intervening years, and the project is well maintained by the local sponsor.

Multiple reaches in the Papillion Creek (see Section 4.1.6) watershed have existing levees (Figure 9) that offer flood risk reduction at varying events. These levees are included in the existing conditions modeling. Hydraulic engineers were consulted to determine the appropriate top of levee stage to apply to each of these reaches. Assigning levees to damage reaches truncates the stage-damage curve computed by the model and excludes damages from the annualized calculation that are occurring at stages below the top of levee stage. Table 2 below provides the leveed reaches (see Figure 14 for reach delineations), top of levee stages and the approximate frequency event from which the levee reduces flood risk. Levee fragility, a statistical distribution of potential levee failure, is not taken into account for preliminary alternatives screening. District geotechnical engineering provided information on levee performance during recent high-water events supporting the conclusion that levee failure is currently unlikely under loading. This assumption is based on a cursory analysis deemed appropriate for screening alternatives, however further refinement of potential levee fragility was completed on the selected plan to ensure flood risk in currently leveed reaches is fully captured and accounted for in the economic analysis.

**Table 2. Levees, Levee Stages, and AEP Level**

| Reach | Top of Levee Stage (feet) | Frequency Event of Levee Reducing Flood Risk |
|---|---|---|
| BP6 | 1018.75 | 10% AEP + 2.6 ft (0.3 ft below 4% AEP) |
| BP7 | 1006.27 | 4% AEP + 1.7 ft (0.5 ft below 2% AEP) |
| BP8 | 996.97 | 10% AEP + 1.9 ft (0.66 ft below 4% AEP) |
| WP9 | 1011.53 | 0.5% AEP + 1.8 ft (0.19 ft below 0.2% AEP) |
| PC1 | 990.00 | 10% AEP + 1.7 ft (1.1 ft below 4% AEP) |

Drawings of all existing Federal levee features can be found in the U.S. Army Corps of Engineers Operation and Maintenance Manuals for each levee. These manuals are considered to be a reliable and authoritative source of information concerning these existing levees. The USACE's National Levee Database (NLD) was also used for feature location and elevation reference in this study. The NLD can be accessed by visiting https://levees.sec.usace.army.mil/.

### 4.1.3 Hydrology and Hydraulics

Generally, the upstream, less urbanized reaches on the Papillion Creek and its tributaries are characterized by shallow channels with heavy vegetation on the overbanks. As the tributaries flow downstream through the increasingly urban environments, many of the streams have been straightened. Several have become entrenched in areas with evidence of sloughing and bank scour. In some reaches, the built environment has encroached heavily into the overbanks while in others, development has been held back to provide grassed overbanks. Several sections already contain engineered flood channels and/or levees. The existing conditions 1 percent AEP flood boundary for Douglas and Sarpy counties is shown in Figure 10.

Steady flow modeling was completed in 2019 using the Hydrologic Engineering Center's River Analysis System (HEC-RAS) software version 5.0.5. The future without-project assumes the same channel geometry, which means no further encroachment or river crossings were anticipated and the same existing conditions geometry file was used during the future without-project alternative modeling. Future without-project hydrology includes a full build-out scenario by the year 2040 based on projections by the Omaha-Council Bluffs Metropolitan Area Planning Agency (MAPA). Flow files were updated to account for full build-out conditions of the watershed and downstream boundary conditions were revised accordingly. The flows utilized in the future without-project alternative are provided in Appendix B-P6. Inundation maps are provided in Appendix B-P15.

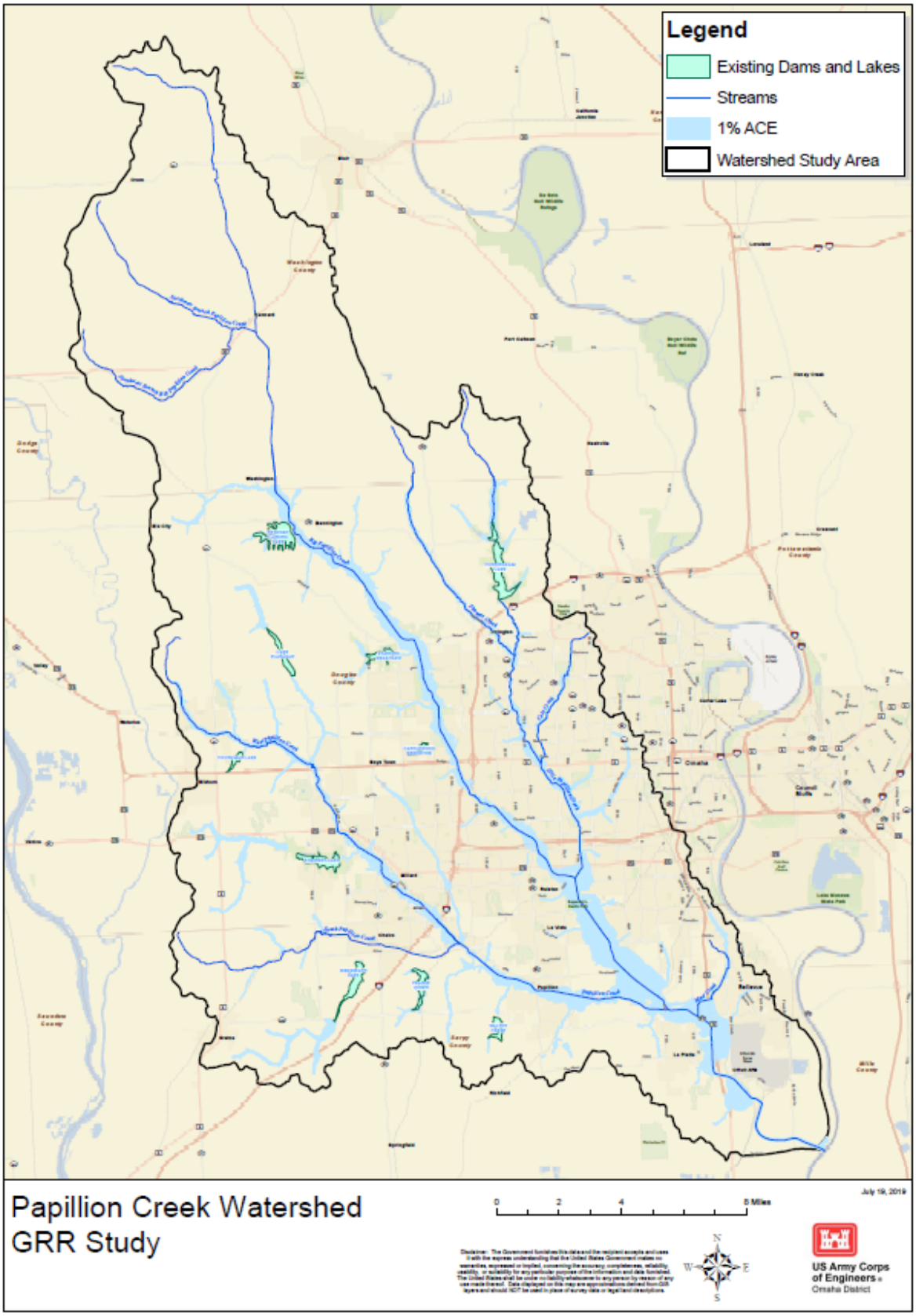



**Figure 10. Map of Existing Conditions 1% AEP**

### 4.1.4 Climate Change

USACE published guidance for incorporating climate change impacts to inland hydrology in civil works studies, designs, and projects in Engineering and Construction Bulletin (ECB) 2018-14.

There exists the potential that future project conditions could be impacted by climate change sometime in the future (Appendix A). This risk is possible but not very likely. Observed streamflow data collected in the vicinity of the project area does not yet exhibit evidence of a shift towards higher stream flows. Peer reviewed journal articles indicate that the frequency of large events is likely increasing but offers little consensus with regards to trends in projected, climate changed hydrology. Note that modeled climate change hydrology has considerable uncertainty as it is affected by other variables like precipitation and temperature which also have their own uncertainty.

Nonetheless, there is some evidence within projected streamflow records, albeit lacking consensus, that peak flows may be trending upward. Additionally, the area encompassing Papillion Creek is highly developed resulting in a considerable population in the 0.2 percent AEP floodplain. Thus, if flood risk were to increase in the future there would be considerable consequences. See Appendix A for the detailed climate change analysis.

### 4.1.5 Floodplain Regulations

Floodplain regulation and floodplain management are effective tools in reducing flood risk and flood damage. The basic principles of these tools are based nationally in the National Flood Insurance Program (NFIP) which requires minimum standards of floodplain management and floodplain regulation for those communities that participate in the NFIP. Standards that exceed the minimum required by the NFIP may be enacted by the states and communities to provide greater flood risk management. Floodplain mapping provides the identification of flood risk in the form of a map which portrays flood boundaries. Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM) Panels exist for the entirety of the Papillion Creek Watershed and both floodplain and floodway delineations are shown. FEMA defines a regulatory floodway as the channel of a river or other watercourse and the adjacent land areas that must be reserved in order to discharge the base flood without cumulatively increasing the water surface elevation more than a designated height (44 CFR 59.1). The initial Flood Insurance Study (FIS) report for Sarpy County, Nebraska and Incorporated Areas, number 31153CV001B was initially effective January 19, 1995. The current effective FIS Report is dated May 3, 2010. The initial FIS report for Douglas County, Nebraska and Incorporated Areas, number 31055CV001D was initially effective December 2, 1979. The current effective FIS report is dated May 19, 2014.

The State of Nebraska has adopted floodplain regulations that are more restrictive than the NFIP minimum standards. Nebraska's minimum standards for floodplain management require that all new construction and substantial improvements of residential structures shall have the lowest floor (including basements) elevated to a minimum of one foot above the base flood elevation (BFE). The national standard is that new or substantially improved structures shall have the lowest floor elevated to or above the BFE. The more stringent requirements for the State of Nebraska are intended to help reduce flood impacts and damages by requiring a one-foot buffer

to account for known flood hazards and uncertainty of changes into the future. By adopting a requirement for more stringent standards in Nebraska, all participating communities will also receive lower premiums (Papio-Missouri River NRD, 2016). Additionally, no new or substantially improved buildings for human occupancy are allowed within the floodway (44 CFR 60.3).

The Papio-Missouri River NRD and all of the communities in the Papillion Creek watershed have adopted the 2016 Multi-Jurisdictional Hazard Mitigation Plan (HMP). An HMP is a community-guided document that identifies both vulnerability to natural and man-made hazards and mitigation measures to reduce or eliminate this vulnerability. The majority of the communities in the watershed have adopted a stricter regulation on the amount of fill that can be placed in the floodplain. Local ordinances are in place which require fill be limited to 25% of the floodplain in the development project area. The remaining 75% of floodplain in the development project area is designated as restricted fill. This allows for less fill in the floodplain as compared to the state and Federal regulations which allow for 100% fill of the floodplain development project area. Each community has included the option to modify or waive this limited fill requirement in cases of redevelopment. The fill limitation regulation was adopted in 2009 and to date, 16 waivers have been issued. The majority of waivers have been granted in two areas of redevelopment, namely at 222nd Street and West Maple and in the Aksarben area.

Floodplain management authorities are exercised through floodplain ordinances or zoning adopted by local jurisdictions. All jurisdictions located within the Papillion Creek Watershed require all new construction or substantial improvement to be one foot above the BFE. Communities with adopted floodplain ordinances (separate from zoning ordinances) include the following:

- The City of Omaha Floodplain Ordinance Number 39946, which is part of the Omaha Municipal Code
- Washington County Floodplain Management Resolution No. 2013

Zoning is an important land use tool that local jurisdictions exercise. Indeed, the state's statutes grant municipalities and counties the power to consider flood hazards in the formulation of zoning regulations. A community may determine that certain areas are hazardous for human habitation and restrict or limit development by amending zoning ordinances. Establishing good zoning regulations for flood risk can help reduce the long-term risk that a community faces from flooding. Communities located within the Papillion Creek Watershed with adopted zoning ordinances include the following:

- City of Bellevue Zoning Ordinance (Ordinance 3619) - Effective August 8, 2011
- City of Bennington Zoning Ordinance (Ordinance 460) - Effective June 9, 2019
- Douglas County Zoning Regulations by Article https://www.dceservices.org/mobile-landuse/zoning-regulations accessed August 15, 2019
- City of Gretna Zoning Ordinance (Ordinance 2000) - Effective July 5, 2017, Modified July 3, 2018
- City of LaVista Zoning Ordinance (Ordinance 848) - Effective November 20, 2001
- The City of Omaha exercises zoning authorities through the Omaha Master Plan

- City of Papillion Zoning Ordinance (Ordinance 1200) - Effective September 19, 1995
- City of Ralston Zoning Ordinance by Article http://www.cityofralston.com/zoning.html accessed August 15, 2019
- Sarpy County Building Codes - Effective January 1, 2017
- Washington County Zoning Resolution (Resolution 2005-19) - Effective June 14, 2005

The future with-project and future without-project conditions all assume continued implementation of local floodplain regulations. In addition to these regulations, the Papillion Creek Watershed Management Plan, which was updated in April 2019 by the Papillion Creek Watershed Partnership (PCWP), contains regulations for floodplain management and development. The PCWP is a coalition of communities affected in the basin and includes Omaha, Bellevue, Boys Town, Gretna, La Vista, Papillion, Ralston, Sarpy County, and the Papio-Missouri River NRD.

### 4.1.6 Economics

For this study, economic existing conditions represent the study area in its current state, including current build-out and development, as well as hydrologic and hydraulic characteristics. Future without-project conditions assume no change in the structure inventory for economic damage modeling, however a long-term plan from MAPA shows full build out by 2040 is taken into account in the hydrology and hydraulic modeling. It is expected that the increased development would change runoff characteristics and permeability, which would potentially affect hydraulic model stages and therefore economic expected damages. The results summarized in this section represent existing conditions only, and modeling of the future hydrology and future without-project conditions and equivalent annual damages were updated during the optimization analysis. To aid in the analysis, the large watershed was divided into 34 damage reaches. Table 3 below describes the breakdown of the damage reaches, and Figure 10 in Section 4.4 below displays the reaches on a map.

**Table 3. Damage Reach Breakdown**

| Damage Reach | Upstream Boundary | Downstream Boundary |
|---|---|---|
| **Big Papillion Creek (BP)** | | |
| BP1 | Upstream Extent | Military Rd. |
| BP2 | Military Rd. | W Maple Rd. |
| BP3 | W Maple Rd. | Blondo St. |
| BP4 | Blondo St. | W Dodge Rd. |
| BP5 | W Dodge Rd. | 105th St. |
| BP6 | 105th St. | Railroad Crossing, downstream of I-80 |
| BP7 | Railroad Crossing, downstream of I-80 | Railroad Crossing, downstream of Q St. |
| BP8 | Railroad Crossing, downstream of Q St. | 36th St. |
| BP9 | 36th St. | Big Papillion/West Papillion Confluence |
| **Papillion Creek (PC)** | | |
| PC1 | Big Papillion/West Papillion Confluence | Hwy 75, south of Offutt AFB |
| **West Papillion Creek (WP)** | | |
| WP1 | Upstream Extent | Old Lincoln Hwy, upstream of 192nd St. |
| WP2 | Old Lincoln Hwy, upstream of 192nd St. | 168th St. |
| WP3 | 168th St. | Pacific St. |

| Damage Reach | Upstream Boundary | Downstream Boundary |
|---|---|---|
| WP4 | Pacific St. | Center St. |
| WP5 | Center St. | 144th St. |
| WP6 | 144th St. | Millard Ave. |
| WP7 | Millard Ave. | Giles Rd. |
| WP8 | Giles Rd. | 96th St. |
| WP9 | 96th St. | Big Papillion/West Papillion Confluence |
| **Little Papillion Creek (LP)** | | |
| LP1 | Downstream of Cunningham Lake | Blair High Rd. |
| LP2 | Blair High Rd. | Maple St. |
| LP3 | Maple St. | Blondo St. |
| LP4 | Blondo St. | Western Ave. |
| LP5 | Western Ave. | Dodge St. |
| LP6 | Dodge St. | Pacific St. |
| LP7 | Pacific St. | Mercy Rd. |
| LP8 | Mercy Rd. | Big Papillion/Little Papillion Confluence |
| **South Papillion Creek (SP)** | | |
| SP1 | Upstream Extent | Upstream of DS WP-2 Tributary |
| SP2 | Upstream of DS WP-2 Tributary | Railroad Crossing, upstream of Big Papillion/South Papillion Confluence |
| SP3 | Railroad Crossing, upstream of Big Papillion/South Papillion Confluence | Big Papillion/South Papillion Confluence |
| **Thomas Creek (TC)** | | |
| TC1 | Upstream Extent | Bennington Rd. |
| TC2 | Bennington Rd. | 108th St. |
| TC3 | 108th St. | Thomas Creek/Little Papillion Confluence |
| **Cole Creek (CC)** | | |
| CC1 | Upstream Extent | Cole Creek/Little Papillion Confluence |
| **Saddle Creek (SC)** | | |
| SC1 | Upstream Extent | Saddle Creek/Little Papillion Confluence |

#### 4.1.6.1 Existing Conditions Expected Annual Damages

The existing conditions without-project conditions expected annual damages (EAD) calculated by the Flood Damage Reduction Analysis (HEC-FDA) model are summarized in Table 4. The EAD is the weighted average of flood damages calculated over a number of events. Just over 70 percent of expected annual damages occur on Big Papillion Creek and Little Papillion Creek tributaries, which are highly developed with significant commercial and industrial uses. Much of the damages on these two streams occur in the downstream reaches, especially near the confluence of the two streams.

**Table 4. Existing Conditions EAD**

| Stream | Reach | Nonresidential | Residential | Emergency | Roads | Total | % of Total |
|---|---|---|---|---|---|---|---|
| Big Papillion | BP1 | $192.42 | $6.79 | $19.92 | $9.96 | $229.09 | 1.2% |
| Big Papillion | BP2 | $205.76 | $2.69 | $20.85 | $10.42 | $239.72 | 1.2% |
| Big Papillion | BP3 | $730.35 | $21.89 | $75.22 | $37.61 | $865.08 | 4.5% |
| Big Papillion | BP4 | $177.13 | $327.81 | $50.49 | $25.25 | $580.68 | 3.0% |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Big Papillion | BP5 | $174.46 | $117.74 | $29.22 | $14.61 | $336.03 | 1.7% |
| Big Papillion | BP6 | $715.55 | $297.07 | $101.26 | $50.63 | $1,164.51 | 6.1% |
| Big Papillion | BP7 | $2,698.96 | $25.94 | $272.49 | $136.25 | $3,133.64 | 16.3% |
| Big Papillion | BP8 | $535.28 | $154.68 | $69.00 | $34.50 | $793.45 | 4.1% |
| *Big Papillion Subtotal* | | *$5,429.91* | *$954.61* | *$638.45* | *$319.23* | *$7,342.20* | *38.2%* |
| Little Papillion | LP1 | $148.83 | $0.10 | $14.89 | $7.45 | $171.27 | 0.9% |
| Little Papillion | LP2 | $270.63 | $0.00 | $27.06 | $13.53 | $311.22 | 1.6% |
| Little Papillion | LP3 | $166.07 | $2.57 | $16.86 | $8.43 | $193.94 | 1.0% |
| Little Papillion | LP4 | $1.67 | $53.17 | $5.48 | $2.74 | $63.07 | 0.3% |
| Little Papillion | LP5 | $485.53 | $173.55 | $65.91 | $32.95 | $757.94 | 3.9% |
| Little Papillion | LP6 | $422.09 | $129.45 | $55.15 | $27.58 | $634.27 | 3.3% |
| Little Papillion | LP7 | $2,312.95 | $206.37 | $251.93 | $125.97 | $2,897.22 | 15.1% |
| Little Papillion | LP8 | $811.22 | $256.02 | $106.72 | $53.36 | $1,227.33 | 6.4% |
| *Little Papillion Subtotal* | | *$4,618.99* | *$821.23* | *$544.02* | *$272.01* | *$6,256.25* | *32.5%* |
| South Papillion | SP1 | $12.28 | $0.50 | $1.28 | $0.64 | $14.70 | 0.1% |
| South Papillion | SP2 | $12.92 | $95.99 | $10.89 | $5.45 | $125.25 | 0.7% |
| South Papillion | SP3 | $617.51 | $47.74 | $66.53 | $33.26 | $765.04 | 4.0% |
| *South Papillion Subtotal* | | *$642.71* | *$144.23* | *$78.69* | *$39.35* | *$904.98* | *4.7%* |
| West Papillion | WP1 | $63.60 | $118.15 | $18.18 | $9.09 | $209.01 | 1.1% |
| West Papillion | WP2 | $0.00 | $54.88 | $5.49 | $2.74 | $63.11 | 0.3% |
| West Papillion | WP3 | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 | 0.0% |
| West Papillion | WP4 | $2.94 | $0.03 | $0.30 | $0.15 | $3.42 | 0.0% |
| West Papillion | WP5 | $415.63 | $15.20 | $43.08 | $21.54 | $495.45 | 2.6% |
| West Papillion | WP6 | $535.26 | $96.15 | $63.14 | $31.57 | $726.12 | 3.8% |
| West Papillion | WP7 | $132.19 | $1.67 | $13.39 | $6.69 | $153.94 | 0.8% |
| West Papillion | WP8 | $35.59 | $0.00 | $3.56 | $1.78 | $40.93 | 0.2% |
| West Papillion | WP9 | $132.20 | $7.26 | $13.95 | $6.97 | $160.38 | 0.8% |
| *West Papillion Subtotal* | | *$1,317.41* | *$293.34* | *$161.08* | *$80.54* | *$1,852.36* | *9.6%* |
| Papillion Creek | PC1 | $1,400.24 | $74.96 | $147.52 | $73.76 | $1,696.48 | 8.8% |
| *Papillion Creek Subtotal* | | *$1,400.24* | *$74.96* | *$147.52* | *$73.76* | *$1,696.48* | *8.8%* |
| Thomas Creek | TC1 | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 | 0.0% |
| Thomas Creek | TC2 | $0.03 | $0.00 | $0.00 | $0.00 | $0.03 | 0.0% |
| Thomas Creek | TC3 | $33.09 | $15.31 | $4.84 | $2.42 | $55.66 | 0.3% |
| *Thomas Creek Subtotal* | | *$33.12* | *$15.31* | *$4.84* | *$2.42* | *$55.69* | *0.3%* |
| Cole Creek | CC1 | $1.66 | $38.80 | $4.05 | $2.02 | $46.53 | 0.2% |
| *Cole Creek Subtotal* | | *$1.66* | *$38.80* | *$4.05* | *$2.02* | *$46.53* | *0.2%* |
| Saddle Creek | SC1 | $776.73 | $171.26 | $94.80 | $47.40 | $1,090.19 | 5.7% |
| *Saddle Creek Subtotal* | | *$776.73* | *$171.26* | *$94.80* | *$47.40* | *$1,090.19* | *5.7%* |
| **Total for Papillion Creek Watershed** | | **$14,220.77** | **$2,513.74** | **$1,673.45** | **$836.73** | **$19,244.69** | **100.0%** |

Notes: FY20 prices; 2.75 percent interest rate; Values shown in $1,000s.

The economic analysis was prepared according to the procedures outlined in the following: Economic and Environmental Principles and Guidelines for Water and Related Resources Implementation Studies (P&G); ER 1105-2-100, Planning Guidance Notebook, dated 22 April 2000; ER 1105-2-101, Risk-Based Analysis for Evaluation of Hydrology/Hydraulics, Geotechnical Stability, and Economics in Flood Damage Reduction Studies, dated 1 March 1996; and Engineer Manual (EM) 1110-2-1619, Risk-Based Analysis for Flood Damage Reduction Studies.

The existing flood risk management system reduces flood risk for some of the highly developed urban portions of the Omaha metropolitan area, which also serves as a regional economic hub and retail market for surrounding rural counties in eastern Nebraska and west Iowa. The study area encompasses a major segment of the economy. Flood disruptions to this area would strongly impact the local and regional economy. The existing conditions economic analysis quantifies and characterizes the economic impact from flooding using risk-based principles.

The economic analysis evaluates both the future with- and without-condition scenarios over a 50-year period of analysis to allow a consistent and appropriate comparison of alternatives. The period of analysis is the time horizon for which project benefits and project operation, maintenance, repair, rehabilitation, and replacement (OMRR&R) costs are evaluated. The period of analysis begins with the base year condition using resources in the study area along with economic and engineering factors thought to exist in the first year a project alternative is expected to become operational. The existing conditions economic analysis was completed in 2019. The base year used for the purposes of analysis is 2026, the year the project is expected to be completed. The selection of 2026 is based on the current schedule of the Chief's Report in 2021, Water Resources Development Act (WRDA) authorization in 2022, construction start in 2024 and a construction duration of five years. The existing conditions and base year have the same assumptions and condition. A 50-year period of analysis was used as the beneficial effects of the flood risk management measures could not be confidently forecasted beyond this interval. Fifty years is also the maximum period of analysis allowed per regulation.

These timeline assumptions provide the temporal framework for the future without-project scenario. The potential annual flood damage for each year in the period of analysis is then computed, discounted back to present value, and annualized to determine the equivalent annual damage for any year during the analysis period.

### 4.1.7 Population and Socioeconomics

Socioeconomic and demographic information gathered for the Papillion Creek study relies heavily upon data obtained from the U.S. Census Bureau. The boundaries of the 0.2% AEP floodplain extent are used as the basis for gathering socioeconomic and demographic conditions for Papillion Creek. The most recent Census data available is from the 2013-2017 American Community Survey (U.S. Census Bureau, 2019). The American Community Survey includes data at the block group level, which provides a reasonable approximation of population and housing unit counts for the Papillion Creek study area (from the 2010 Census). There are 172 census block groups intersecting the Papillion Creek 0.2% AEP study area.

Table 5 summarizes population and housing unit counts for the Papillion Creek study area. Based on census block group data, the study area is home to approximately 207,000 residents, or about 51% of the city's total population. The population density of the study area (1,142 persons per square mile) is below that of the city (2,800 persons per square mile).

**Table 5. Population and Housing Unit Summary, Papillion Creek, 2010**

| | Count of Census Block Groups | Area of Block Groups (sq mi) | 2010 Population | Population Density (per sq mi) | 2010 Total Households |
|---|---|---|---|---|---|
| Papillion Creek Census Block Groups | 172 | 181 | 206,774 | 1,142 | 88,725 |
| Omaha | - | 142 | 408,958 | 2,880 | 162,627 |
| Douglas County | - | 339 | 517,110 | 1,525 | 202,411 |
| Sarpy County | - | 248 | 158,840 | 640 | 58,102 |
| Nebraska | - | 77,421 | 1,826,341 | 24 | 721,130 |
| U.S. | - | 3,800,000 | 308,745,538 | 81 | 116,716,292 |

Source: U.S. Census Bureau, 2010.

Table 6 summarizes housing units by occupancy type. Based on block group data, the home ownership rate (61%) is slightly higher than citywide (53.6%) as well as Douglas County (56.8%), but lower than Sarpy County (66.4%). The vacancy rate is lower than all other geographic areas except Sarpy County, which has an equal vacancy rate at 4.6 percent.

**Table 6. Housing Unit Summary, Papillion Creek, 2017**

| | Owner Occupied Percentage | Renter Occupied Percentage | Vacant Percentage |
|---|---|---|---|
| Papillion Creek Census Block Groups | 61.0% | 34.4% | 4.6% |
| Omaha | 53.6% | 39.1% | 7.3% |
| Douglas County | 56.8% | 36.2% | 7.0% |
| Sarpy County | 66.4% | 29.0% | 4.6% |
| Nebraska | 60.0% | 30.8% | 9.2% |
| U.S. | 56.0% | 31.8% | 12.2% |

Source: U.S. Census Bureau, released 2019.

Table 7 summarizes race in the Papillion Creek study area. Based on block group data, the study area is comprised primarily of those identified as White Alone (81.1%), Black or African American Alone (6.1%) or Hispanic or Latino (6.0%).

**Table 7. Summary of Race, Papillion Creek, 2017**

| Subject | Papillion Creek Census Block Groups | Omaha, Nebraska | Douglas County, Nebraska | Sarpy County, Nebraska | Nebraska | United States |
|---|---|---|---|---|---|---|
| Hispanic or Latino (of any race) | 6.00% | 13.7% | 12.2% | 8.7% | 10.5% | 17.6% |
| White alone | 81.10% | 67.4% | 70.2% | 81.8% | 79.8% | 61.5% |
| Black or African American alone | 6.10% | 12.1% | 10.9% | 3.7% | 4.6% | 12.3% |
| American Indian and Alaska Native alone | 0.30% | 0.4% | 0.3% | 0.3% | 0.7% | 0.7% |
| Asian alone | 3.80% | 3.5% | 3.4% | 2.5% | 2.2% | 5.3% |
| Native Hawaiian and Other Pacific Islander alone | 0.00% | 0.1% | 0.0% | 0.1% | 0.1% | 0.2% |
| Some other race alone | 0.10% | 0.2% | 0.2% | 0.1% | 0.1% | 0.2% |
| Two or more races | 2.50% | 2.7% | 2.6% | 2.8% | 2.0% | 2.3% |

Source: U.S. Census Bureau, released 2019.

As shown in Table 7 for most minority populations, the Papillion Creek study area includes a lower proportion of minority populations than the City of Omaha as a whole. More discussion of the potential impacts to minority and low-income populations is included in the Other Social Effects discussion in Appendix F.

### 4.1.8 Land Use

Papillion Creek consists of approximately 400 square miles located in Washington, Douglas, and Sarpy counties including the Omaha Metropolitan Area and flows in a southeasterly direction through a mixture of residential and commercial areas to the Missouri River near Bellevue, Nebraska. Figure 11 shows land use by parcel within the 0.2 percent AEP boundary plus a 100-foot buffer specifically for economic analysis.


**Figure 11. Land Use by Parcel in the Papillion Creek Study Area**

Table 8 provides a percentage breakdown of the land use in the study area used specifically for economic analysis. Based on the data, agricultural land use makes up the largest share of total land use in the study area, followed by Industrial and Residential purposes. Future development areas (as identified by the respective cities and counties) make up 15 percent of the study area.

**Table 8. Land Use Breakdown**

| Land Use | Acres | Percentages |
|---|---|---|
| Agriculture | 5,978 | 35% |
| Aviation | 174 | 1% |
| Commercial | 1,385 | 8% |
| Future Development | 2,563 | 15% |
| Government | 243 | 1% |
| Industrial | 3,103 | 18% |
| Mixed | 554 | 3% |
| Multi-Res | 525 | 3% |
| Other | 0 | 0% |
| Railroad | 260 | 2% |
| Residential | 2,224 | 13% |
| **Total** | **17,009** | **100%** |

### 4.1.9 WATER QUALITY

In accordance with the Clean Water Act (CWA) (33 United States Code (U.S.C.) §1251), states, Tribes, or the Environmental Protection Agency (EPA) must develop standards for their jurisdiction. Pursuant to the CWA, water quality consists of three components: 1) designated and existing uses, 2) water quality criteria necessary to protect these uses, and 3) an anti-degradation policy (40CFR Part 131.6; USACE, 2008). Designated uses for waterbodies and streams within the Papillion Creek basin included primary contact recreation, water supply for agriculture, aquatic life, warmwater A and B classifications and aesthetics.

In accordance with Section 303(d) of the CWA, states must identify surface waters that do not meet EPA-approved water quality standards. These affected waters must be placed on a 303(d) list which requires these waters to have total maximum daily load (TMDL) to be developed. A TMDL is based on the maximum amount of a pollutant that a body of water can receive and still meet water quality standards set forth and on an allocation of that pollutant amount among various sources. Primary pollutants identified in the Papio-Missouri River Basin Water Quality Management Plan (2018) include nutrients, pesticides, sediment, and bacteria. Streambank instability and bed degradation are prevalent throughout the system from channelization, armoring, damming and increased surface runoff. Waterbody impairments for the Papillion Creek basin are associated with primary contact recreation and aquatic life designated uses. Impairments and pollutants of concern include excessive chlorophyll, total phosphorus, total nitrogen, sediment, mercury, algal blooms, turbidity, pH, low dissolved oxygen, E. coli bacteria and "unknown" which is likely associated with the loss of habitat for the aquatic community (NDEQ, 2018).

For the Papillion Creek segment (MT1-10100), which extends from the confluence of Big Papillion Creek downstream to its confluence with the Missouri River, TMDLs have been developed for E. coli in 2008 and approved in 2009. The fish consumption advisory was lifted in 2012 however, according to the last reporting cycle in 2016, a TMDL was still needed for selenium (EPA, 2016). Big Papillion Creek (MT1-10120) and Little Papillion Creek (MT1-10111) have also been listed for E. coil. West Papillion Creek (MT1-10250) has been listed for Hazardous Index Compounds. As of 2016, the Little Papillion and Big Papillion Creeks are classified as impairment-category 4A, meaning that these waterbodies have an EPA-approved TMDL plan in place and implemented while West Papillion Creek is categorized as a 5, meaning this waterbody has violated water quality standards and a TMDL is still needed (NDEQ, 2018).

In addition to the streams within the Papillion Creek basin, the Nebraska Department of Environmental Quality (NDEQ) conducted assessments on 15 of the 18 lakes present within this watershed; and of those, 11 were identified as impaired for fish consumption advisory, bacteria, nutrients, chlorophyll a and pH. Presently, the entire Papillion Creek watershed has been identified as a priority area by NDEQ (NDEQ, 2018). NDEQ has identified various practices that could help reduce the sedimentation, nutrient loading and E. coli present within the watershed. These priorities identified measures include stream restoration, wetland restoration, grassed waterways, riparian buffers, riparian terracing, livestock exclusion fencing, cover crops and sediment control basins.

#### 4.1.9.1 WETLANDS

There are no large wetland complexes within the proposed project location due to the heavy urbanization, agrarian land uses and severe modification of the Papillion Creek basin. Small wetland areas can be found on the landward side of some of the leveed sections of the creek. These wetlands are primarily sediment basins that allow storm water from interior drainage to settle prior to draining into the creek through a culvert that runs under the levee. Wetlands can also be found in some of the bays, along the fringes, and in the upstream delta areas of the reservoirs in the Papillion Creek tributaries basin. Small amounts of low-quality wetlands may also be present along the fringes of the streams and tributaries in the Papillion Creek basin.

Two wetland areas were identified along the Big Papillion Creek during a May 2019 site visit in the areas where the levees would be raised. A 0.38-acre palustrine emergent wetland is located on the landward side of the levee along the left bank adjacent to Menards between L Street and 72nd Street. This wetland is located approximately 50 feet from the toe of the levee. In addition to this wetland, a 3.3-acre lake is located along the right bank of the Big Papillion Creek between L Street and 72nd Street. This lake runs directly adjacent to the toe of the levee for approximately 1,300 feet.

#### 4.1.9.2 FISHERIES

Prior studies show that the fish population in the basin is dominated by generalist minnow species that are tolerant of lower quality habitat. As a result, the overall habitat quality of the streams within the basin was determined to be poor due to the high level of development along the creeks and the multiple modifications that have occurred within the streams for flood risk reduction and bank stabilization. A total of 23 species of fish were collected in the streams of the Papillion Creek Basin during a 2006 study. Over 95 percent of the fish collected were species from the minnow family (*cyprinidae*).

#### 4.1.9.3 MIGRATORY BIRDS

The Papillion Creek basin falls within the Central Flyway which merges easterly towards the Mississippi Flyway as it follows along the Missouri River. This route has been recognized as a collective north-south migratory pathway that houses 114 U.S and 21 Canadian localities of special importance to birds migrating. An estimated 400 species from 50 avian families utilize the Central Flyway to and from breeding and wintering grounds (Johnsgard, 2012).

Utilizing the U.S. Fish and Wildlife Service's (USFWS) Information, Planning, and Consultation (IPaC) online tool, 21 migratory birds of Conservation Concern were identified as having the potential to occur, or breed within the study area. They are: American Bittern, American Golden Plover, Bald Eagle, Black-billed Cuckoo, Bobolink, Buff-breasted Sandpiper, Cerulean Warbler, Dunlin, Eastern Whip-poor-will, Golden Eagle, Hudsonian Godwit, Kentucky Warbler, Least Bittern, Lesser Yellowlegs, Prothonotary Warbler, Red-headed Woodpecker, Ruddy Turnstone, and Rusty Blackbird.

#### 4.1.9.4 Reptiles and Amphibians

Presently, 13 species of amphibians and 47 species of reptiles are known to exist in the entire State of Nebraska. In Eastern Nebraska, the tiger salamander (*Ambystoma trigrinum*), cricket frog (*Acris crepitans*), woodhouse toad (*Bufo woodhousii*), western gray tree frog (*Hyla*

*chrysoscelis*), plains leopard frog (*Rana blairi*), northern leopard frog (*Rana pipiens*) and western striped chorus frog (*Pseudacris triseriata*), are all amphibians that have a high probability of being found in and around the project area.

Some reptiles expected to be found within the Papillion Creek basin would be the blue racer (*Coluber constrictor*), prairie kingsnake (*Lampropeltis calligaster*), milk snake (*Lampropeltis triangulum*), common watersnake (*Nerodia sipedon*), bull snake (*Pituophis catenifer*), varying species of gartersnakes (Thamnophis spp.), the prairie skink (Eumeces septentrionalis), snapping turtle (*Chelydra serpentina*), and painted turtle (*Chrysemys picta*) (Lynch, 1985). During a site visit in May of 2019, a large spiny softshell turtle (*Apalone spinifera*) was observed basking on the bank of the low flow channel in Little Papillion Creek between Dodge Street and 72nd Street.

The quality of the habitat for reptiles and amphibians in most of the proposed construction areas is relatively poor because the creeks are flashy, so the water levels rise and fall rapidly. The vegetation is dominated by smooth brome grass and reed canary grass with a few areas of trees along the steep channel banks. Most of the frogs and turtles spend the majority of their time in the low flow channel, along the water's edge, or in the vegetation immediately next to the channel. Some snakes, toads, and leopard frogs can be found using the grasses on the channel bench and along the channel side slopes above the bench.

#### 4.1.9.5 Threatened and Endangered Species

In accordance with Section 7 of the Endangered Species Act (ESA) (7 U.S.C. § 136, 16 U.S.C. § 1531), the USFWS was consulted to obtain information on Federally-listed threatened and endangered species that have the potential to occur within the proposed project area. A letter dated November 20, 2018 was submitted to the USFWS Region 6 Ecological Services Field Office requesting information on anticipated impacts that may be associated with proposed alternatives and a list of Federally-listed threatened and endangered species that may be found in the study area. The USFWS responded with a letter dated April 16, 2019 that provided Federally listed species that may occur within the proposed project area or be affected by the proposed project. Three Federally listed threatened or endangered species were identified as having the potential to occur within the study area. They include the threatened northern long-eared bat (*Myotis septentrionalis*), western prairie fringed orchid (*Platanthera praeclara*), and the endangered pallid sturgeon (*Scaphirhynchus albus*).

#### 4.1.9.6 State Listed Species of Concern

According to the Nebraska Natural Heritage Program, four species of State concern have the potential to occur in Washington, Douglas, and Sarpy counties: lake sturgeon (*Acipenser fulvescens*), sturgeon chub (*Macrhybopsis gelida*), river otter (*Lutra canadensis*), and American ginseng (*Panax quinquefolium*). It is not anticipated that the Papillion Creek basin provides adequate habitat to support any of these species.

#### 4.1.9.7 Vegetation

Vegetation in eastern Nebraska was historically a tallgrass prairie with a limited extent of woody vegetation found adjacent to rivers and streams. Prior to 1855, a distinct prairie-forest ecotone restricted to floodplains, terraces and other uplands bordering riparian areas existed. It is thought that the lack of fire intensity and frequency allowed woody vegetation to colonize the region.

Presently, cottonwood (*Populus deltoides*), bur oak (*Quercus macrocarpa*), American basswood (*Tilia americana*), and rough-leaved dogwood (*Cornus drummondii*) are more common than they were prior to settlement of the region (Rothenberger, 1989). Within the immediate study area, habitat types were historically upland deciduous forests along the floodplain of the streams and tributaries of Papillion Creek basin and upland tallgrass prairie beyond the riparian corridors. Today, vegetation and habitat types have been severely altered from natural, historical conditions due to land use conversion. Most of the remaining riparian forest is confined to the banks within the stream channels of a few of the reaches. Most of the streams have been channelized, straightened, or modified in some other way. These reaches are dominated by smooth brome grass above the bankfull bench and reed canary grass on the bankfull bench and below. Other vegetation that can be found mixed in with the smooth brome grass includes bluegrass, fescue, smartweed, common milkweed, crown vetch, yellow sweet clover, white clover, and curly dock.

Data collection for the Nebraska Stream Condition Assessment Protocol (NeSCAP) and the Brown Thrasher Habitat Evaluation Procedure (HEP) were conducted as part of this study and has been utilized to assess impacts to vegetation and evaluate mitigation requirements.

### 4.1.10 Cultural Resources

Many cultural resource sites are located within the Papillion Creek watershed. Cultural resources can be defined as physical evidence or place of past human activity: site, object, landscape, structure; or a site, structure, landscape, object, or natural feature of significance to a group of people traditionally associated with it.

Consultation with the Nebraska State Historic Preservation Office (SHPO), Tribes, and other interested parties was initiated in November 2018. The Omaha Tribe indicated that they wanted to participate in consultation and expressed concern over a major village site known to exist within the study area. USACE met with Tribal Council representatives at the location of this site on December 7, 2018. At the meeting it was discussed how any of the potential alternatives would not cause an impact to this particular area, and the Tribe did not express any significant concerns with other locations. This final document will be shared with all the Tribes who were contacted during study scoping.

A file search with History Nebraska was completed by a USACE archaeologist on June 4, 2019. The file search identified numerous surveys located within the Papillion Creek watershed. There are 26 sites within the one-mile radius of the considered alternatives, but only one site has been recorded within the Areas of Potential Effect (APE).

Based upon the results of the file search, and the fact that a majority of potential construction areas have been previously impacted, there is a low likelihood of adverse effects on historic properties. As the process of plan formulation took time and the study area is so large, survey contract(s) were not suggested until after the plan formulation phase is final. A Programmatic Agreement (PA), in consultation with the Nebraska SHPO, the Advisory Council on Historic Preservation, and Interested Parties is being finalized to address potential impacts to unrecorded historic properties that may be discovered prior to, or during, the construction of levees, floodwalls, and reservoirs on undeveloped land. This includes both structural and nonstructural alternatives.

The draft PA was sent to the SHPO, the ACHP, the Papio NRD, the Ponca Tribe of Nebraska, the Omaha Tribe, the Otoe-Missouria Tribe, the Ponca Tribe of Indians of Oklahoma, the Pawnee Nation of Oklahoma, the Winnebago Tribe and the Iowa Tribe of Nebraska and Kansas for comment prior to finalization on December 18. 2020. There was an informational webinar for January 26, 2021 to address any questions. The PA has been signed by USACE, Nebraska SHPO, and the Papio NRD. Coordination with the tribes will continue throughout the project.

### 4.1.11 Environmental Justice

Executive Order 12898 Environmental Justice. In compliance. USACE is obligated under E.O. 12898 of 1994 and the Department of Defense's Strategy on Environmental Justice of 1995, which direct federal agencies to identify and address any disproportionately high adverse human health or environmental effects of federal actions to minority and/or low-income populations.

Based on block group data, the study area is comprised primarily of those identified as White Alone (81.1%), Black or African American Alone (6.1%) or Hispanic or Latino (6.0%). For most minority populations, the Papillion Creek study area includes a lower proportion of minority populations than the City of Omaha as a whole. In addition, the Papillion Creek study area reflects higher than average income and home value, an average poverty rate and a lower unemployment rate compared to most of the other geographic areas (Appendix F).

## 4.2 Problems and Opportunities

This section describes problems and opportunities that can be addressed through water and land resource management to reduce flood risk. Problems are defined as undesirable conditions to be changed through the implementation of an alternative plan. Opportunities are defined as positive conditions that can be achieved by an alternative plan.

Problem: Flash flooding in the Papillion Creek watershed presents a severe and recurring risk to public health, safety, and property in the Papillion Creek Basin due to seasonal rainfall events combined with undersized bridges, culverts, and channels and extensive development in the floodplain. Based on updated floodplain mapping at the time of alternative measure development, there are approximately 4,700 structures in the 0.2% AEP floodplain with an approximate structure value of $1.9B and EAD of over $19M. In addition, there are several critical facilities that lie within the floodplain, including three law enforcement facilities, 13 emergency services facilities, six schools and one airport. The population at risk is approximately 25,000 people at night and 59,000 people during the day within the 0.2% AEP floodplain. As discussed in Section 4.1.1, the basin experiences recurrent flooding and there is an anticipated increase in risk due to development and a possible increase in flows due to climate change.

Continued monitoring of climate trends are recommended throughout the project's PED phase and its planning horizon (100 years). An adaptive management approach is recommended where measures could be added in the future to build resilience into the project if the potential for increasing streamflows begin to materialize.

Opportunities:

- Reduce flood risk to life and health safety in the Papillion Creek Basin.

- Reduce flood risk to property, businesses, and infrastructure in the Papillion Creek Basin.
- Increase flood risk awareness in the Papillion Creek Basin community.
- Improve access to and quality of recreation where compatible with flood risk management in the Papillion Creek Basin.

## 4.3 Planning Objectives and Constraints

In accordance with ER 1105-2-100 Appendix E, objectives are to be specific, flexible, measurable, realistic, attainable, and acceptable. This study consists of two sets of objectives: the federal objective, which every USACE planning study shares; and the project objectives, which are developed on a per project basis. These objectives are detailed below

The Federal objective of this flood risk management study and other water and related land resources planning is to provide contributions to NED consistent with protecting the nation's environment, pursuant to Federal environmental statues, applicable executive orders, and other Federal planning requirements. Contributions to the NED are increases in the net value of the national outputs of goods and services, including reduced flood damages, that accrue in the planning area, and to the nation overall.

The water and land resource problems and opportunities identified in this study are refined and stated as specific planning objectives to provide focus for the formulation of alternatives. These planning objectives reflect the problems and opportunities and represent desired positive changes in the without-project condition. All objectives will be evaluated based on a 50-year period of analysis, starting at base year of project completion. The base year for the project is currently forecasted to be 2026 based on the current schedule of the Chief's Report in 2021, WRDA authorization in 2022, construction start in 2024 and a construction duration of five years.

Planning objectives are specific statements that describe the desired measurable results of the planning process by solving the identified problems and exercising the opportunities. The planning objectives were used in the formulation and evaluation of alternative plans:

1) Reduce the likelihood and consequences of flooding on human life and safety in the Papillion Creek Basin through the 50-year period of analysis.
2) Reduce the risk of flood damage to property, businesses, and infrastructure (including critical facilities) in the Papillion Creek Basin due to flooding through the 50-year period of analysis.
3) Incorporate natural and nature-based systems, where possible, to preserve and increase the area and habitat function of the Papillion Creek and its tributaries consistent with Section 1184 of WRDA 2016.
4) A secondary objective of a justified flood risk management (FRM) plan is to improve recreational opportunities in the Papillion Creek watershed.

Planning constraints represent restrictions that limit the extent of the planning process and potential solutions. Plans should be formulated to meet the objectives and avoid violating the constraints. All civil works planning studies are subject to universal constraints including resource availability and legal and policy constraints. Study-specific constraints affect formulation, evaluation, and selection process decisions. In this study, the following constraints were identified:

1) Study-specific constraints: No study specific constraints have been identified.

## 4.4 ALTERNATIVE MEASURES

Alternative plans are formulated to achieve planning objectives within the constraints. In this study, alternative plans consist of a combination of structural and/or nonstructural measures, strategies, or actions that meet, fully or partially, various planning objectives. The initial plan formulation exercises involved the generation of preliminary concepts and examination of specific measures for flood risk management from both a structural and nonstructural approach.

Two iterations of the planning process were conducted with the sponsor prior to the development of the selected plan. Measures originally considered included dams, levees, floodwalls, flood tunnels, off channel detention, water diversions, channel widening, nonstructural measures, bridge modifications, bridge removal, road modifications, and culvert modifications. These measures were evaluated for their ability to meet the following criteria:

- Completeness – extent to which a measure/alternative provides for and accounts for all necessary investments and or other actions necessary to ensure realization of the planned effects.
- Effectiveness – extent to which a measure/alternative alleviates the specified problems and achieves the specified opportunities.
- Efficiency – extent to which a measure/alternative is the most cost-effective means of alleviating the specified problem and realizing the specified opportunities.
- Acceptability – workability and viability of the measure/alternative with respect to acceptance by state and local entities and the public and compatibility with existing laws, regulations, and public policies.

Any measure that did not meet the four planning criteria of complete, effective, efficient, and acceptable was removed from the final array of measures. The results are summarized in Table 9, Table 10, and Table 11. These measures were then developed into combinations culminating in the creation of a list of alternatives to be evaluated under this study. As the alternatives passed through subsequent evaluation and screening processes, the economic analysis of each alternative was used as a critical ranking factor in the final selection process.

**Table 9. Initial Assessment of Measures for Big Papillion Creek**

| Measure | Objective Addressed | Screening Criteria | | | | Conclusion |
|---|---|---|---|---|---|---|
| | | Completeness | Effectiveness | Efficiency | Acceptability | |
| **Construct Dam Site 1 and Dam Site 3C in Washington County** | Reduce flood risk | Y | Y | Y | Y | **This measure is carried forward** |
| **Construct Dam Site 7** | Reduce flood risk | Y | Y | Y | Y | **This measure is carried forward** |

| Measure | Objective Addressed | Screening Criteria | | | | Conclusion |
|---|---|---|---|---|---|---|
| | | Completeness | Effectiveness | Efficiency | Acceptability | |
| **Construct Dam Site 8a** | Reduce flood risk | Y | Y | Y | Y | **This measure is carried forward** |
| **Construct Dam Site 9a** | Reduce flood risk | Y | Y | Y | Y | **This measure is carried forward** |
| **Levee improvements on lower Big Papillion** | Reduce flood risk | Y | Y | Y | Y | **This measure is carried forward** |
| **Flood tunnels** | Reduce flood risk | Y | Y | N | Y | There are other more efficient measures to meet the objectives, such as channel widening and levees, due to high cost **this measure is not carried forward** |
| **Off channel detention** | Reduce flood risk | Y | Y | N | Y | There are other more efficient measures to meet the objectives, such as channel widening and levees, due to high cost **this measure is not carried forward** |
| **Divert Water to Dam Site 8A** | Reduce flood risk | Y | Y | N | Y | There are other more efficient measures to meet the objectives, such as channel widening and levees, due to high cost **this measure is not carried forward** |
| **Divert Water to Standing Bear Lake** | Reduce flood risk | Y | Y | N | Y | There are other more efficient measures to meet the objectives, such as channel widening and levees, due to high cost **this measure is not carried forward** |
| **Channel Widening (Blondo to L Street)** | Reduce flood risk | Y | Y | Y | Y | **This measure is carried forward** |
| **Levees/floodwalls (Blondo to L Street)** | Reduce flood risk | Y | Y | N | Y | There are other measures (channel widening) less costly to meet the objectives**,** therefore **this measure is not carried forward** |
| **Acquisition, relocations, elevations and floodproofing where applicable** | Reduce flood risk | Y | Y | Y | Y | **This measure is carried forward** |
| **Construct recreation features compatible with reservoir construction (trails, boat ramps, fishing access, fish habitat)** | Increase Recreation | Y | Y | Y | Y | **This measure is carried forward** |

| Measure | Objective Addressed | Screening Criteria | | | | Conclusion |
|---|---|---|---|---|---|---|
| | | Completeness | Effectiveness | Efficiency | Acceptability | |
| **Construction of trails** | Increase Recreation | Y | Y | Y | Y | **This measure is carried forward** |
| **Y=Yes, N=No, P=Partial** | | | | | | |

**Table 10. Initial Assessment of Measures for Little Papillion Creek**

| Measure | Objective Addressed | Screening Criteria | | | | Conclusion |
|---|---|---|---|---|---|---|
| | | Completenes | Effectivenes | Efficiency | Acceptabilit | |
| **Widen RR and Hwy Bridge at I-80** | Reduce flood risk | Y | Y | Y | Y | **This measure is carried forward** |
| **Widen or remove bridge at Pacific St.** | Reduce flood risk | Y | Y | Y | Y | **This measure is carried forward** |
| **Remove pedestrian bridges** | Reduce flood risk | Y | Y | Y | Y | **This measure is carried forward** |
| **Remove 1st Data Bridge** | Reduce flood risk | Y | Y | Y | Y | **This measure is carried forward** |
| **Floodwall at NFM (72nd and Dodge)** | Reduce flood risk | Y | Y | Y | Y | **This measure is carried forward** |
| **Channel Improvements (Maple to I-80)** | Reduce flood risk | Y | Y | Y | Y | **This measure is carried forward** |
| **Levee/floodwall (Dodge to Center and Center to L)** | Reduce flood risk | Y | Y | Y | Y | **This measure is carried forward** |
| **Dam Site 10** | Reduce flood risk | Y | Y | Y | Y | **This measure is carried forward** |
| **Detention basin on Cole Creek** | Reduce flood risk | Y | N | N | Y | Detention at this location would not remove enough flow to affect flood risk without substantial earth work therefore **this measure is not carried forward** |
| **Redesign road along Saddle Creek to carry flood** | Reduce flood risk | N | Y | N | Y | Carrying flood flows in the streets would not effectively reduce flood risk because the road cannot be lowered without impacting combined sanitary sewer underneath therefore **this measure is not carried forward** |

| Measure | Objective Addressed | Screening Criteria | | | | Conclusion |
|---|---|---|---|---|---|---|
| | | Completenes | Effectivenes | Efficiency | Acceptabilit | |
| **Construct a parallel pipe along Saddle Creek to carry flood** | Reduce flood risk | Y | N | N | Y | The high cost of construction and low potential benefit make this measure infeasible**, therefore this measure is not carried forward** |
| **Acquisition, relocations, elevations and floodproofing where applicable – specifically buyout of trailer court at I-80** | Reduce flood risk | Y | Y | Y | Y | **This measure is carried forward** |
| **Construct recreation features compatible with reservoir construction (trails, boat ramps, fishing access, fish habitat)** | Increase Recreation | Y | Y | Y | Y | **This measure is carried forward** |
| **Construction of trails** | Increase Recreation | Y | Y | Y | Y | **This measure is carried forward** |
| **Y=Yes, N=No, P=Partial** | | | | | | |

**Table 11. Initial Assessment of Measures on West Papillion Creek and South Papillion Creek**

| Measure | Objective Addressed | Screening Criteria | | | | Conclusion |
|---|---|---|---|---|---|---|
| | | Completenes | Effectivenes | Efficiency | Acceptabilit | |
| **Dam Site 12** | Reduce flood risk | Y | Y | Y | Y | **This measure is carried forward** |
| **Increase size of culvert at Maple** | Reduce flood risk | Y | N | Y | Y | Initial analysis shows increasing the culvert size would not measurably change the floodplain **therefore this measure is not carried forward** |
| **Channel improvement above W Center for ¼ miles** | Reduce flood risk | Y | Y | Y | Y | **This measure is carried forward** |
| **Channel improvement above 144th for ½ mile** | Reduce flood risk | Y | Y | Y | Y | **This measure is carried forward** |
| **Channel improvement Harrison to West Center** | Reduce flood risk | Y | Y | Y | Y | **This measure is carried forward** |

| Measure | Objective Addressed | Screening Criteria | | | | Conclusion |
|---|---|---|---|---|---|---|
| | | Completenes | Effectivenes | Efficiency | Acceptabilit | |
| **West Papillion levee improvements** | Reduce flood risk | Y | Y | Y | Y | **This measure is carried forward** |
| **Dam Site 19 on South Papillion** | Reduce flood risk | Y | Y | Y | Y | **This measure is carried forward** |
| **West Papillion Dam Site 2 on South Papillion** | Reduce flood risk | Y | N | N | Y | The high cost of construction and low potential benefit make this measure infeasible**, therefore this measure is not carried forward** |
| **Acquisition, relocations, elevations and floodproofing where applicable – specifically buyout of trailer court at I-80** | Reduce flood risk | Y | Y | Y | Y | **This measure is carried forward** |
| **Construct recreation features compatible with reservoir construction (trails, boat ramps, fishing access, fish habitat)** | Increase Recreation | Y | Y | Y | Y | **This measure is carried forward** |
| **Construction of trails** | Increase Recreation | Y | Y | Y | Y | **This measure is carried forward** |
| **Y=Yes, N=No, P=Partial** | | | | | | |

From this qualitative assessment any measure that was found to not at least partially satisfy a study objective and each of the four planning criteria was eliminated from further consideration. The initial array of measures carried forward from Tables 10, 11, and 12 were further evaluated and screened by conducting a cursory, screening-level cost-benefit analysis using rough order of magnitude costs and benefits. The screening-level cost-benefit analysis led to additional screening out of several measures due to a lack of positive net benefits. As a result, the following five nonstructural (further defined in Appendix G) and six structural measures were retained for further evaluation based on expectation that they had the most promise for net benefits among the various flood risk management measures considered:

**Structural Measures**

- Raise existing levees
- New levees
- Widen channel
- Floodwalls
- Dams with reservoirs/dry dams
- Bridge modification/removal

**Nonstructural Measures**

- Dry or wetproofing structures
- Elevation of structures
- Filling in basements
- Flood warning system
- Relocation or acquisition

The most common nonstructural measures are elevations and dry floodproofing. Elevations include raising the existing building from its original foundation to the design flood elevation (Figure 12). This measure is recommended for residential buildings, with or without basements. In the Papillion Creek watershed, it is required that the lowest floor be elevated at least one foot above the BFE to be in compliance with local and state codes. Therefore, the design flood elevation (DFE) for this study is the BFE plus one additional foot. Elevation can be performed using fill material, extended foundation walls, piers, posts, piles, or columns. Elevation is also a successful technique for reinforced slab-on-grade structures. If the elevated foundation below the first floor is an enclosed masonry perimeter, then appropriately sized flood vents must be included.

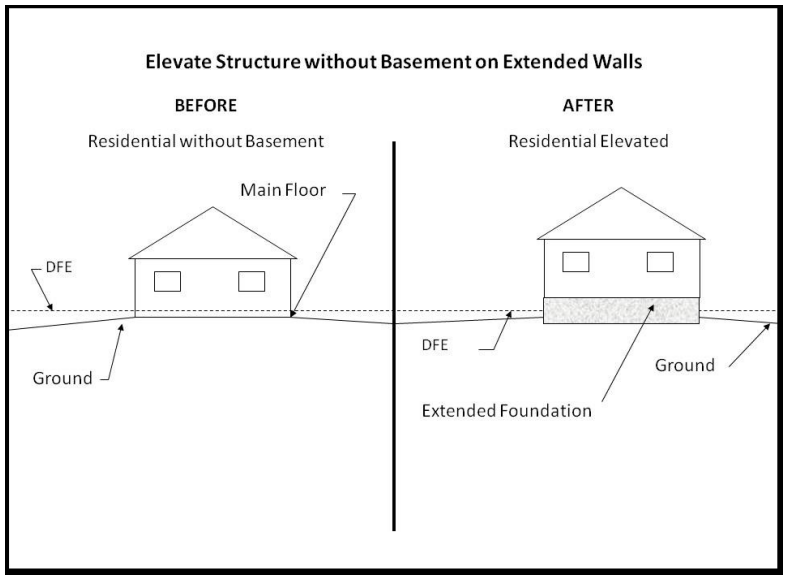



**Figure 12. Elevation of Structure on Extended Foundation**

Dry floodproofing of commercial and other non-residential buildings involves implementing techniques that prevent floodwaters from entering the building. Applying a water-resistant sealant around the building is used to prevent flood water from entering. The sealant layer is then protected with a brick veneer or similar material. Closure panels are used at building openings and a sump pump and drain system must be installed as part of the measure to control seepage through closure devices. A back-up power supply for the pump may be necessary. Backflow prevention devices must be installed on sanitary sewer lines. Dry floodproofing can typically be implemented up to 4 feet. A schematic of the dry floodproofing technique is shown in Figure 13.

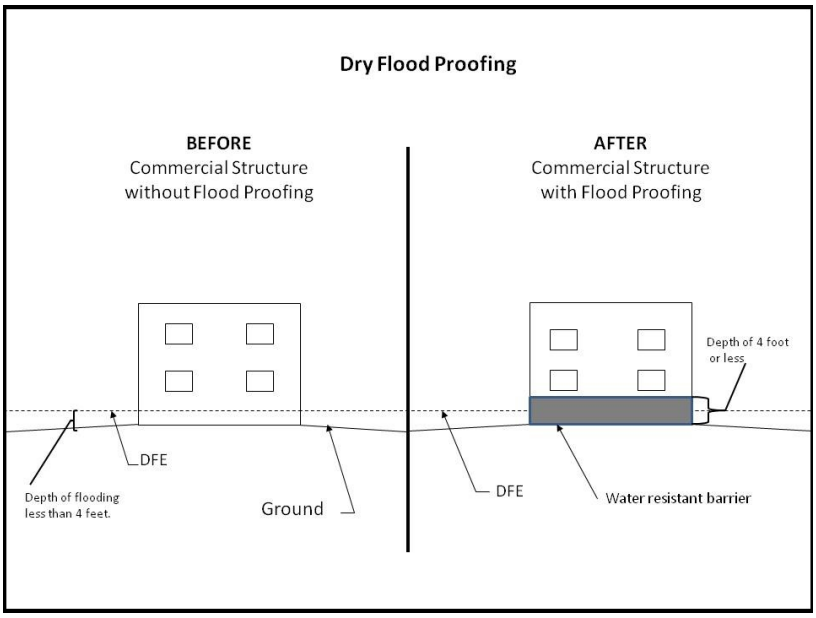



**Figure 13. Commercial Dry Floodproofing**

The plan formulation of the Papillion Creek basin alternatives assumes that actions on each of the major streams (i.e. Big Papillion Creek, Little Papillion Creek, etc.) have independent utility and benefits through most of the reaches due to streams confluence areas lying at the far southeast end of the basin. For example, a levee constructed on Big Papillion Creek does not provide a measurable positive or negative effect of the flood risk on Little Papillion Creek (except at the confluence itself). Therefore, alternatives were formulated and evaluated on each stream individually and not compared against alternatives on other channels. There are a few reaches that are affected by multiple alternatives downstream of the confluences and those minor influences have been accounted for in Table 27 and Table 29 to ensure benefits are not double counted in the tentatively selected plan (TSP). Having passed review for engineering adequacy, environmental and public acceptability, and the other alternatives evaluation criteria as described herein, the remaining alternative with the highest net benefits to the national economy was identified as the National Economic Development Plan (NED plan). The final NED plan includes a composite NED plan for each stream combined together, resulting in a more comprehensive flood risk management plan for the entire watershed.

The formulation and evaluation of alternative plans focused on the previously identified economic damage reaches (Table 3) in order to focus the analysis at a reasonable, reach-based scale. Special attention was given to focusing on reaches with the highest economic flood risks (EAD) based on an assumption that those reaches presented the highest potential for producing positive net benefits. This was based on the assumption that construction costs for channel modifications, bridge replacements, new levees or floodwalls, raising existing levees, and new dry or wet dams would be relatively high and would likely have high real estate costs, so there would have to be high benefits available to demonstrate economic viability. Reaches with relatively low EADs were considered for primarily nonstructural alternatives. Previously considered dam sites, such as WP4 and WP5 that were not expected to have a significant

hydrologic influence were not included in the analysis. Figure 14 is a map showing the reaches and existing conditions EAD.

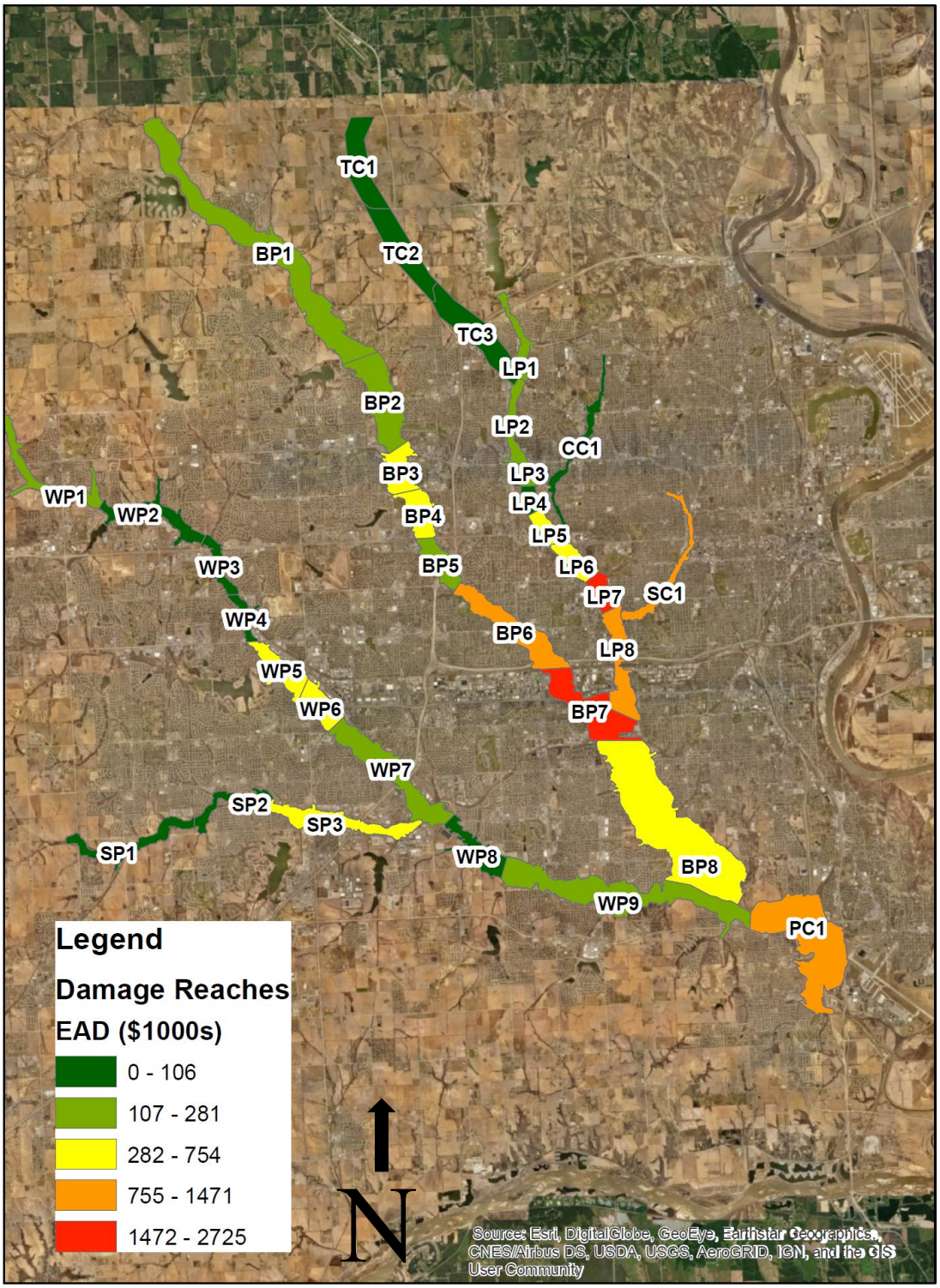



**Figure 14. Channel Reaches and Existing Conditions EADs**

For the initial alternative evaluation, one structural alternative was developed for each reach based on the following criteria:

- On reaches where existing levees/floodwalls exist – levee/floodwall raises were evaluated – assumption that real estate would be minimal.
- On reaches where no levees/floodwalls exist – channel widening was evaluated – assumption that channel widening would require less real estate.
- Dam sites that were carried forward were initially evaluated as wet dams only based on existing sponsor developed cost estimates.
- No real estate costs were considered for any of the alternatives in the initial array of alternatives.

Table 12 presents a summary of the initial array of alternatives formulated and evaluated. Each alternative was evaluated for economic viability, technical feasibility, and effectiveness at meeting the study objectives using HEC-FDA analysis and estimated construction costs (Table 13). For preliminary evaluation and screening of alternative plans an assumed three feet of additional levee/floodwall height was incorporated as a simplifying assumption to address uncertainties and allow expedited the evaluation. Alternative specific refinements were incorporated based on risk and uncertainty during the optimization analysis after the TSP and draft report stage. An additional 3 feet was used as a simplifying assumption (based on prior work in basin) that provides at least 90 percent assurance of containing the design flood to expedite development of cost estimates over a large area in a short period of time. During optimization of the TSP, the risk was incorporated in all channel and levee projects with appropriate profile to provide assurance of containing the optimized design event.

**Table 12. Initial Array of Alternative Plans**

| Initial Array | Alt 1 - No Action Alternative | Alt 2 – Dams/ Reservoirs | Alt 3 - Channel Modifications/Levees/ Floodwalls | Alt 4 - Nonstructural |
|---|---|---|---|---|
| **West Papillion** | No Action | Dam Site 12 | - Levee Raises/Floodwall<br>- Channel Widening | Elevation,<br>Dry Floodproofing,<br>Basement Fill,<br>Acquisition |
| **South Papillion** | No Action | Dam Site 19 | Channel Widening | Elevation,<br>Dry Floodproofing,<br>Basement Fill,<br>Acquisition |
| **Little Papillion** | No Action | Dam Site 10* | - New Levee/Floodwall<br>- Channel Widening | Elevation,<br>Dry Floodproofing,<br>Basement Fill,<br>Acquisition |
| **Big Papillion** | No Action | Dam Site 3,<br>Dam Site 7,<br>Dam Site 8a,<br>Dam Site 9a | - Channel Widening<br>- Levee Raise/Floodwall | Elevation,<br>Dry Floodproofing,<br>Basement Fill,<br>Acquisition |
| **Papillion Creek** | No Action | | Levee Raise/Floodwall | Elevation, |

| | | | | |
|---|---|---|---|---|
| | | | | Dry Floodproofing, Basement Fill, Acquisition |
| **Cole Creek** | No Action | | | Elevation, Dry Floodproofing, Basement Fill, Acquisition |
| **Saddle Creek** | No Action | | | Elevation, Dry Floodproofing, Basement Fill, Acquisition |
| **Thomas Creek** | No Action | | | Elevation, Dry Floodproofing, Basement Fill, Acquisition |

*Dam Site 10 is located on Thomas Creek, a tributary to Little Papillion Creek; however, the flood risk benefits are accrued on Little Papillion Creek, so it is included in that alternative.

**Table 13. Evaluation of Initial Array of Alternatives**

| **West Papillion Creek** | | | | | |
|---|---|---|---|---|---|
| **Initial Array of Alternatives** | | **Benefits** | **Cost** | **Screening** | **Reason** |
| **Alt 1 - No Action** | | N/A | N/A | **Retain** | N/A |
| **Alt 2 – Dams** | Dam Site 12 | $10,003,000 | $22,200,000 | **Drop** | Costs exceed benefits |
| **Alt 3 – Channel Modifications/ Levees/ Floodwalls** | **Widen Channel – 2% AEP** | | | | |
| | WP 6 (144th St to Millard Ave) | $12,364,523 | $31,048,557 | **Drop*** | Costs exceed benefits |
| | WP 7 (Millard Ave to RR Bridge) | $3,116,893 | $96,362,960 | **Drop** | Costs exceed benefits |
| | **Levee Raise – 0.2% AEP plus 3 feet** | | | | |
| | WP 9 (96th St to Confluence) | $2,926,103 | $17,637,729 | **Drop** | Costs exceed benefits |
| **Alt 4 – Nonstructural** | Elevation, Dry Floodproofing, Basement Fill (193 structures) | $98,420 | $589,754 | **Drop as stand-alone alt/retain for some reaches**** | Cost exceed benefits |
| **South Papillion Creek** | | | | | |
| **Initial Array of Alternatives** | | **Benefits** | **Cost** | **Screening** | **Reason** |
| **Alt 1 - No Action** | | N/A | N/A | **Retain** | N/A |
| **Alt 2 – Dams** | Dam Site 19 | $22,482,000 | $25,400,000 | **Retain** | Costs are within the margin of |

| | | | | | |
|---|---|---|---|---|---|
| | | | | | error of benefits |
| **Alt 3 – Channel Modifications/ Levees/ Floodwalls** | **Widen Channel – 2% AEP** | | | | |
| | SP 3 (156th to Confluence) | $13,546,140 | $25,139,283 | **Drop** | Costs exceed benefits |
| **Alt 4 – Nonstructural** | Elevation, Dry Floodproofing, Basement Fill (85 Structures) | $214,300 | $475,042 | **Drop** | Costs exceed benefits |
| **Little Papillion Creek** | | | | | |
| **Initial Array of Alternatives** | | **Benefits** | **Cost** | **Screening** | **Reason** |
| **Alt 1 - No Action** | | N/A | N/A | **Retain** | N/A |
| **Alt 2 – Dams** | Dam Site 10 (Thomas Creek) | $44,954,000 | $26,200,000 | **Retain** | Benefits exceed costs |
| **Alt 3 – Channel Modifications/ Levees/ Floodwalls** | **Widen Channel – 2 % AEP** | | | | |
| | LP 2 - LP 8 (Maple St to Grover St) | $15,416,586 | $52,793,623 | **Drop** | Costs exceed benefits |
| | **New Levee - 0.2% AEP plus 3 feet** | | | | |
| | LP 5- LP 8 (Cass St to Saddle Creek) | $67,865,347 | $9,598,585 | **Retain** | Benefits exceed costs |
| **Alt 4 – Nonstructural** | Elevation, Dry Floodproofing, Basement Fill (489 Structures) | $720,820 | $1,657,966 | **Drop as stand-alone alt/retain for some reaches**** | Costs exceed benefits |
| **Big Papillion Creek** | | | | | |
| **Initial Array of Alternatives** | | **Benefits** | **Cost** | **Screening** | **Reason** |
| **Alt 1 - No Action** | | N/A | N/A | **Retain** | N/A |
| **Alt 2 – Dams** | Dam Site 1 and 3C | $105,846,000 | $177,000,000 | **Drop** | Costs exceed benefits |
| | Dam Site 7 | $5,343,000 | $14,800,000 | **Drop** | Costs exceed benefits |
| | Dam Site 8a | $5,357,000 | $10,300,000 | **Drop** | Costs exceed benefits |
| | Dam Site 9a | $2,976,000 | $6,800,000 | **Drop** | Costs exceed benefits |
| **Alt 3 – Channel Modifications/ Levees/ Floodwalls** | **Widen Channel – 2 % AEP** | | | | |
| | BP4-BP5 (Blondo St to Pacific St) | $28,532,928 | $23,714,086 | **Retain** | Benefits exceed costs |
| | BP 6 (Pacific St to W Center Rd) | $3,817,057 | $21,668,440 | **Drop** | Costs exceed benefits |
| | **Levee Raise/Floodwall - 0.2% AEP plus 3 feet** | | | | |
| | BP 7-BP 8 (L St to Harrison St) | $86,084,183 | $21,169,197 | **Retain** | Benefits exceed costs |

| | | | | | |
|---|---|---|---|---|---|
| | BP 8 – BP 9 (Harrison St to US 75) | $3,125,225 | $44,731,413 | **Drop** | Costs exceed benefits |
| | PC 1 (US 75 to Harlen Lewis | $467,217 | $38,104,545 | **Drop** | Costs exceed benefits |
| | LP 8 (L St to Confluence) | $29,052,849 | $3,681,593 | **Retain** | Necessary in order to implement levee raise in BP7-8 |
| **Alt 4 – Nonstructural** | Elevation, Dry Floodproofing, Basement Fill (422 Structures) | $513,890 | $1,596,241 | **Drop as stand-alone alt/retain for some reaches**** | Costs exceed benefits |
| **Cole Creek** | | | | | |
| **Initial Array of Alternatives** | | **Benefits** | **Cost** | **Screening** | **Reason** |
| **Alt 1 - No Action** | | N/A | N/A | **Retain** | N/A |
| **Alt 4 – Nonstructural** | Elevation, Dry Floodproofing, Basement Fill (4 Structures) | $4,250 | $16,044 | **Drop** | Costs exceed benefits |
| **Papillion Creek** | | | | | |
| **Initial Array of Alternatives** | | **Benefits** | **Cost** | **Screening** | **Reason** |
| **Alt 1 - No Action** | | N/A | N/A | **Retain** | N/A |
| **Alt 4 – Nonstructural** | Dry Floodproofing (39 Structures) | $118,040 | $91,638 | **Retain** | Benefits exceed costs |
| **Saddle Creek** | | | | | |
| **Initial Array of Alternatives** | | **Benefits** | **Cost** | **Screening** | **Reason** |
| **Alt 1 - No Action** | | N/A | N/A | **Retain** | N/A |
| **Alt 4 – Nonstructural** | Elevation, Dry Floodproofing, Basement Fill (54 Structures) | $216,000 | $139,669 | **Retain** | Benefits exceed costs |
| **Thomas Creek** | | | | | |
| **Initial Array of Alternatives** | | **Benefits** | **Cost** | **Screening** | **Reason** |
| **Alt 1 - No Action** | | N/A | N/A | **Retain** | N/A |
| **Alt 4 – Nonstructural** | Elevation, Dry Floodproofing, Basement Fill (12 Structures) | $14,870 | $48,092 | **Drop** | Costs exceed benefits |

*Channel widening in WP 6 was dropped during initial screening, however reformulation efforts identified a floodwall alternative, which was evaluated further.
**While standalone nonstructural alternatives for the specific system were dropped, specific reaches with positive benefits will be carried forward for additional analysis and optimization.

## 4.5 Final Array of Alternatives

Table 13 presents the results of the evaluation and screening of the initial array of alternatives for each of the creeks to arrive at the final array. The final array of alternative plans (Table 14) were

refined and fully evaluated both independently and in combination focusing on those plans that maximized cost effectiveness, thereby increasing the net economic benefit. The initial and final array was developed in December 2018 and was subsequently refined through multiple rounds of analysis, highlighted in the following sections, for the TSP in September 2019 and ultimately the final Recommended Plan in January 2021. Based on the details of this study and information available at various stages, there were some alternative features carried forward at various stages that later were confirmed to be in the plan and some that ultimately were screened out.

**Table 14. Final Array of Alternative Plans**

| Final Array | Alt 1 - No Action Alternative | Alt 2 – Dams/ Reservoirs | Alt 3 - Channel Modifications/ Levees/ Floodwalls | Alt 4 - Nonstructural | Alt 5 – Combined Plans |
|---|---|---|---|---|---|
| **West Papillion** | No Action | | Floodwall | Elevation, Dry Floodproofing, Basement Fill | Alt 3 + Alt 4 |
| **South Papillion** | No Action | Dam Site 19 | | | |
| **Little Papillion** | No Action | Dam Site 10 | New Levee/ Floodwall | Elevation, Dry Floodproofing, Basement Fill | Alt 2 + Alt 3 + Alt 4 |
| **Big Papillion** | No Action | | - Channel Widening<br>- Levee Raise/ Floodwall | Elevation, Dry Floodproofing, Basement Fill | Alt 3 + Alt 4 |
| **Papillion Creek** | No Action | | | Dry Floodproofing | |
| **Saddle Creek** | No Action | | | Elevation, Dry Floodproofing, Basement Fill | |

Concept-level cost estimates were refined and projected construction periods for each of the final alternatives were developed in accordance standard USACE estimating practice. The total first cost for each alternative includes the estimated construction cost, cost for lands, easements and rights of way, engineering and design cost, supervision and administration cost, and contingencies. Interest during construction calculated for each alternative was then added to the total first cost to derive the economic cost of each alternative. The economic cost was then annualized for a 50-year period of analysis and the FY20 interest rate of 2.75 percent. Other direct costs of project implementation were determined and included in the total annual project implementation cost.

Figure 15 shows the location of the final array of structural plans based on the specific reaches along the creek channels (excluding nonstructural). A more detailed description of what is included in each plan is discussed in Section 4.5. Of note, while standalone nonstructural alternatives were dropped for West Papillion, Little Papillion, and Big Papillion Creeks as shown

in Table 13, specific reaches in those streams were carried forward for additional analysis both independently and in combination with other structural alternatives.

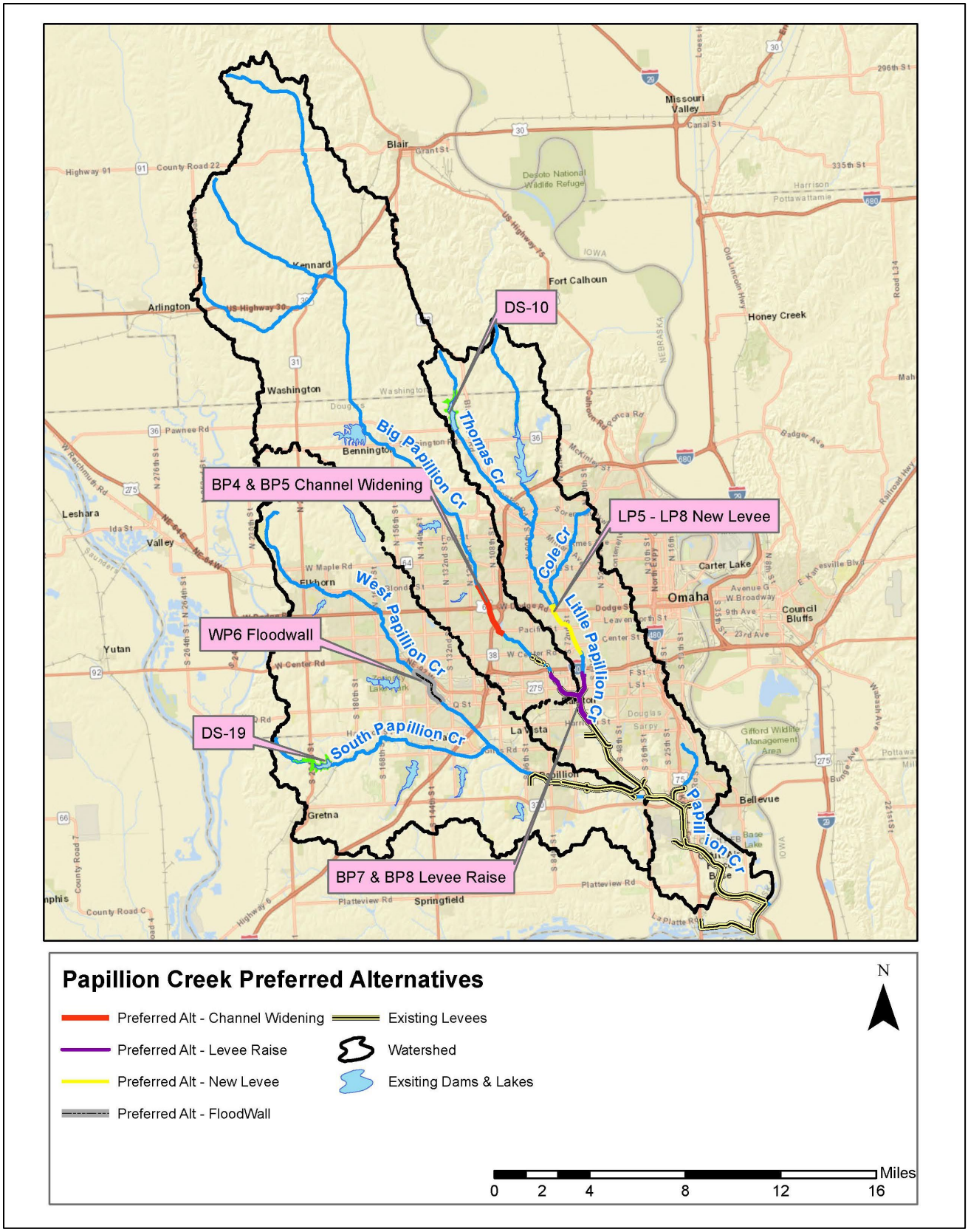



**Figure 15. Map of the Final Array of Structural Alternative Plans**

### 4.5.1 No Action

Under the No Action Alternative, there would be no construction actions taken or changes to the existing flood risk management system or its current operations, maintenance, or management practices in any of the channels in the Papillion Creek Basin. Because no flood risk management actions would occur, flood risk in the basin would persist and worsen as the basin continues to develop. The No Action plan does not successfully address the planning objectives. The No Action alternative does not alleviate risks to public health and safety and flood-prone properties. While some local emergency preparedness plans can be updated and general awareness of the flooding risks can be increased, this is an inadequate measure when taken alone.

### 4.5.2 West Papillion Creek Alternatives

#### 4.5.2.1 Alternative 2 – Dams/Reservoirs

No dams were carried forward into detailed analysis on West Papillion Creek.

#### 4.5.2.2 Alternative 3 – Channel Modifications/Levees/Floodwalls

Channel widening was originally screened out on West Papillion Creek due to high costs in the combined reaches. However, based on the potential benefits in reach WP6, a modified alternative was formulated that included a floodwall in reach WP6. This floodwall would extend from Millard Ave to 144th Street. However, it would require a substantial tie-off to high ground in reach WP5 so that floodwaters would not outflank and flow behind the walls. The tie-off would likely be a levee and would extend from 144th Street to 149th Street. The floodwall would provide flood risk management to the 1 percent AEP plus three feet to account for risk and uncertainty (Figure 16). The floodwall height would be approximately 6.5 feet on the left bank and 6.0 feet on the right bank on average. The levee tie-off would be an average height of 6.8 feet on the left bank and 5.9 feet on the right bank. The length of this alternative is approximately 1.75 miles. The floodwall would require three road closure structures, which could be accommodated using HESCO barriers since the required height is less than three feet (Table 15).

**Table 15. Closure Structure Requirements for West Papillion Creek**

| West Papillion Creek Floodwall | | | | |
|---|---|---|---|---|
| **Street Name** | **Min Bridge Deck Elevation** | **Levee Height** | **Closure Height (ft)** | **Bridge Width (ft)** |
| L Street | 1065.66 | 1067.34 | 1.68 | 36 |
| 144th Street | 1070.86 | 1071.64 | 0.78 | 100 |
| 149th Street | 1071.97 | 1073.04 | 1.07 | 48 |

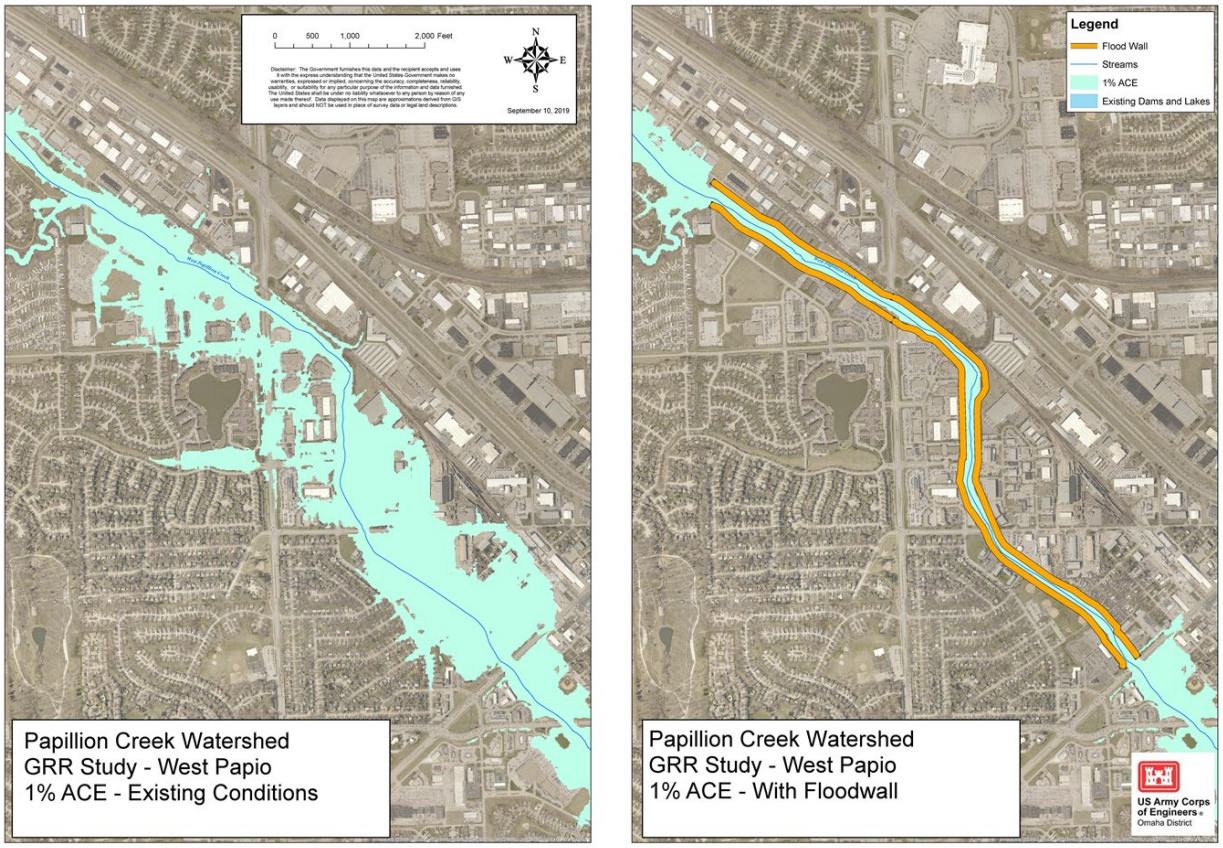



**Figure 16. With and Without-Project 1% AEP for the West Papillion Floodwall**

### 4.5.2.3 Alternative 4 – Nonstructural

The nonstructural alternative was first formulated as a standalone alternative for West Papillion Creek, which was not a justified standalone project. This alternative would include implementation of nonstructural measures on 22 structures along West Papillion Creek. The nonstructural alternative includes elevations and filling in basements for residential structures and dry floodproofing and filling in basements for commercial structures. Any structures located in the floodway can only be acquired, not floodproofed. Those reaches that had positive net benefits were carried forward to be combined with other plans. Further analysis completed in optimization for a combined structural and nonstructural plan.

### 4.5.2.4 Alternative 5 – Combination

Alternative 5 would include a combination of Alternative 3 and Alternative 4. An analysis of the economics of each alternative in the final array is shown in Table 16.

**Table 16. West Papillion Creek Economic Comparison of Final Array of Alternatives**

| Final Array of Alternatives | Alt 3 – Floodwall | Alt 4 – Nonstructural | Alt 5 – Combination* |
|---|---|---|---|
| **Construction Costs** | $10,123,640 | $1,549,872 | $11,673,512 |
| **Real Estate Costs** | $1,933,326 | $0 | $1,933,326 |
| **Mitigation Costs** | $149,000 | $0 | $149,000 |
| **Total First Costs** | $12,205,966 | $1,549,872 | $13,755,838 |
| **Construction Period (years)** | 8 | 0.5 | 8 |
| **Interest During Construction (IDC) (8 years construction, 2.75%)** | $1,170,005 | $0 | $1,170,005 |
| **Total Investment** | $13,375,970 | $1,549,872 | $14,925,842 |
| **Avg Annual Cost (2.75%, 50 yr)** | $495,458 | $57,409 | $552,867 |
| **OMRR&R** | $10,839 | $0 | $10,839 |
| **Total Avg Annual Cost** | $506,297 | $57,409 | $563,706 |
| **Equivalent Avg Annual Benefits** | $418,570 | $84,800 | $503,370 |
| | | | |
| **Benefit/Cost Ratio** | 0.83 | 1.48 | 0.89 |
| **Net Benefits** | -87,730 | $27,390 | -$60,340 |

*The nonstructural measures are not implemented in the same reaches as the floodwall so benefits and costs have been added together in the combination alternative.

### 4.5.3 South Papillion Creek Alternatives

#### 4.5.3.1 Alternative 2 – Dams/Reservoirs

Alternative 2 includes construction of Dam Site 19 (DS19) on South Papillion Creek. A preliminary design of DS19 was completed by HDR under contract to the Papio-Missouri River NRD in 2018, and that design was utilized to complete the preliminary analysis and cost estimate for the draft report. During the optimization analysis, the design for DS19 was updated to ensure compliance with all USACE engineering and dam safety standards. The preliminary cost estimate included a very high contingency of 88 percent to address the design updates anticipated to be necessary to meet USACE criteria. The contingency generally goes down as the study progresses and a more detail analysis is performed, contingencies are updated for the more detailed recommended plan as appropriate. According to the 2018 preliminary design report, DS19 includes construction of a 1,450-foot long earthen dam which would impound approximately 74 surface acres of water. The design also includes construction of an upstream sediment control basin to manage long-term sedimentation. The recreational features and opportunities associated with DS19 would be similar to those at existing reservoir sites in the Papillion Creek watershed, including fishing, canoeing, hiking, biking, and picnicking.

Both a wet and dry dam was considered under this alternative. Dry dams are catchment areas designed to hold excess water in times of flooding, temporarily filling the pool area and after the event passes, essentially fully draining with negligible water storage in normal conditions. These structures provide short-term flood storage to reduce downstream flood risk. A dry dam does not maintain a permanent reservoir pool, so the entire potential volume of its reservoir is available for flood storage. The practical implication of this is that dry dams do not need to be as large as dams with impoundments. This may result in cost savings where the embankment size, outlet works, and required real estate could be reduced or simplified. A preliminary design effort

established the basic geometry and materials for the embankment, as well as the overall size and complexity of the needed outlet works and emergency spillway. Additionally, since a dry dam is designed to be drained relatively rapidly after it has filled, the higher releases could result in potentially damaging downstream flows. Some downstream channel improvements, slope armor, or other measures could be necessary to address that risk.

USACE economic policy requires that a dry dam must demonstrate economic viability (positive net benefits) as a flood risk management alternative before evaluating it as a multi-purpose project (wet dam). The multi-purpose project economic evaluation then compares all of the additional costs against potential recreation benefits (Section 5) to determine if a multi-purpose reservoir is economically justified.

#### 4.5.3.2 Alternative 3 – Channel Modifications/Levees/Floodwalls

No actions were carried forward in Alternative 3 on South Papillion Creek.

#### 4.5.3.3 Alternative 4 – Nonstructural

There are no structures on South Papillion Creek that have nonstructural measures proposed.

#### 4.5.3.4 Alternative 5 – Combination

There is no combined plan for South Papillion Creek.

The economic analysis of DS19 (dry) is shown in Table 17. Costs and benefits of the wet dam are included in the recreation analysis in Section 4.8.2.

**Table 17. South Papillion Creek Economic Comparison of Final Array**

| Final Array of Alternatives | Alt 2 – DS19 Dry |
|---|---|
| **Construction Costs** | $10,340,564 |
| **Real Estate Costs** | $10,193,443 |
| **Mitigation Costs** | $722,400 |
| **Total First Costs** | $21,256,407 |
| **Construction Period (years)** | 8 |
| **IDC (8-year construction, 2.75%)** | $2,669,411 |
| **Total Investment** | $23,925,817 |
| **Avg Annual Cost (2.75%, 50 yr)** | $886,234 |
| **OMRR&R** | $176,000 |
| **Total Avg Annual Cost** | $1,062,234 |
| **Equivalent Avg Annual Benefits** | $986,760 |
| | |
| **Benefit/Cost Ratio** | 0.93 |
| **Net Benefits** | -75,480 |

### 4.5.4 Little Papillion Creek Alternatives

#### 4.5.4.1 Alternative 2 – Dams/Reservoirs

Alternative 2 includes construction of Dam Site 10 (DS10) on Thomas Creek, which is a tributary to Little Papillion Creek. A preliminary design of DS10 was completed by USACE in 1975, and that design was utilized to complete the preliminary analysis and cost estimate for the

final array of alternatives. According to the 1975 report, DS10 would include flood control storage of 1,957 acre-feet to regulate the design standard project flood. The 1,140-acre-foot multipurpose pool would provide a 125-acre lake. The multipurpose pool (wet dam) would hold all of the sediment expected to accumulate during the project's 50-year economic life. The recreational features and opportunities associated with DS10 would be similar to those at existing reservoir sites in the Papillion Creek watershed, including fishing, canoeing, hiking, biking, and picnicking. As described in the next section, this site was later evaluated as a dry dam as well.

#### 4.5.4.2 Alternative 3 – Channel Modifications/Levees/Floodwalls

Alternative 3 would construct a new levee/floodwall from reach LP6 to reach LP8 (Figure 17). This is approximately from Cass Street to Saddle Creek. Cass Street is not used as an upstream tie-in as it is lower than the surrounding terrain. Modeling assumptions were made which assumed that a levee was made along Cass Street and used a closure structure across the street until the new levee tied into existing high ground. The 1 percent AEP levee/floodwall plus three feet to account for risk and uncertainty has an average height of 4.5 feet on both banks for approximately 2.5 miles. A total of 11 road closure structures would be needed for this alternative since the top of the levee would be higher than the top of the road bridges at several crossings (Table 18). Four of the road closure structures could be accommodated using temporary HESCO barriers since the required height is less than three feet. Mechanical closure structures designed to deploy automatically as flood waters rise were evaluated on the remaining seven crossings as part of the alternatives analysis.

**Table 18. Closure Structure Requirements on Little Papillion Creek**

| Little Papillion Creek Levee/Floodwall | | | | |
|---|---|---|---|---|
| **Street Name** | **Min Bridge Deck Elevation** | **Levee Height** | **Closure Height (ft)** | **Bridge Width (ft)** |
| Ped Bridge 1 | 1029.03 | 1032.08 | 3.05 | 9.5 |
| Ped Bridge 2 | 1026.68 | 1033.86 | 7.18 | 10.1 |
| Ped Bridge 3 | 1029.95 | 1033.88 | 3.93 | 9.5 |
| Pine Street | 1034.9 | 1034.98 | 0.08 | 76.5 |
| First Data Access | 1035.2 | 1035.75 | 0.55 | 58.2 |
| Ped Bridge 4 | 1035.7 | 1036.28 | 0.58 | 13.4 |
| Pacific Street | 1033.7 | 1038.58 | 4.88 | 74.5 |
| 72nd Street | 1033.15 | 1041.83 | 8.68 | 114 |
| Ped Bridge 5 | 1037.66 | 1042.42 | 4.76 | 10.5 |
| Dodge Street | 1042.1 | 1044.44 | 2.34 | 109.3 |
| Cass Street | 1044.27 | 1047.9 | 3.63 | 78.5 |

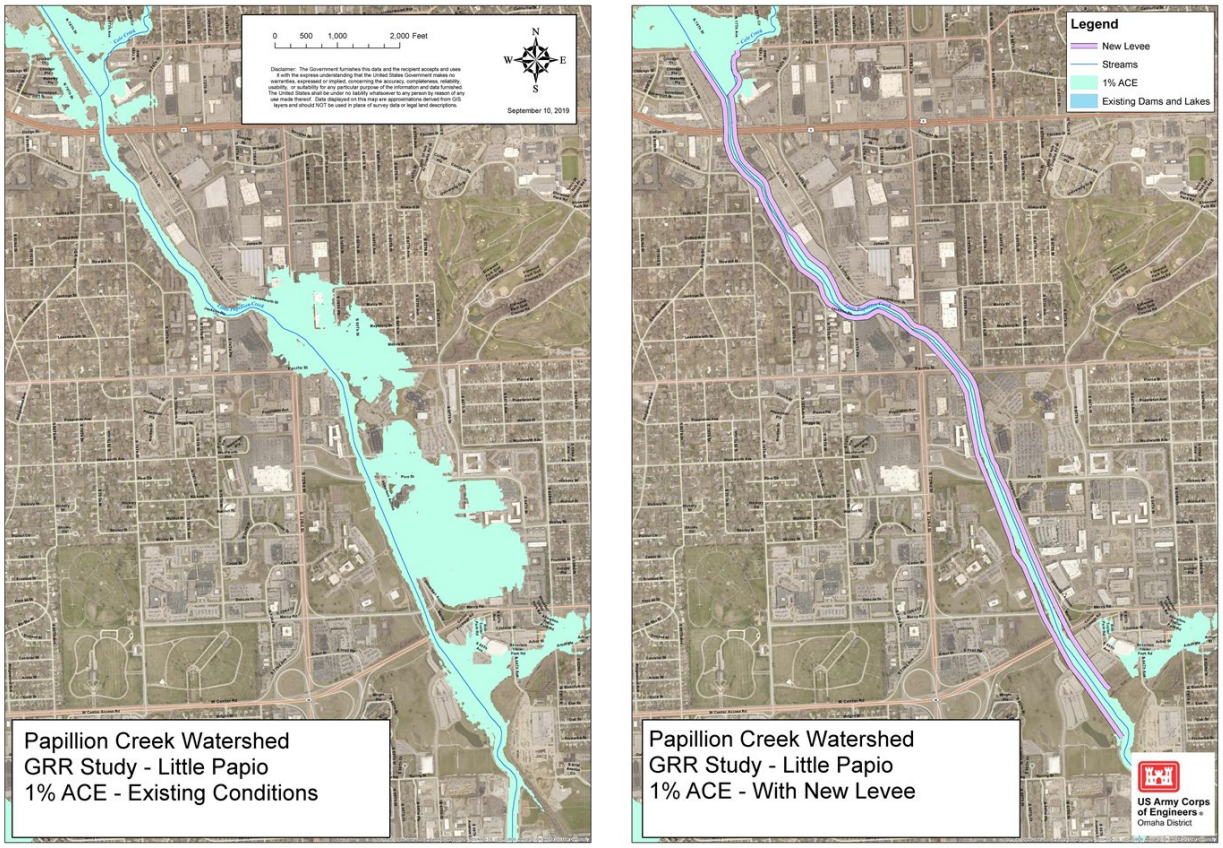



**Figure 17. Little Papillion Creek Levee With and Without-Project 1% AEP**

### 4.5.4.3 Alternative 4 – Nonstructural

The nonstructural alternative was first formulated as a standalone alternative for Little Papillion Creek, which was not a justified standalone project. Those reaches that had positive net benefits were carried forward to be combined with other plans. This alternative would include implementation of nonstructural measures on 12 structures in Little Papillion reach 7. The nonstructural alternative includes dry floodproofing and filling in basements for commercial structures and elevation and filling in basements for residential structures.

### 4.5.4.4 Alternative 5 – Combination

Alternative 5 would include a combination of Alternative 2, Alternative 3 and Alternative 4. The design of Dam Site 10 would be the same as in Alternative 2 and the levees in Alternative 3 would be sized for the 1 percent AEP plus three feet considering the effects of having the dam in place (the downstream effect on levee/floodwall heights was assumed to be the same for both the wet and dry versions of the Alternative 2 dam). Because USACE policy requires demonstrating the economic viability of the dry dam, the combination plan (Alternative 5) presents the costs and benefits of combining the dry dam with Alternative 3 and Alternative 4. The economic results for the combination with the wet dam are presented in Section 5. The combination of levees with the dam allows for a smaller levee height and fewer road closure structures (Table 19), while capturing a similar level of benefits. Results for the Little Papillion Creek

levee/floodwall alternative with DS10 was not explicitly modeled hydraulically. To determine these heights, the top elevation of each closure structure was assumed to be equal the 1 percent AEP water surface from the DS10 analysis with an additional three foot for risk and uncertainty. This value, therefore, does not include the effects due to the presence of levees.

**Table 19. Little Papillion Creek Closure Structures**

| Crossing Name | Required Height with DS10 (ft) | Required Height without DS10 (ft) | Bridge Width (ft) |
|---|---|---|---|
| Ped. Bridge 1 | 0.27 | 3.05 | 9.5 |
| Ped. Bridge 2 | 4.05 | 7.18 | 10.1 |
| Ped. Bridge 3 | 1.18 | 3.93 | 9.5 |
| Pine St | - | - | 76.5 |
| First Data Access | - | 0.55 | 58.2 |
| Ped. Bridge 4 | - | 0.58 | 13.4 |
| Pacific St | 1.35 | 4.88 | 74.5 |
| 72nd St | 3.98 | 8.68 | 114 |
| Ped. Bridge 5 | 1.35 | 4.76 | 10.5 |
| Dodge St | - | 2.34 | 109.3 |
| Cass St | 0.45 | 3.63 | 78.5 |

The new levee/floodwall has an average height of 2.2 feet on both banks. A total of seven road closure structures would be needed for this alternative since the top of the levee would be higher than the top of the road bridges at several crossings. At this stage of the analysis it was assumed HESCO barriers would be utilized for five of the bridges since the top of the levee is less than three feet above the bridge height. The remaining two bridges would require mechanical closure structures, including a 4.05-foot structure on Pedestrian Bridge 2 and a 4.8-foot structure on 72$^{nd}$ Street. Closure structures would be designed to deploy automatically as flood waters rise.

There is overlap in the nonstructural alternative and new levee/floodwall in LP7. In the combination plan, nonstructural measures would not be implemented in reaches where the channel includes a new levee/floodwall except to address residual risk. An economic analysis of the Final Array is shown in Table 20.

**Table 20. Little Papillion Creek Economic Comparison of Final Array of Alternatives**

| Final Array of Alternatives | Alt 2 – DS 10 (Dry) | Alt 3 – New Levee /Floodwall | Alt 4 – Nonstructural | Alt 5 – Combination | |
|---|---|---|---|---|---|
| | | | | Alt 2 (Dry) + Alt 3 | Alt 2 (Dry) + Alt 3 + Alt 4* |
| **Construction Costs** | $12,656,303 | $24,032,946 | $1,911,345 | $22,322,149 | $24,233,494 |
| **Real Estate Costs** | $10,641,532 | $7,068,785 | $0 | $17,710,317 | $17,710,317 |
| **Mitigation Costs** | $766,400 | $0 | $0 | $766,400 | $766,400 |
| **Total First Costs** | $24,064,235 | $31,101,731 | $1,911,345 | $40,798,866 | $42,710,211 |
| **Construction Period (years)** | 8 | 8 | 0.5 | 8 | 8 |
| **IDC (years construction, 2.75%)*** | $2,951,114 | $3,258,780 | $0 | $4,592,626 | $4,592,626 |
| **Total Investment** | $27,015,350 | $34,360,511 | $1,911,345 | $45,391,492 | $47,302,837 |
| **Avg Annual Cost (2.75%, 50 yr project life)** | $1,000,673 | $1,272,745 | $70,798 | $1,681,343 | $1,752,141 |
| **OMRR&R** | $176,000 | $14,814 | $0 | $190,814 | $190,814 |
| **Total Avg Annual Cost** | $1,176,673 | $1,287,559 | $70,798 | $1,872,157 | $1,942,955 |
| **Equivalent Avg Annual Benefits** | $1,959,900 | $1,716,230 | $459,310 | $4,476,730 | $4,936,040 |
| | | | | | |
| **Benefit/Cost Ratio** | 1.67 | 1.33 | 6.49 | 2.39 | 2.54 |
| **Net Benefits** | $678,080 | $533,710 | $388,510 | $2,604,570 | $2,993,090 |

*The nonstructural alternative overlaps with the structural alternative in LP7 and would be impacted by the change in hydraulics from implementation of DS10, so there are likely fewer nonstructural measures implemented in the combined plan once the updated modeling is incorporated in optimization.

## 4.5.5 Big Papillion Creek Alternatives

### 4.5.5.1 Alternative 2 – Dams/Reservoirs

No dams have been carried forward on Big Papillion Creek.

### 4.5.5.2 Alternative 3 – Channel Modifications/Levees/Floodwalls

Alternative 3 includes widening the channel of Big Papillion Creek in reaches BP4 and BP5 (Figure 18). This is approximately Blondo Street to just downstream of Pacific Street. Channel

widening projects have been completed on Big Papillion Creek in the past, so this analysis is focused upstream of the existing projects. The proposed bench width of 120 feet between the 99 percent and 50 percent AEP water surface elevations was determined to maximize the benefits while minimizing the number of bridges that would need to be modified. In order for this alternative to be effective, the 105$^{th}$ Street Bridge would need to be widened with an approximate 120-foot bench width. Additional analysis of a channel widening/levee combination was considered in optimization.

Alternative 3 also proposes to raise the Big Papillion Right Bank and Big Papillion Left Bank levees in reaches BP5 to BP8 (L Street to Harrison Street) to the 1 percent AEP plus three feet to account for risk and uncertainty. This alternative would need to include raising a section of the Little Papillion Left Bank and Little Papillion Right Bank levee (reach LP8) from L Street to the confluence to prevent the levee from being flanked as a result of the levee raise on the Big Papillion levee. The Little Papillion levee raise would include a levee tie off on the north side of L Street. This levee alternative assumes that the railroad embankment and Harrison Street are tied into to prevent water from entering into the protected area. A parallel levee segment could be constructed instead of tying into the railroad embankment (approximately 60 feet high), but this was not looked at due to cost constrictions. Any tie-ins with non-project features will require coordination to ensure real estate access. The average new height of the Big Papillion levee is approximately 9.2 feet on the left bank and 7.6 feet on the right bank. This equates to a raise on the existing levees of approximately 3.25 feet. The length of this alternative on the Big Papillion spans nearly 2.9 miles. The average new height of the levee on the Little Papillion is approximately 9 feet on the left bank and 5.8 feet on the right. This equates to a raise of approximately 4.4 feet on the existing levee section. The new length of the levee section is approximately 1 mile. This levee alternative would require three road closure structures (Table 21). Two could utilize HESCO barriers since they are less than three feet in height. The other would require a mechanical closure structure approximately 5.6 feet tall. The closure structure would be designed to deploy automatically as flood waters rise.

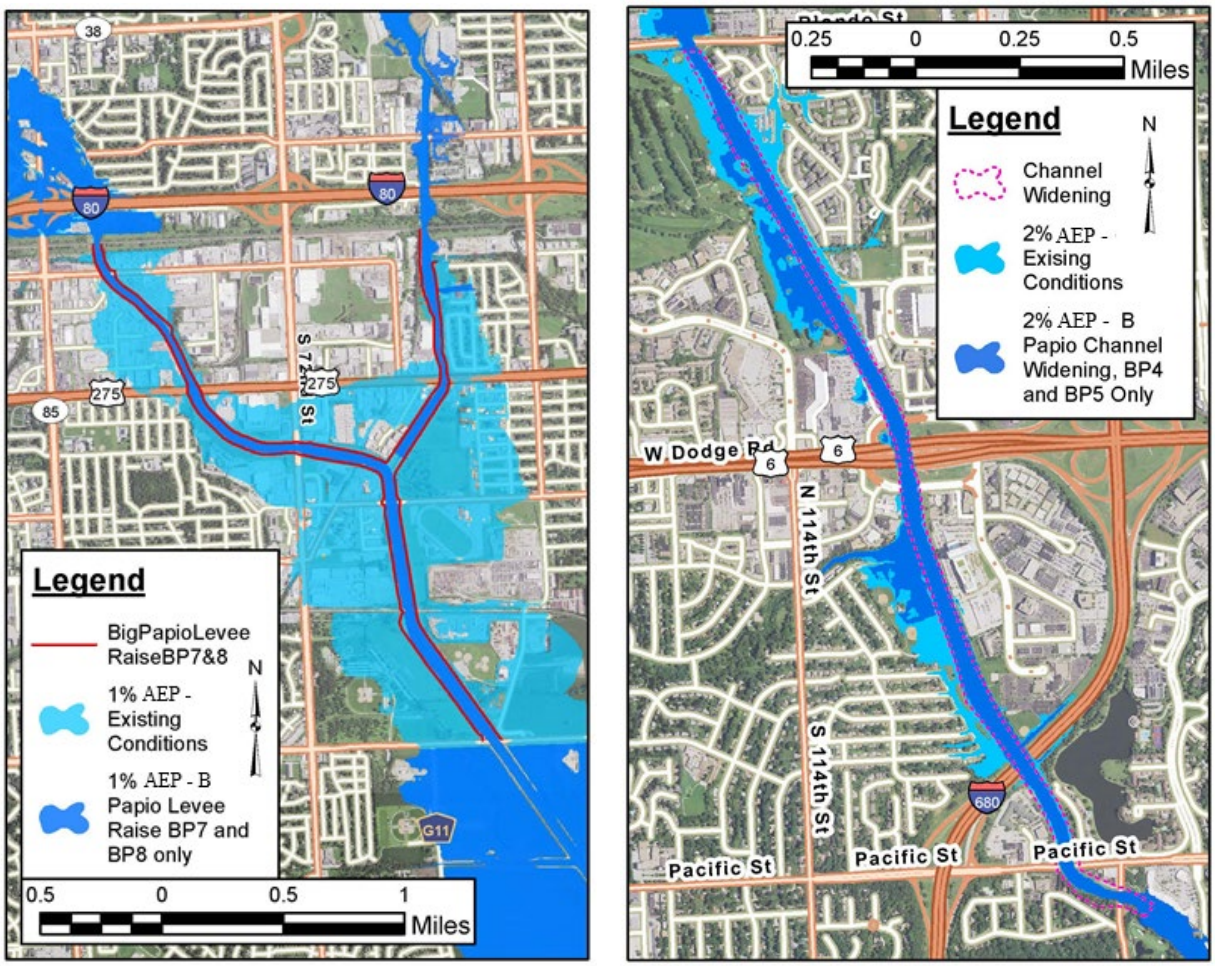



**Figure 18. Big Papillion Channel Widening in BP4 and BP5 and Levee Raise in BP7 and BP8**

**Table 21. Big Papillion Creek Closure Structures at the 1% AEP**

| Crossing Name | Required Height (ft) | | Closure Structure Width (ft) |
|---|---|---|---|
| | Left Bank | Right Bank | |
| L St | - | 8.8 | 82.0 |
| 72nd St | 0.8 | 0.8 | 83.0 |
| Q St | 4.0 | 3.2 | 40.0 |
| Railroad Bridge | 2.8 | 3.3 | 16.5 |
| Harrison St | - | 0.5 | 43.0 |
| L St (Little Papillion) | 7.8 | 5.0 | 81.6 |

### 4.5.5.3 Alternative 4 – Nonstructural

The nonstructural alternative was first formulated as a standalone alternative for Big Papillion Creek, which was not a justified standalone project. Those reaches that had positive net benefits were carried forward to be combined with other plans. This alternative would include implementation of nonstructural measures on 11 structures in the BP3 reach. The nonstructural

alternative includes dry floodproofing and filling in basements for commercial structures and elevation and filling in basements for residential structures.

#### 4.5.5.4 Alternative 5 – Combination

Alternative 5 would include a combination of Alternative 3 and Alternative 4. The channel widening and levee raises would be implemented as described in Alternative 3. Nonstructural measures would be implemented in reaches where the channel does not include a widening or levee raise. Nonstructural measures would also be included in the optimized plan to address residual risk in reaches where structural alternatives are being implemented. An economic analysis of the final array of alternatives is shown in Table 22.

**Table 22. Big Papillion Creek Economic Comparison of Final Array of Alternatives**

| Final Array of Alternatives | Alt 3 – Channel Widening and Levee Raise | Alt 4 – Nonstructural | Alt 5 – Combination* |
|---|---|---|---|
| **Construction Costs** | $28,720,505 | $1,739,738 | $30,460,243 |
| **Real Estate Costs** | $9,403,193 | $0 | $9,403,193 |
| **Mitigation Costs** | $202,000 | $0 | $202,000 |
| **Total First Costs** | $38,325,698 | $1,739,738 | $40,065,436 |
| **Construction Period (years)** | 8 | 0.5 | 8 |
| **IDC (years construction, 2.75%)*** | $1,102,357 | $0 | $3,978,488 |
| **Total Investment** | $42,959,355 | $1,739,738 | $44,043,924 |
| **Avg Annual Cost (2.75%, 50 yr)** | $1,630,225 | $64,441 | $1,631,427 |
| **OMRR&R** | $19,146 | $0 | $19,146 |
| **Total Avg Annual Cost** | $1,649,371 | $64,441 | $1,650,573 |
| **Equivalent Avg Annual Benefits** | $2,801,490 | $221,610 | $3,023,100 |
| | | | |
| **Benefit/Cost Ratio** | 1.70 | 3.44 | 1.83 |
| **Net Benefits** | $1,215,360 | $157,170 | $1,372,530 |

*The nonstructural measures are not implemented in the same reaches as the structural alternative, so benefits and costs have been added together in the combination alternative.

### 4.5.6 Papillion Creek Alternatives

No dams, channel widening, levees, or floodwalls were carried forward into detailed analysis on Papillion Creek. This alternative would include implementation of nonstructural measures on 39 structures in Reach PC1. The nonstructural alternative includes dry floodproofing and filling in basements for commercial structures and elevation and filling in basements for residential structures. An economic analysis of the nonstructural alternative is shown in Table 23.

**Table 23. Nonstructural Analysis on Papillion Creek**

| Final Array of Alternatives | Papillion Creek Alt 4 – Nonstructural |
|---|---|
| **Construction Costs** | $2,473,956 |
| **Real Estate Costs** | $0 |
| **Mitigation Costs** | $0 |
| **Total First Costs** | $2,473,956 |
| **Construction Period (years)** | 0.5 |
| **IDC (years construction, 2.75%)** | $0 |
| **Total Investment** | $2,473,956 |
| **Avg Annual Cost (2.75%, 50 yr)** | $91,638 |
| **OMRR&R** | $0 |
| **Total Avg Annual Cost** | $91,638 |
| **Equivalent Avg Annual Benefits** | $118,040 |
| **Benefit/Cost Ratio** | 1.29 |
| **Net Benefits** | $26,400 |

### 4.5.7 Cole Creek Alternatives

No alternatives were carried forward on Cole Creek.

### 4.5.8 Saddle Creek Alternatives

No dams, channel widening, levees, or floodwalls were carried forward into detailed analysis on Saddle Creek. The nonstructural alternative on Saddle Creek includes measures on 54 structures in reach SC1. The nonstructural measures carried forward were elevations and filling in basements for residential structures and dry floodproofing and filling in basements for commercial structures. An economic analysis of this alternative is shown in Table 24.

**Table 24. Nonstructural Analysis on Saddle Creek**

| Final Array of Alternatives | Saddle Creek Alt 4 – Nonstructural |
|---|---|
| **Construction Costs** | $3,770,668 |
| **Real Estate Costs** | $0 |
| **Mitigation Costs** | $0 |
| **Total First Costs** | $3,770,668 |
| **Construction Period (years)** | 0.5 |
| **IDC (years construction, 2.75%)** | $0 |
| **Total Investment** | $3,770,668 |
| **Avg Annual Cost (2.75%, 50 yr)** | $139,669 |
| **OMRR&R** | $0 |
| **Total Avg Annual Cost** | $139,669 |
| **Equivalent Avg Annual Benefits** | $216,000 |
| **Benefit/Cost Ratio** | 1.55 |
| **Net Benefits** | $76,330 |

### 4.5.9 THOMAS CREEK ALTERNATIVES

No alternatives were carried forward on Thomas Creek. DS10 is located on Thomas Creek, however its analysis and results are included in the Little Papillion alternatives analysis since most of the benefits accrue on Little Papillion Creek.

## 4.6 ENVIRONMENTAL CONSIDERATIONS – FINAL ARRAY OF ALTERNATIVES

Environmental considerations were applied to the final array of alternatives in accordance with the P&Gs which provide that a NED plan must be consistent with protecting the Nation's environment, pursuant to statutes, applicable executive orders, and other Federal Planning Requirements. Provisions for environmental considerations are part of the Environmental Quality (EQ) Account and dictate that EQ procedures should be applied early in the planning process so that significant natural and cultural resources of the study area may be identified and inventoried, used to develop planning objectives, and accommodate a reasonable set of alternative plans which achieve planning objectives. An Environmental Assessment was undertaken in this study in accordance with 40 CFR 1500 Parts 1500-1508, 1 July 1986. Details of the existing and future environmental conditions and appropriate considerations thereof are found in the Environmental Assessment accompanying this Feasibility Report in Appendix H. The following material summarizes the potential impacts on natural resources for each stream based on the final array of alternatives in order to inform plan formulation to ensure that the EQ Account is taken into consideration for the NED.

**West Papillion Creek**: Construction of the floodwall on West Papillion Creek would require the removal of trees and other vegetation from a 15 to 20-foot-wide area on either side of the proposed floodwalls for the entire length of the alignment. All grass areas that would be disturbed during construction would be re-seeded once construction is complete. The loss of 4.28 acres of mature, primarily tall broadleaf trees would require replacement to mitigate the impact. Potential to utilize the upland banks along the creek for tree replacement could occur for on-site mitigation.

**South Papillion Creek**: Implementation of DS19 would result in permanently converting approximately 9,100 linear feet of stream to an open water resource when the dam would be operated at the maximum pool level. This would alter hydraulic conveyance, sediment transport dynamics, in-stream habitat and surrounding riparian vegetation.

It is estimated that approximately 20 acres of the trees lining the creek channel would be inundated by the filling of the normal pool of the proposed reservoir which would require replacement to mitigate for the loss. It is likely that mitigation could occur within the 135 acres of land surrounding the reservoir between the normal pool elevation and the maximum flood pool elevation for on-site mitigation.

**Big Papillion Creek**: Widening the channel would require the removal of approximately 5.8 acres of trees lining over 4,300 feet of the right bank between Blondo Street and Dodge Street. Tree species to be removed include native box elder, silver maple, and cottonwoods. The 5.8 acres of trees that are lost would require replacement to mitigate for the impact. Trees could be

placed along on the upland bank outside the creek channel within the proposed project area for on-site mitigation. Two wetland areas were identified during a May 2019 site visit in the areas within the footprint of where the levees would be raised. A 0.38-acre palustrine emergent wetland is located on the landward side of the levee along the left bank adjacent to Menards between L Street and 72nd Street. This wetland is located approximately 50 feet from the toe of the levee. The levee raise would move the toe of the levee approximately 30 feet closer to the wetland, however, it would not result in the placement of any fill in the wetland. In addition to this wetland, a 3.3-acre lake is located along the right bank of the Big Papillion Creek between L Street and 72nd Street. This lake runs directly adjacent to the toe of the levee for approximately 1,300 feet. The levee would be raised an average of 3.3 feet in this location, which would result in the filling of up to 0.15 acres of the lake adjacent to the levee. The loss of the 0.15 acres of lacustrine wetland habitat in this location would be mitigated by the lacustrine habitat created by the construction of DS10. No other potential wetland impacts were identified for the proposed levee raises along the Big Papillion Creek.

**Little Papillion Creek**: Construction of DS10 on Thomas Creek would alter hydraulic conveyance and sediment transport dynamics, as well as in-stream habitat and adjacent riparian vegetation. DS10 as a wet dam would result in approximately 9,200 linear feet of stream permanently converted to an open water resource when the dam is operated at the maximum pool level. Approximately 22 acres of the trees lining the creek channel would be inundated by the filling of the normal pool of the proposed reservoir. The trees that are lost would be replaced within the 148 acres of land surrounding the reservoir between the normal pool elevation and the maximum flood pool elevation for on-site mitigation. DS10 as a dry dam would directly fill approximately 0.25 acres of palustrine emergent wetlands from embankment construction. These wetlands would be mitigated by the wetlands that will develop adjacent to the creek bed along the 800-foot long backwater pool that would be created within the creek channel upstream of the dam face.

New levee and floodwall construction on the Little Papillion Creek would result in the removal of a strip of vegetation up to 70 feet wide and running the entire length of the proposed levee/floodwall alignment on both sides of the creek. Once construction is complete, the new levees and all areas disturbed by construction activities would be re-seeded. It should also be noted that there are several areas along the Little Papillion Creek where the new levee footprint could extend into areas that are currently concrete parking lots or sidewalks. Levee construction in these areas would result in more vegetated grassy areas and reduce impervious surfaces adjacent to the creek.

**Papillion & Saddle Creeks**: Typical nonstructural measures that would be implemented on Papillion and Saddle Creeks include elevating structures, dry floodproofing, and filling basements and would occur in previously developed areas and often within the footprint of existing structures. It is not anticipated this alternative would adversely impact environmental resources.

Additional analysis of impacts to environmental resources and habitat function can be found in Section 5 and in Appendices H and H1.

Other environmental considerations within the Papillion Creek basin include species of special concern; according to the USFWS IPAC database, the northern long-eared bat, pallid sturgeon and western prairie fringed orchid have historic ranges within the project area and have the potential to occur. During an agency scoping meeting for the proposed project on December 10, 2018, the Nebraska Game and Parks Commission (NGPC) stated that there are no known hibernacula for northern long-eared bats within the Papillion Creek Basin. Tree clearing activities required under the various proposed alternatives would be restricted to the period between November 1st and March 31st to avoid the taking of potential maternity roost trees during the pup season (June 1 to July 31) and to avoid taking potential roost trees during the active season (April 1 to October 31) for the bats. Where trees are inundated under proposed wet dam alternatives, it is estimated it could take up to five years for the reservoirs to fill to normal pool level; thereby trees within the reservoirs would be expected to slowly die as the pool levels rise, and portions of the crowns of the trees would likely remain above the normal pool elevation. As such, northern long-eared bats would be able to find other suitable trees to roost in outside the reservoir pool if and when the trees within the reservoir pool are completely inundated or otherwise become unsuitable habitat for the bats. For these reasons, the alternatives carried forward may affect, but are not likely to adversely affect northern long-eared bats. USACE determined that none of the alternative plans would have an effect on pallid sturgeon or western prairie fringed orchid due to lack of unsuitable habitat. Additional analysis on impacts to species of special concern can be found in Sections 5.18 and 5.19 and Appendix H.

Other sensitive resources within the basin, such as cultural resources, were also considered during early plan formulation. Initial reviews for recorded sites noted three recorded areas adjacent to the APE, but not within the footprint of the proposed floodwall alternative on Little Papillion Creek. One site was also recorded within the footprint of the proposed DS19 alternative on South Papillion Creek. Consultation with the Nebraska SHPO, Tribes, and other interested parties was initiated in November 2018. The Tribes included in this effort are the Ponca Tribe of Nebraska, the Omaha Tribe, the Otoe-Missouria Tribe, the Ponca Tribe of Indians of Oklahoma, the Pawnee Nation of Oklahoma, the Winnebago Tribe and the Iowa Tribe of Nebraska and Kansas. Based on the limited surveys within the basin, it was recommended a Programmatic Agreement (PA) be developed. A PA would establish a process for consultation, review, and compliance for Section 106 of the National Historic Preservation Act which as well as streamline and enhance historic preservation and project delivery efforts. Further information on cultural resources and the PA can be found in Section 5.22, Appendix H and Appendix M.

## 4.7 Life Safety Assessment

Planning Bulletin (PB) 2019-04, issued June 20, 2019, requires the identification of potential risks to life safety in the problems, opportunities, or objectives early in the study, and for plan formulation and evaluation to explicitly consider risks to life safety in all flood risk management studies. USACE has adopted a set of four Tolerable Risk Guidelines to guide the process of examining and judging the significance of estimated risks of dams or levees through the use of risk assessment. The goal of evaluating the life safety risk during the planning stage is to formulate, recommend, and implement cost effective plans to reduce the risk posed by the

infrastructure to achieve all four Tolerable Risk Guidelines (TRGs) as they relate to societal and individual life risks.

Societal life risk represents the relationship between the probability (or frequency) of a hazard and the consequences or life loss potential. In general, society is more averse to risk if multiple fatalities were to occur from a single event. In contrast, society tends to be less averse to risks that result in few fatalities each from many events, even if the total cumulative fatality losses from the many small events is larger than that from the single large event.

Individual life risk represents the probability of life loss for an individual or group that is at risk of life loss due to a hazard based on location, vulnerability, and response. For levee or dam breach evaluations, individual life safety risk is influenced by location, exposure, and vulnerability within a leveed or dammed area. It should be noted that the probability of individual risk is the same, whether there is just one individual or many persons at the same risk.

The four TRGs are defined below along with how they apply to current flood risk projects in the Papillion Creek Watershed:

TRG 1: Understanding the Risk.
TRG 1 focuses on considering whether society is willing to live with (tolerate) risks associated with flood risk management infrastructure projects (levee, floodwalls, dams, etc.) in order to receive the benefits of living and working in the floodplain area behind the project. In short, is the risk worth the benefits provided by the project. Assessment of this risk applies the societal risk criteria and higher risks can be tolerated by exception. Understanding the risk for the alternatives being considered was achieved through conducting a semi-quantitative risk assessment (SQRA) and developing a Life Safety Matrix plot of the results.

TRG 2: Building Risk Awareness.
TRG 2 involves continually communicating levee and/or dam safety risks to non-federal sponsors, affected populations, and stakeholders so that all understand what risks exist and what risks exists and how they may change over time. The NRD is actively engaged in building risk awareness through working with the Papio Partnership and collaborating with USACE, FEMA, National Weather Service, and USGS to share available mapping and maintains a comprehensive flood warning system in the basin.

TRG 3: Fulfilling Daily Responsibilities.
TRG 3 involves assessing whether the inherent risks associated with levee and/or dam structures are properly monitored and maintained. The NRD is very active and responsive in fulfilling their sponsorship O&M responsibilities on a number of USACE projects, as well as numerous non-Federal flood risk management projects.

TRG 4: Actions to Reduce Risk.
TRG 4 involves considering a full spectrum of potential actions that could contribute to reduced individual and/or societal life safety risks in a cost-effective, socially acceptable, and environmentally sustainable manner. The NRD actively pursues maintenance and upgrades on their levee systems to ensure continued accreditation status within the

FEMA National Flood Insurance Program; and has a long-range implementation plan (LRIP) for managing flood risks, improving water quality, and increasing recreation activities for the watershed. The LRIP is maintained and updated every five years.

For this study, the Levee Screening Tool (LST) was used during the TSP-level analysis to inform potential life safety risks associated with new and existing levees and floodwalls, and existing risk assessment information from the four existing USACE Papillion dam sites was used to inform potential life safety risks associated with the proposed Dam Sites 10 and 19. An updated life safety assessment is included with the Recommended Plan.

### 4.7.1 Levees

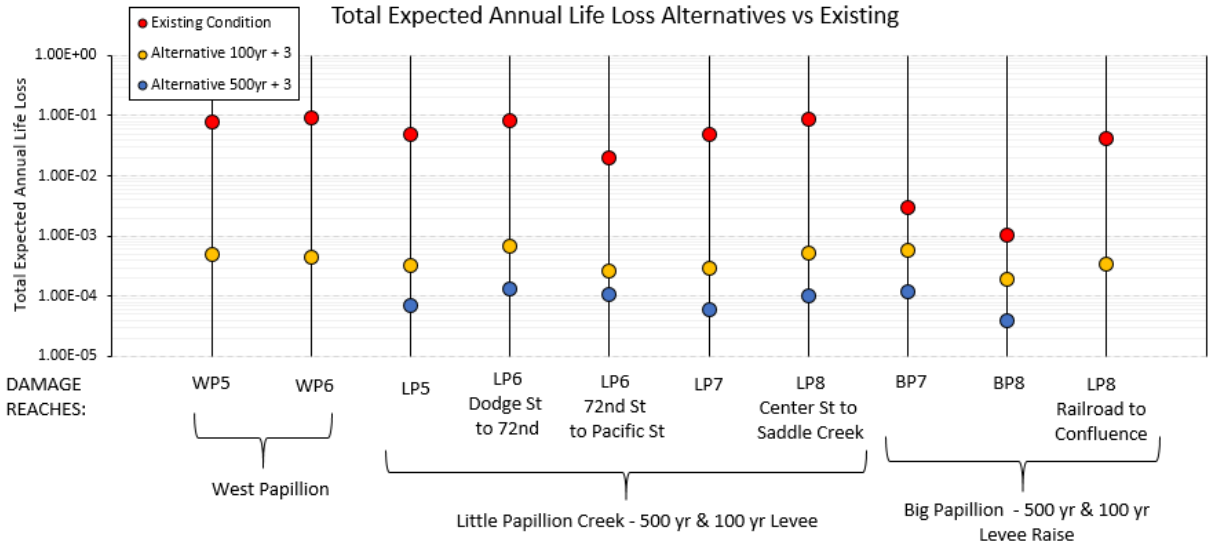
A levee safety assessment of the existing and new levees was conducted for the Draft Report using the LST in the NLD. The NLD is for known existing levees only, and proposed projects would not be created within the NLD. Fragility curves were based upon the existing levee systems along the Big Papillion Creek within the study area and used information available in the NLD and LST for those systems. The LST evaluates a number of safety criteria and provides a common basis on which to assess the expected performance and inundation consequences for levees across the nation. The LST combines the probabilities of various potential failure modes with consequences using life loss curves based on depth of flooding. The purpose of this analysis is to assess the life safety risks associated with each proposed levee/floodwall and levee raise alternative in comparison to the existing conditions. Additional technical details on the LST methodology and results can be found in Appendix L.

For the Draft Report, the levee life safety analysis focused on evaluating the life loss from the overtopping potential failure mode for the various new levee/floodwall alternatives on the West Papillion, Big Papillion, and Little Papillion Creeks. For all of these alternatives a 1 percent AEP + 3 feet design elevation equates to about a 0.2 percent AEP probability of overtopping; and the 0.2 percent AEP + 3 feet design elevation equates to about a 0.1 percent AEP probability of overtopping. The average annual life loss reduction for each of the alternatives is summarized in Table 25. These results do not fully account for the high likelihood that floodwater depths greater than two feet would likely occur during existing conditions, which would increase the existing conditions expected life loss as well as the reduction in life loss for the alternatives.

None of the LST results for the existing conditions show an annual life loss of more than 1 with the largest annual life loss reaches being WP6 (0.0917) and LP8 (0.0856). The with-project conditions analysis for the alternatives show that they all produce greater than 99 percent reduction in annualized life loss, except for the Big Papillion system. The Big Papillion system already provides some amount of flood risk management with its existing levees and therefore has the lowest existing conditions life safety risk to start with so there is less opportunity to improve the life safety condition.

**Table 25. Annualized Life Loss Expected for Existing Conditions and Alternatives**

| Alternatives | Damage Reaches | Existing | Alternative 1% AEP + 3 ft | Alternative 0.2% AEP + 3 ft |
|---|---|---|---|---|
| **West Papillion** | WP5 - Floodwall to Zorinsky | 7.92E-02 | 4.89E-04 | N/A |
| | WP6 - 144th to Millard Ave | 9.17E-02 | 4.54E-04 | N/A |
| **Little Papillion Creek – 0.2% AEP & 1% AEP Levee** | LP5 - Cass St to Dodge St | 4.99E-02 | 3.28E-04 | 7.13E-05 |
| | LP6 - Dodge St to 72nd St | 8.15E-02 | 6.66E-04 | 1.36E-04 |
| | LP6 - 72nd St to Pacific St | 2.02E-02 | 2.66E-04 | 1.08E-04 |
| | LP7 - Pacific St to Center St | 4.88E-02 | 3.00E-04 | 6.05E-05 |
| | LP8 - Center St to Saddle Creek | 8.56E-02 | 5.19E-04 | 1.04E-04 |
| **Big Papillion – 0.2% AEP & 1% AEP Levee** | BP7 - L St to Q St | 2.96E-03 | 5.78E-04 | 1.19E-04 |
| | BP8 - Q St to Harrison St | 1.04E-03 | 1.92E-04 | 3.86E-05 |
| | LP8 - Railroad to Confluence | 4.19E-02 | 3.35E-04 | N/A |

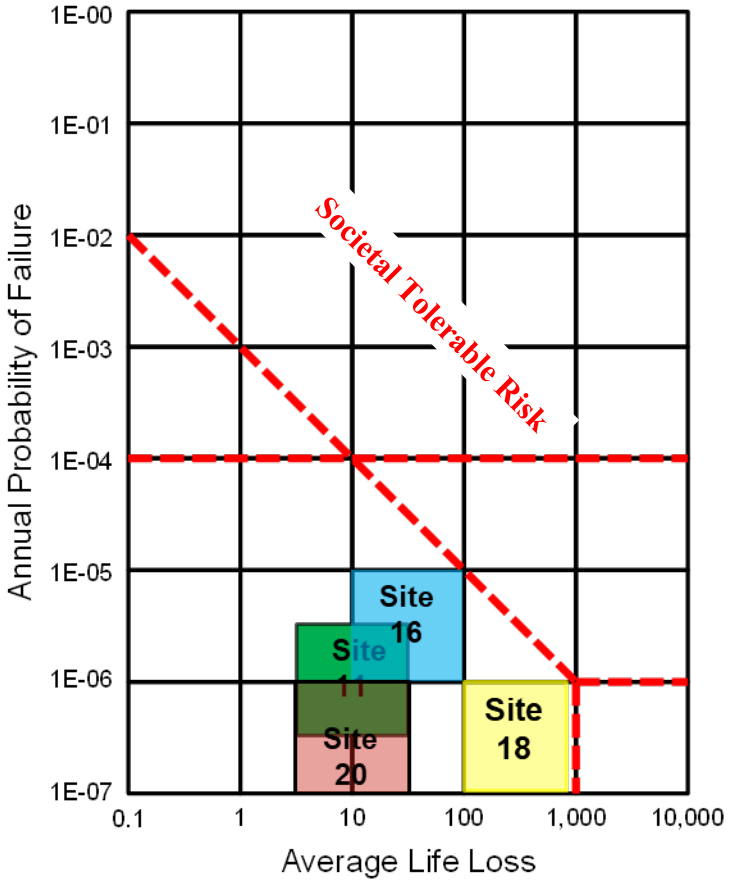



### 4.7.2 DAMS

For the TSP analysis, a review of prior risk analysis data for the four existing USACE dams within the Papillion Creek Basin concluded that it is very likely that life safety risks for the proposed dams at sites 10 and 19 will meet societal life safety risk limit (TRG 1). The existing Papillion Dam Sites (Zorinsky, Wehrspann, Cunningham, and Standing Bear) all meet societal life safety risk limits as shown on their f/N Life Safety Risk Matrix plot (Figure 19).

Because the proposed Dam Sites 10 and 19 are each located within a short distance of and exhibit similar watershed and geology conditions as one or more of the existing dams, it is expected that no unique dam safety risk issues are anticipated for either dam. In addition, by constructing new dams following current USACE design criteria and construction techniques and by incorporating lessons learned from other projects should result in keeping the probability of any potential failure mode for Dam Sites 10 and 19 at least as low as (and likely lower) than what is seen at the existing dams. Both of the proposed dams have much less storage volume and have significantly smaller population at risk (PAR) than the four existing dams, which is expected to produce lower average life loss.

Based on the past performance records of the existing Papillion Dams, the risk for Dam Sites 10 and 19 is expected to be below tolerable risk guidelines (Figure 19) potentially similar to that for the other dams. For a detailed discussion see Appendix L.




2)

**Figure 19. Tolerable Risk Guidelines Plot**

## 4.8 Identification of the Tentatively Selected Plan (TSP)

The Tentatively Selected Plan discussed below was identified based on information available at that point in the study analysis. It should be noted that this plan described below, was subsequently refined in optimization (Section 4.10) and recommended plan selection (4.11).

### 4.8.1 Standalone Tentatively Selected Plan for Flood Risk Reduction

The standalone TSP for flood risk reduction is a composite (TSP) plan consisting of the alternatives that produce the highest net economic benefits and includes West Papillion Creek Alternative 4 (Nonstructural), Little Papillion Creek Alternative 5 (Combination), Big Papillion Creek Alternative 5 (Combination) and Alternative 4 (Nonstructural) for Papillion Creek and Saddle Creek, as shown in Table 26. The flood risk management economic data (total project costs, net benefits, and project BCR) are summarized in Table 27.

The cost estimate was prepared using the Corps of Engineers' MII cost estimating computer program. For each component of the plan, preliminary engineering designs were developed to determine quantities which were then used to develop the cost estimates. The unit costs for the construction features were computed by estimating the equipment, labor, material, and production rates appropriate to the project. These estimates were developed with a specific price level date and were then escalated for inflation (fully funded) to the anticipated midpoint of construction (See Cost Appendix E).

Costs for OMRR&R were estimated for each component of the plan and are based on life cycle cost analysis and then annualized to determine equivalent annual OMRR&R costs. The analysis only includes the new (net) additional OMRR&R costs the non-Federal sponsor would be expected to incur based on the proposed project. The analyses considered and accounted for the new additional OMRR&R in each year of occurrence considering a 50-year period of analysis. The assumptions (based on Omaha District and NRD experience) used in determining the new additional OMRR&R costs for each alternative are as follows: Levee and floodwall OMRR&R includes periodic culvert inspection, culvert repair, rock for levee tops and toe stabilization, cleaning pipes for inspection, weed spraying, and mowing. Channel maintenance includes similar activities. Dam OMRR&R includes periodic inspections each year for the first three years following construction, then every two years for the following four years, and finally every five years. OMRR&R costs also include monthly inspection and data collection on piezometers, maintenance, and mowing.

**Table 26. Standalone TSP for Flood Risk Management Components**

| Final Array | Alt 2 – Dams | Alt 3 – Channel Improvements / Levees / Floodwalls | Alt 4 – Nonstructural | Alt 5 – Combined Plans |
|---|---|---|---|---|
| **West Papillion** | | Floodwall | Elevation, Dry Floodproofing, Basement Fill | Alt 3 + Alt 4 |
| **South Papillion** | Dam Site 19 (dry) | | | |
| **Little Papillion** | Dam Site 10 (dry) | New Levee/Floodwall | Elevation, Dry Floodproofing, Basement Fill | Alt 2 + Alt 3 + Alt 4 |
| **Big Papillion** | | - Channel Widening - Levee Raise/Floodwall | Elevation, Dry Floodproofing, Basement Fill | Alt 3 + Alt 4 |
| **Papillion Creek** | | | Dry Floodproofing | |
| **Saddle Creek** | | | Elevation, Dry Floodproofing, Basement Fill | |

**Table 27. Standalone TSP for Flood Risk Management Without Recreation**

| | Total First Cost | AA NED Benefits | AA NED Costs | Net Annual NED Benefits | BCR |
|---|---|---|---|---|---|
| **West Papillion Creek** | $1,549,872 | $84,800 | $57,409 | $27,390 | 1.48 |
| **Little Papillion Creek** | $42,710,211 | $4,936,040 | $1,942,950 | $2,993,090 | 2.54 |
| **Big Papillion Creek** | $40,065,436 | $3,023,100 | $1,650,570 | $1,372,530 | 1.83 |
| **Papillion Creek** | $2,473,956 | $118,040 | $91,640 | $26,400 | 1.29 |
| **Saddle Creek** | $3,770,668 | $216,000 | $139,670 | $76,330 | 1.55 |
| **Total*** | **$90,570,143** | **$7,990,560** | **$3,882,240** | **4,108,320** | **2.06** |

*Totals do not equal sum of alternatives due to impacts from multiple alternatives on the same reaches.

Two alternatives, DS19 on South Papillion Creek and the floodwall on West Papillion Creek did not show economic viability (benefits greater than costs) at the time of TSP. However, due to the preliminary nature of the costs and benefits and the fact that economic justification is close for both of these actions, the alternatives were carried forward for more detailed analysis and optimization (Section 4.10).

### 4.8.2 TSP With Recreation

#### 4.8.2.1 Recreation Analysis

All of the channel reaches where widening and levee/floodwalls are proposed have an existing trail system which is part of the Omaha Metro trail system. No opportunities exist for creating new trails associated with these actions and existing construction cost estimates include replacement of the trails where they would be impacted by the plan. However, the construction of Dam Sites 10 and 19 (if justified upon refinement as wet reservoirs) could provide recreational opportunities in addition to flood risk management. Construction of dry dams would not have any recreational features included.

The recreational features and opportunities associated with the multipurpose reservoir sites would likely be similar to those at existing reservoir sites in the Papillion Creek watershed. Recreational opportunities would likely include fishing, canoeing, hiking, biking, and picnicking. Based on the guidelines in Appendix E, ER 1102-2-100, Planning Guidance Notebook (April 2000), the Unit Day Value (UDV) method was selected as the appropriate method for valuing the recreation benefits.

Data on existing dam sites in the watershed was provided by the Papio-Missouri River NRD and USACE staff including dam size and configuration, recreational features, and visitation data. In reviewing the data, Dam Sites 10 and 19 would have similar recreation resource, operations and use characteristics as the existing Papillion sites. In addition, the proposed multipurpose pool area for Dam Site 10 would be similar in size to the area at the existing Standing Bear site. Therefore, visitation at Dam Site 10 is estimated to be similar to that at Standing Bear. Dam Site 19 is proposed to be about 64 percent of the size of Standing Bear, with estimated visitation use

in similar proportion. For both proposed dam alternatives, given the proximity to other existing Papillion sites, it is possible the proposed dam alternatives could result in a transfer of visitation use from existing sites. Therefore, the visitation estimates for both dam alternatives account for the potential transfer or displaced use. The estimated loss is based on a recreational creel survey that was conducted during the opening of another Papillion reservoir which recently opened in 2015 by the NRD. The survey noted that approximately 20 percent of the respondents indicated they would have been fishing at another Papillion reservoir prior to the new reservoir. Thus, it was assumed that potential visitation use from the proposed dam sites for this analysis could result in a 20 percent loss or transfer from other existing Papillion sites.

#### 4.8.2.1.1 RECREATION BENEFITS

As noted above, the UDV method was selected as the appropriate valuation method for estimating recreation benefits for the dam alternatives. In applying UDVs, all of the activities considered in the study area, with and without-project, fall into the general recreation category.

Table 28 displays the annual recreation benefits and costs associated with DS10 and DS19 alternatives. A detailed analysis of recreation is found in Appendix F. Costs include the difference in construction and real estate costs between a wet and dry dam, as well as the costs for construction of specific recreation features. At the time of TSP in September 2019, DS19 was not shown to be economically justified for flood risk management; therefore, DS19 with recreation was not part of the TSP. However, since the uncertainty in the cost and benefits could result in either justification or lack of justification, it was decided that the DS19 wet dam alternative would be considered further during the optimization phase of the project if further refinements of the benefits and costs resulted in DS19 showing economic justification for a dry dam. The total cost difference between a dry dam and a wet dam at DS10 includes $8,349,411 in increased real estate and wet dam construction costs and $1,000,000 in construction of recreation features. The difference between a dry dam and a wet dam at DS19 includes $4,579,192 in increased real estate and wet dam construction costs and $1,000,000 in construction of recreation features. Those costs have been applied in Table 28 against the annualized benefits for recreation to calculate the net benefits and BCR.

**Table 28. Recreation Benefits and Costs for DS19 and DS10**

| | Total Cost | Average Annual NED Costs | Average Annual NED Benefits | Net Annual NED Benefits | BCR |
|---|---|---|---|---|---|
| **DS10** | $9,586,103 | $428,311 | $653,394 | $225,083 | 1.53 |
| **DS19** | $5,739,295 | $265,929 | $420,244 | $154,315 | 1.58 |

Table 29 summarizes the overall NED benefits of the plan with recreation added at DS10. DS19 is not included in the TSP with recreation since DS19 is not justified as part of the FRM TSP.

**Table 29. Flood Risk Management Plan with Recreation**

| | Total Cost | Average Annual NED Benefits | Average Annual NED Costs | Net Annual NED Benefits | BCR |
|---|---|---|---|---|---|
| **West Papillion Creek** | $1,549,872 | $84,800 | $57,409 | $27,390 | 1.48 |
| **Little Papillion Creek** | $52,296,318 | $5,589,440 | $2,371,270 | $3,218,170 | 2.36 |
| **Big Papillion Creek** | $40,065,436 | $3,023,100 | $1,650,570 | $1,372,530 | 1.83 |
| **Papillion Creek** | $2,473,956 | $118,040 | $91,640 | $26,400 | 1.29 |
| **Saddle Creek** | $3,770,668 | $216,000 | $139,670 | $76,330 | 1.55 |
| **Total*** | **$100,156,250** | **$8,643,950** | **$4,310,550** | **$4,330,400** | **2.01** |

*Totals do not equal sum of alternatives due to impacts from multiple alternatives on the same reaches.

## 4.9 TENTATIVELY SELECTED PLAN

In compliance with USACE policy, the TSP is the plan that reasonably maximizes net NED benefits while fulfilling the other planning objectives and constraints. As part of the study process a Tentative Selected Plan is identified relatively early in the study process (September 2019), allowing for that plan to then be further analyzed in detail including optimization of plan details and allowance for time to further feasibility level of design for selected features.

For multi-purpose reservoir plans, the reservoir must be economically viable based on flood risk management benefits only (most efficiently achieved with a dry dam) and then recreation benefits can be used to justify the additional costs of creating a multi-purpose reservoir and associated recreational features. If both steps can be fulfilled, then the resulting multi-purpose dam can be included as part of the tentatively selected plan. Table 28 presents the TSP based on the analysis completed up to that milestone. Based on the cost and benefit analysis of the final array of alternatives, the TSP NED Plan alternatives were West Papillion Alt 4, Little Papillion Alt 5, Big Papillion Alt 5, Papillion Creek Alt 4, and Saddle Creek Alt 4 (Table 30 and Figure 20). This plan is estimated to produce $8,643,950 in annual benefits at an annual cost of $4,310,550 (total project cost of $100,156,248), for a BCR of 2.01 at the current Federal discount rate of 2.75 percent (Table 29).

**Table 30. TSP**

| Final Array | Alt 2 – Dams | Alt 3 – Channel Improvements / Levees / Floodwalls | Alt 4 – Nonstructural | Alt 5 – Combined Plans |
|---|---|---|---|---|
| **West Papillion** | | Floodwall | Elevation, Dry Floodproofing, Basement Fill | Alt 3 + Alt 4 |
| **South Papillion** | Dam Site 19 | | | |
| **Little Papillion** | Dam Site 10 | New Levee/Floodwall | Elevation, Dry Floodproofing, Basement Fill | Alt 2 (DS 10 with Recreation) + Alt 3 + Alt 4 |
| **Big Papillion** | | - Channel Widening<br>- Levee Raise/Floodwall | Elevation, Dry Floodproofing, Basement Fill | Alt 3 + Alt 4 |
| **Papillion Creek** | | | Dry Floodproofing | |
| **Saddle Creek** | | | Elevation, Dry Floodproofing, Basement Fill | |

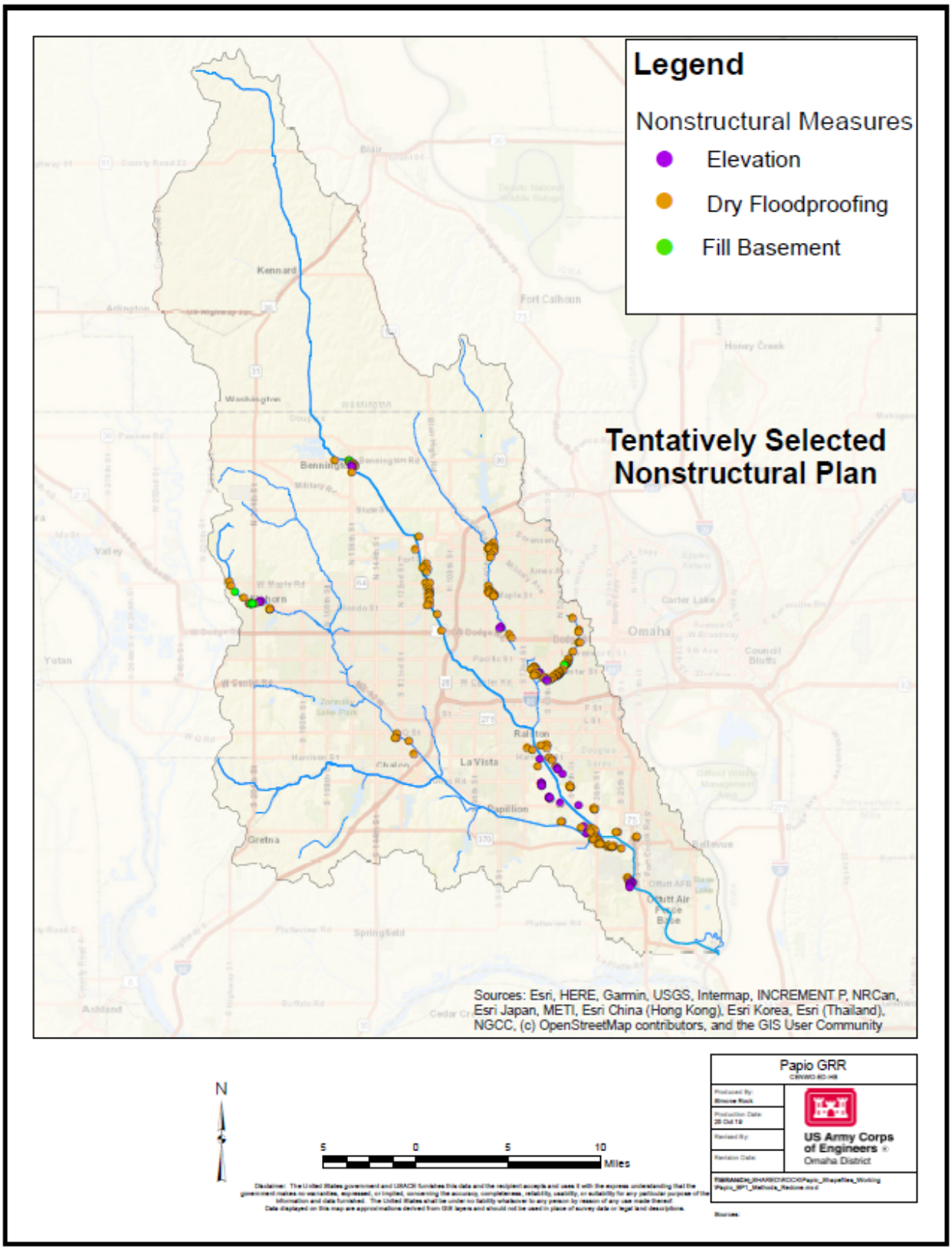



**Figure 20. TSP of Nonstructural Measures**

### 4.9.1 Non-Economically Justified Plans Recommended for Optimization

At the time of the TSP in September 2019 there was a lack of clarity on justification for some alternative given the preliminary level of information and analysis. As a result, two alternatives were carried forward for more complete analysis including West Papillion Creek Alternative 3 (Channel Improvements/Levees/Floodwall) and South Papillion Creek Alternative 2 (DS19).

#### 4.9.1.1 *West Papillion Creek Alternative 3 – Channel Improvements / Levees / Floodwall*

The West Papillion Creek structural alternative produced a BCR slightly below 1.0 at 0.83. However, based on the uncertainty in the benefits and the distribution of the BCR (Economics Appendix F) there is a median BCR of 0.99 and a 25 percent chance it could be as high as 1.34. There are 28 critical facilities on the West Papillion Creek, which is more than any of the other streams, and there was enough uncertainty in the preliminary analysis and the changes which could come from incorporating the future condition hydrology and climate change, that the West Papillion Creek structural alternative was recommended to be carried forward along with the nonstructural alternatives into optimization and refinement. If economic viability is not realized through further optimization and refinement, then the recommended plan would consist only of nonstructural measures on West Papillion Creek

#### 4.9.1.2 *South Papillion Creek Alternative 2 – Dam Site 19*

The South Papillion Creek Dam Site 19 dry dam alternative produced a BCR slightly below 1.0 at 0.93 based solely on flood risk management NED costs and benefits. However, a significant percentage of the cost is associated with real estate ($10.19 million or 48.0%) and construction contingencies ($3.78 million or 15.9%). When the recreation costs and benefits are incorporated into the plan, the BCR increases to 1.06. Based on the uncertainty in the costs and benefits and the changes which could come from incorporating the future condition hydrology and unsteady modeling, it was recommended to carry both the dry dam and wet dam alternatives forward into optimization and refinement. If economic viability is not realized through further optimization and refinement, the recommended plan for South Papillion Creek would consist only of site-specific nonstructural measures.

### 4.9.2 Risk and Uncertainty

Risk and uncertainty are intrinsic in water resources planning and design, particularly at the Tentatively Selected Plan phase of the planning process. This section describes various categories of risk and uncertainty pertinent to the study and the understanding at the time of TSP in September 2019. Risk and uncertainty were considered further during optimization and further analysis and were updated later in the study for the Recommended Plan as summarized in section 4.11.10.

**Potential Induced Flooding**

The potential for induced flooding was not fully captured in the development of the TSP since only steady state flow modeling was completed in the TSP phase of the project. Induced damages were calculated as negative values in the economic determination of net benefits within the limitations of steady state flow modeling. The potential induced flooding was further investigated during optimization with completion of unsteady flow modeling. Induced flooding was confirmed during the Recommended Plan analysis, and nonstructural measures were evaluated for mitigation of the induced flooding impacts.

**Economics**

For the TSP analysis, all alternatives used existing hydrology as opposed to the future 2040 build-out hydrology. Economic analysis may underestimate damages and alternatives may be under-designed. However, because this was kept consistent across all alternatives and outputs were compared to that from the existing conditions, this was sufficient for selection of a TSP. Full build-out hydrology was utilized in optimization and evaluation of the recommended plan.

There was further refinement of the nonstructural alternatives based on updates to the structural alternatives. This refinement will change some of the structures identified in the nonstructural alternative and will also impact the nonstructural cost estimates. In addition, uncertainty parameters for structure values, first floor elevations, stage errors and equivalent record length were refined during optimization based on additional structure field surveys and updated hydraulic modeling. Current structure values for the TSP analysis were based on assessor data and were then updated during optimization to reflect depreciated replacement value; vehicle values were updated based on additional research and analysis; and road damage and emergency costs were updated based on available data and included in the economic modeling rather than added as a percentage of structure, content and vehicle damages. Other damage categories (emergency response, cleanup costs, etc.) were not included in the TSP analysis but were researched and yet explored may be included in the economic optimization analysis.

**Hydraulics and Hydrology**

1D steady state hydraulic modeling was used throughout the TSP analysis potentially resulting in over-designed alternatives. Channel widening alternatives utilized a single cross-section and followed the original channel alignment. Costs may be inflated due to the lack of optimization of the channel cross-sections and alignment. Damage reach WP9 extends from the confluence with the Big Papillion to the upstream extent of the levee system on the West Papillion. Because the levee system offers significantly more flood risk management in the upstream section, treating as one damage reach may not fully capture benefits provided in the shorter section that offers much less flood risk reduction**.**

**Geotechnical**

Fragility curves were developed and incorporate into the analysis for the existing levees in the Papillion Creek system. During the development of the TSP, based on assumptions that the levees would not fail until overtopped. All existing levees have been tested by several minor to moderate floods with no issues of failure, therefore development of the TSP with no fragility

curves was considered to be low risk. Fragility curves were developed and evaluated during optimization, prior to completion of the final report.

**Civil Design**

It was assumed during TSP that utilities that cross the project can be relocated or incorporated into the project with minimal cost. A complete register of utilities in the proposed alignments was completed in optimization with an emphasis on locating underground utilities. Coordination with utility owners should determine relocation costs and methods and address any problems during optimization.

## 4.10 Optimization of the TSP

ER 1105-2-100 dictates that the USACE shall find the plan that maximizes the benefits associated with the NED account. From TSP in September 2019, these alternatives were carried forward: DS10, a new levee or floodwall on the Little Papillion Creek, channel widening on Big Papillion Creek, levee raise on Big Papillion Creek, and optimization of the nonstructural alternatives. Additionally, two alternatives were carried forward and analyzed using unsteady flow modeling despite having a BCR slightly below unity at the TSP level of detail but within margin of error of benefits and costs: DS19 and the West Papillion floodwall. For each alternative, construction costs were quantified, real estate needs were determined, and flood damage reduction was evaluated to determine the optimal design.

Hydraulic modeling during this phase of the analysis was completed using the HEC-RAS version 5.0.7. Unsteady flow modeling was used to optimize all alternatives identified in the TSP during steady flow modeling to identify the designs that yielded the maximum benefit. To appropriately analyze these alternatives, the future without project condition also had to be modeled using unsteady hydraulic modeling.

Damage reaches used in the FDA model were updated to more accurately assess the numerous levee systems and segments in the Papillion Creek watershed under the existing condition. Updating the reaches to account for existing levees more accurately included delineating based on left or right bank, different geotechnical failure functions, and different exterior-interior functions. Damage reaches were also updated to model the impacts of the tentatively selected alternatives more precisely during optimization to ensure that only benefits accruing as a result of the alternatives are being counted. Analysis during optimization of alternatives is based on an FY21 price level, FY21 discount rate of 2.5 percent, and a 50-year period of analysis.

### 4.10.1 West Papillion Creek Floodwall

One structural alternative on West Papillion Creek was carried forward for further analysis while not meeting NED criteria for inclusion as part of the TSP. With additional hydrologic and hydraulic analysis and preliminary updates to the economic input data, an additional analysis was completed for the floodwall.

It was determined early in the process that on the West Papillion Creek, floodwalls would be the only structural alternative option due to the limited space available. The exception to this is on the left bank upstream tie-off where there is a currently undeveloped lot that would allow construction of a tie-back levee. The West Papillion levee/floodwall alternative modeled with unsteady flow hydraulic modeling is approximately 1.75 miles and extends from Boxelder Creek to Millard Avenue for three heights of the 1 percent AEP energy grade line, 1 percent AEP energy grade line plus an additional three feet (Figure 21), and 1 percent AEP energy grade line plus an additional five feet. Although some benefits were realized as early as the 4 percent AEP event, the economic analysis determined that none of the modeled heights provided enough benefits to exceed the costs (Table 31). Results showed conclusively that any further consideration of the structural alternative was not justified. Therefore, the West Papillion Creek levee/floodwall alternative was dropped from further analysis.

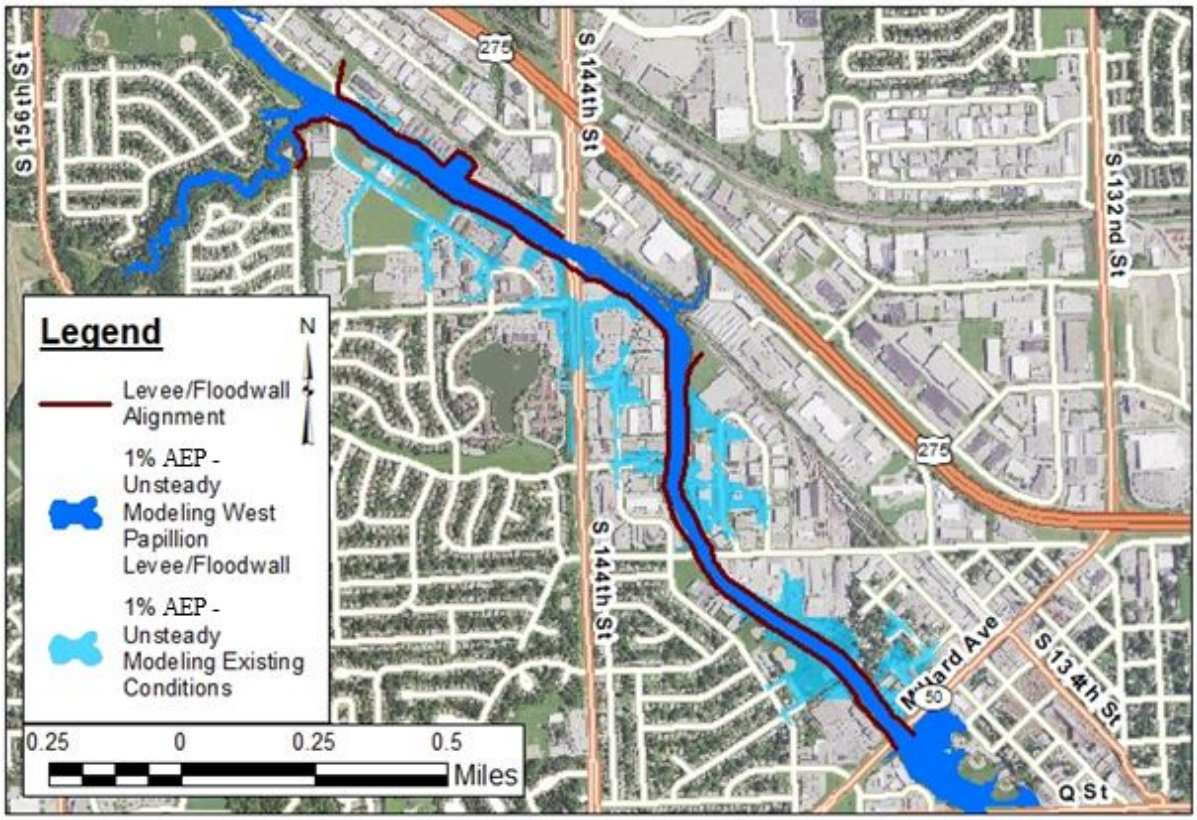



**Figure 21. 1% AEP Unsteady Flow Modeling Results for the Levee/Floodwall on West Papillion**

**Table 31. West Papillion Floodwall Cost and Benefits (FY20 Price Levels)**

| 1% AEP energy grade line + 3 feet | Floodwall |
|---|---|
| **Construction Costs** | 14,998,263 |
| **Real Estate Costs** | 2,274,727 |
| **Total First Costs** | 17,272,990 |
| **IDC** | 575,140 |
| **Total Investment** | 17,848,129 |
| **Annualized Investment** | 661,111 |
| **OMRR&R** | 10,839 |
| **Total Annual** | 671,950 |
| **Annual Benefits** | 302,610 |
| **Net Annual Benefits** | **-369,340** |
| **BCR** | **0.45** |

### 4.10.2 South Papillion Creek Dam Site 19

Optimization of the dams include estimating the hydrologic loading curve and estimating the cut and fill balance calculations as described to meet the hydrology and hydraulics minimum requirements in ER 1110-2-1156. The parameters changed included the spillway crest elevation, the Probably Maximum Flood (PMF) events outputs, and the calculated top of dam. Cut and fill quantities were then calculated for all the DS10 and DS19 dam and spillway height combinations to determine the best design compared to the costs.

DS19 was modeled first as a dry dam to determine flood risk benefits were above a 1.0 BCR before being modeled as a wet dam and including recreational benefits. A DS19 dry dam configuration was required to determine cost allocation and demonstrate that DS19 met the flood risk management economic justification (Table 32) without recreation benefits prior to moving forward with the DS19 wet dam analysis.

The addition of DS19 reduced water surface elevations downstream to the West Papillion – South Papillion confluence. While decreased discharges are seen all the way to the Papillion Creek – Missouri River confluence, the benefits are less noticeable downstream of the West Papillion – South Papillion confluence. Initially, the wet dam showed more benefits than the DS19 dry dam. This is because the outlet works of the wet dam configuration restricted the more frequent flows from the dam more significantly than the dry dam configuration. Therefore, the goal of the dry dam analysis became to match downstream benefits more closely to those of the wet dam configuration and more accurately identify the costs and benefits associated with creating a permanent pool. The configuration of the dry dam outlet works was modified to mirror the outlet works of the wet dam configuration. A riser was added with small openings to the length of the intake structure, much like a perforated riser pipe, to allow discharge at any pool elevation. The openings along the intake structure varied in size and placement, which was dictated by what was needed to closely match the wet dam downstream discharges at all eight modeled AEP events.

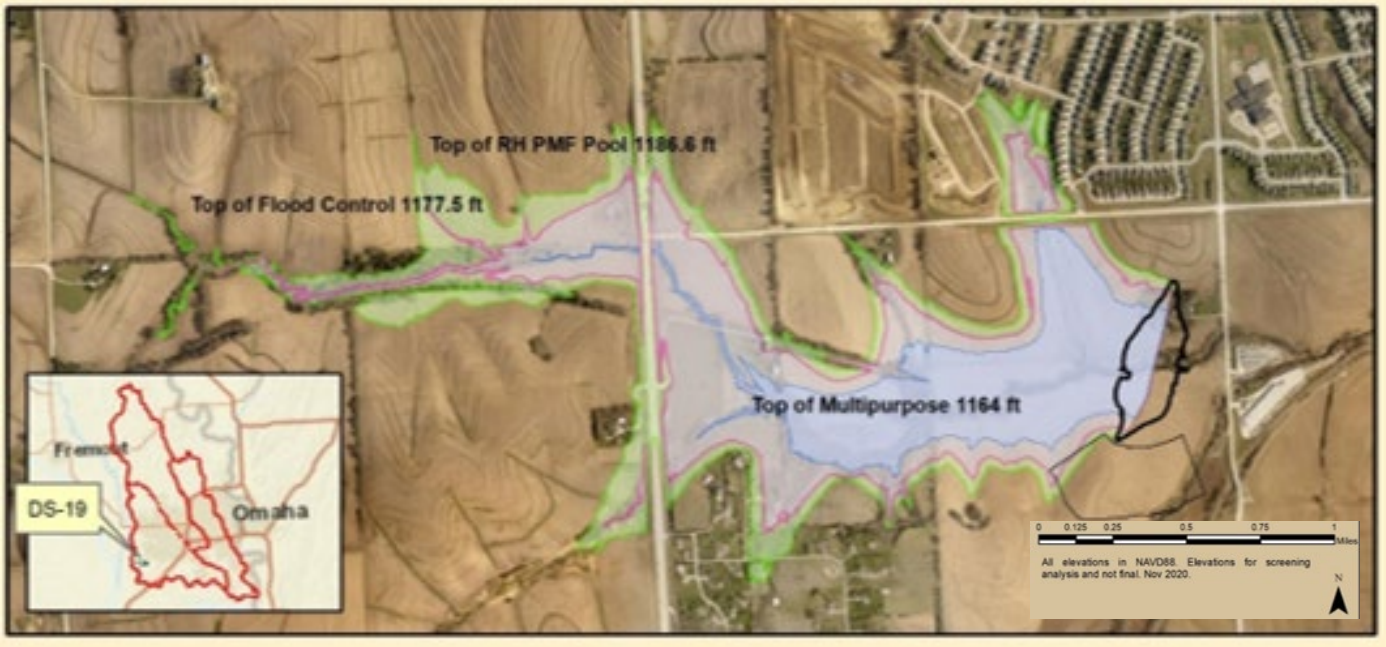



**Figure 22. Vicinity Map Showing the Location of Dam Site 19**

An earthen dam is to be constructed at DS19. Each dam embankment and spillway combination was modeled in the Civil 3D model to determine the spillway cut and embankment fill quantities and the project footprints to assist in the optimization process. A key component of the design assumptions is that the native material obtained through excavation of the spillway will be suitable for use as dam embankment fill material. This assumption is supported by borings drilled and logged within the spillway footprint for HDR's preliminary geotechnical investigation report (HDR, 2018) that verified that the native material is cohesive and suitable for use as dam embankment fill material. The results of the optimization process concluded that a top of dam embankment elevation and a spillway crest and width combination that produced reasonable spillway cut and embankment fill balance was the recommended option moving forward. The selected combination is a wet dam with a top of dam elevation of 1,187.7 with an auxiliary spillway crest elevation of 1,177.5 and an auxiliary spillway bottom width of 550 feet (see Appendix A-2 for additional details).

The dam outlet works will consist of an intake structure, a low-level inlet conduit, and an outlet conduit. The intake structure is a reinforced concrete box shaft with metal trash racks protecting the openings. Two 6-foot wide by 5.5 feet tall low-flow openings are to be at a 1,164-foot mean sea level (MSL) elevation. The dam outlet conduit is to be a reinforced concrete pipe with an internal diameter of 6 feet (see Figure 23). The class of the culvert is to be based on the surrounding soil (see the structural Appendix D for further details).

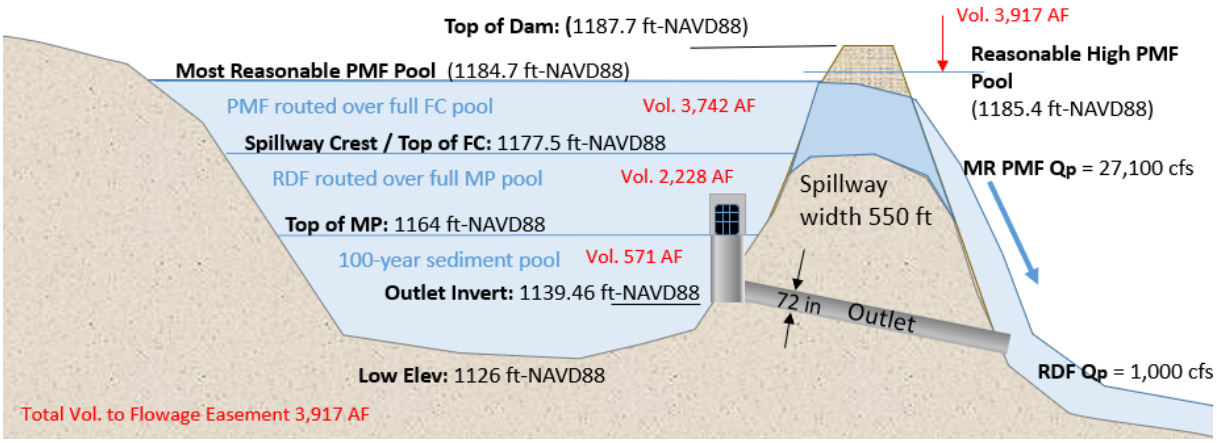



**Figure 23. DS19 Wet Dam Hydrologic Diagram**

**Table 32. South Papillion DS19 Cost and Benefits**

| DS19 | Dry | Balance | Recreation | Balance + Rec |
|---|---|---|---|---|
| **Construction Costs** | $9,149,643 | $15,828,314 | $3,932,744 | $19,761,058 |
| **Real Estate Costs** | $3,900,900 | $5,959,516 | 0 | $5,959,516 |
| **Mitigation Costs** | $166,280 | $244,622 | 0 | $244,622 |
| **Total First Costs** | $13,216,823 | $22,032,452 | $3,932,744 | $25,965,196 |
| **IDC (60 months construction, 2.5%)** | $771,856 | $1,273,970 | $160,093 | $1,434,063 |
| **Total Investment** | $13,988,680 | $23,306,422 | $4,092,837 | $27,399,259 |
| **Avg Annual Cost (2.5%, 50 yr project life)** | $493,214 | $821,740 | $144,305 | $966,045 |
| **OMRR&R*** | $179,307 | $179,307 | $122,460 | $301,767 |
| **Total Avg Annual Cost** | $672,521 | $1,001,046 | $266,765 | $1,267,812 |
| **Equivalent Avg Annual Benefits** | $750,680 | $966,390 | $805,801 | $1,772,191 |
| **Net Benefits** | $78,160 | -$34,657 | $539,036 | $504,379 |
| **BCR** | 1.12 | 0.97 | 3.02 | 1.40 |

*OMMRR&R cost based on an annualized cost for periodic inspections.

#### 4.10.2.1 South Papillion Creek Dam Site 19 SCRB

Based on further analysis clarifying that both dry and wet dams were justified, and greater benefits were associated with the wet dam (Table 34 and Figure 24). The next step was to clarify the costs and benefits assigned to each purpose (Flood Risk Management and Recreation), since there are differences in the cost sharing requirements for each. When comparing FRM benefits between the dry dam and wet dam for dam site 19, additional FRM benefits are obtained with the wet dam alternative. Recreation benefits are also achieved with the wet dam at DS19. In order to obtain an equitable distribution of costs among flood risk and recreation at DS19, a separable cost-remaining benefit (SCRB) analysis was conducted as outlined in ER 1105-2-100. The separable costs-remaining benefits method is recommended for general use in allocating costs of

Federal multiple-purpose projects. It differs from the generally recognized benefits method in that the amount of benefits used as a basis for the allocation in the recommended method is limited by the costs of available single-purpose alternative projects. It differs from the generally recognized benefits method in that the amount of benefits used as a basis for the allocation in the recommended method is limited by the costs of available single-purpose alternative projects.

The SCRB cost allocation approach provides for: (1) assigning to each purpose its separable costs, i.e., the added costs of including the purpose in the project; and (2) assigning to each purpose a share of the residual or remaining joint costs in proportion to the remaining benefits; i.e., the benefits (as limited by alternative costs) less the separable costs. Thus, the method provides for an equitable sharing among the purposes in the savings resulting from multiple-purpose plan. The separable cost-remaining benefit approach for DS19 is outlined in Table 33 below. The hydrology Appendix A-2 provides further details on the development of the single purpose alternative cost for flood risk management and recreation used in the cost allocation for DS19.

**Table 33. DS19 Separable Cost-Remaining Benefit (Average Annual Values)**

| | FRM | Recreation | Total | Notes |
|---|---|---|---|---|
| Average Annual Benefits | $966,390 | $805,801 | $1,772,191 | FRM benefits are the sum of dry dam FRM benefits and the incremental FRM benefits from the dam with reservoir. Recreation benefits are based on UDV methodology. |
| Single Purpose Alternative Cost | $1,001,046 | $1,267,812 | $2,268,858 | Upon evaluation of the single purpose alternative cost for FRM and Recreation, it was determined that the single purpose costs for each would not cost less than the cost of the proposed alternative. Therefore, the costs for the proposed alternative were used for the single purpose recreation cost and the costs for the proposed FRM only dam with reservoir alternative were used for the single purpose FRM cost for this analysis. |
| Limited Benefits/Costs | $966,390 | $805,801 | $1,772,191 | Equal lesser value of the average annual benefits and single purpose alternative costs. |
| Separable Costs | $0 | $266,765 | $266,719 | The separable cost for each project purpose is the difference between the cost of the multiple-purpose project and the cost of the project with the other purpose omitted. |
| Remaining Benefits | $966,390 | $539,036 | $1,505,426 | Remaining benefits are computed by subtracting the separable costs from the limited benefits/costs. Used to proportion the joint costs to each purpose. |

| | | | | |
|---|---|---|---|---|
| Percent of Total | 64.2% | 35.8% | 100% | Proportion of the total remaining benefits. |
| Joint Costs | | | $1,001,046 | Joint costs are the difference between the total project costs and the sum of all separable costs. |
| Allocated Joint Cost | $642,610 | $358,436 | $1,001,046 | Allocated joint costs equal the percent of remaining benefits times the total joint costs. |
| Total Allocation | $642,610 | $625,202 | $1,267,812 | Separable costs plus the allocated joint costs. |
| Benefit-Cost Ratio | 1.50 | 1.29 | 1.40 | Total allocation divided by the average annual benefits. |

Once a plan was determined, monitoring costs related to the mitigation were estimated. Appendix H, Environmental Assessment provides additional detail on the determination of these costs. Monitoring costs were attributed to each component of the structural project based on their respective shares of the implementation costs associated with the environmental mitigation. Monitoring costs were assumed to occur in the first five years after project completion, annualized over the 50-year period of analysis, and added to the total annual costs.

**Table 34. South Papillion Dam Site 19 Costs**

| Dam Site 19 Wet Dam Alternative | Cost |
|---|---|
| Construction Cost | $12,697,337 |
| PED | $1,294,196 |
| S&A | $1,035,357 |
| Contingency | $4,734,169 |
| Total Construction Costs | $19,761,058 |
| LERRD | $5,959,516 |
| Mitigation | $244,622 |
| **Total First Costs** | **$25,965,196** |
| Interest During Construction (2.5%, 5yr, Mid) | $1,434,063 |
| Total Investment Costs | $27,399,259 |
| Annualized Investment Costs (2.5%) | $966,045 |
| Annual OMRR&R Costs | $301,767 |
| Annual Monitoring Costs | $729 |
| **Total Annual Costs** | **$1,268,541** |

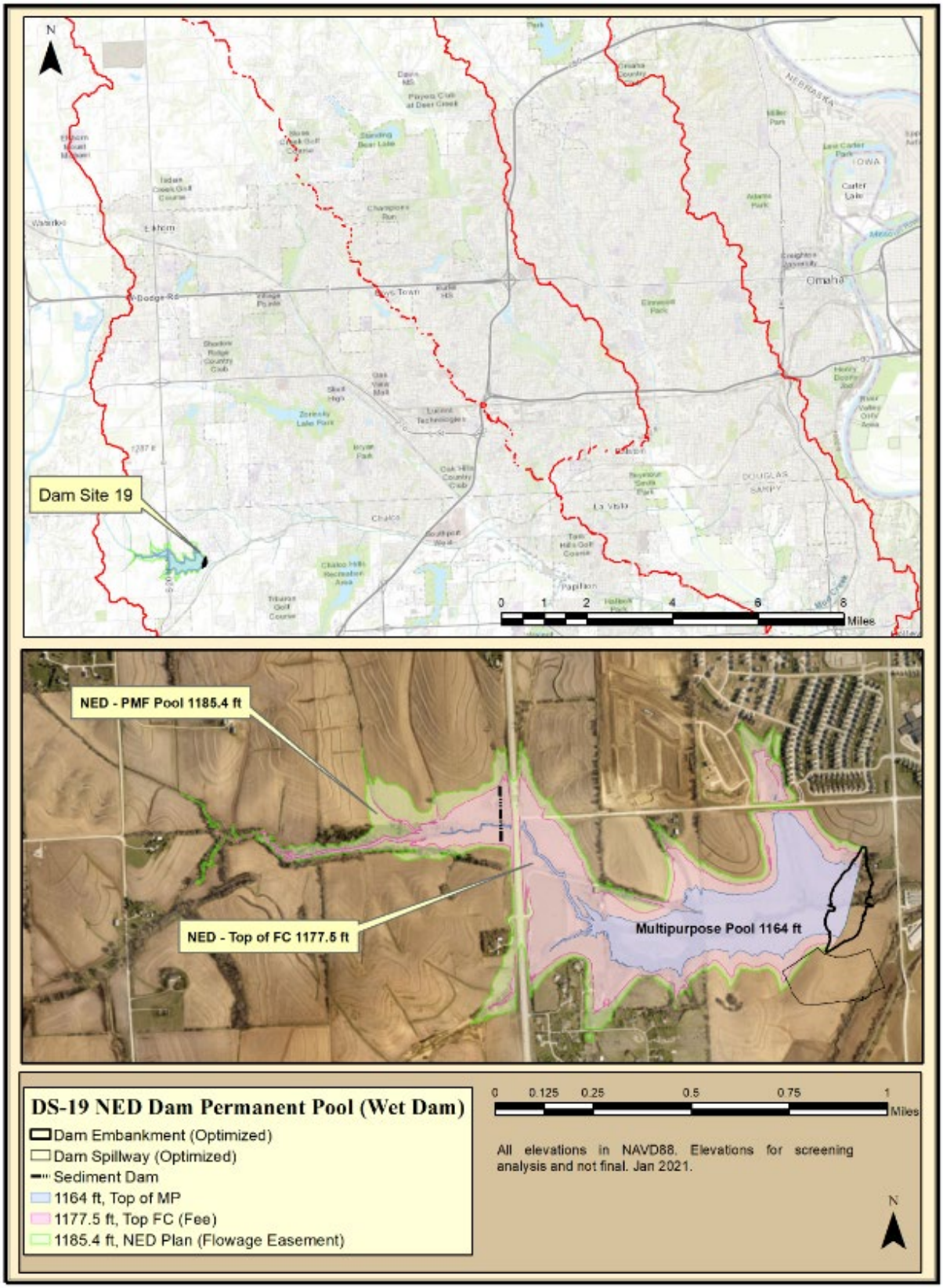



**Figure 24. DS19 Wet Dam Location**

### 4.10.3 Little Papillion Creek Dam Site 10

DS10 was modeled first as a dry dam to determine flood risk benefits before considering evaluating as a wet dam to include recreational benefits. Based on public comments received on the draft report and discussions with the non-Federal sponsor, only the DS10 dry dam was carried forward, therefore the wet dam analysis was dropped from consideration. A dry dam does not maintain a permanent reservoir pool, so the entire potential volume of its reservoir is available for flood storage. The practical implication of this is that dry dams do not need to be as large as dams with a reservoir pool (Figure 25). With the decrease in required size, there may be cost savings with embankment size, outlet works, and required real estate. Under steady flow modeling, DS10 proved to have the greatest benefits when modeled in combination with a new levee on the Little Papillion Creek spanning from Cole Creek to Saddle Creek. Therefore, DS10 was only analyzed as part of this combination for optimization and not modeled separate of the levee alternative. The addition of DS10 reduced downstream water surface elevations past the confluence with the Little Papillion, as far downstream as Mercy Road.


**Figure 25. Vicinity Map Showing the Location of Dam Site 10**

An earthen dam is to be constructed at DS10. Each dam embankment and spillway combination were modeled in the civil model to determine the cut and fill quantities and the project footprints to assist in the optimization process. A key component of the design assumptions is that the native material obtained through excavation of the spillway will be suitable for use as dam embankment fill material. The selected combination is a dry dam with a top of dam elevation of 1207.4 feet North American Vertical Datum of 1988 (NAVD88) with an auxiliary spillway crest elevation of 1191.6 feet NAVD88 and an auxiliary spillway bottom width of 100 feet. The dam outlet conduit is to be a concrete box culvert with a 7 foot rise and an 8 foot span (see Figure 26). The class of the conduit is to be based on the surrounding soil. See the structural Appendix D for further details.

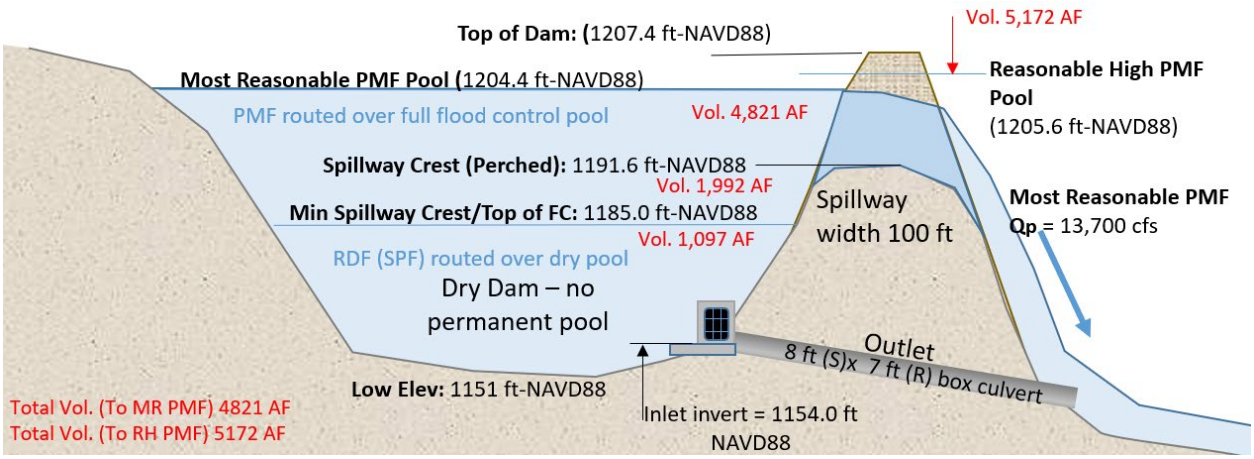



**Figure 26. DS10 Hydrologic Diagram**

### 4.10.4 Little Papillion Creek Levee/Floodwall

Optimization of the levees consisted of modeling three different heights to determine the height that maximizes the NED benefits. Because weir flow is based on the elevation of the energy grade line rather than the water surface elevation in HEC-RAS, each of these alternatives was initially modeled by setting the top of the levee/floodwall equal to the elevation of the 1% AEP energy grade line elevation. Two additional heights were modeled for the optimization of alternatives. One used the 1 percent AEP water surface elevation with three additional feet of height and the second used the 1 percent AEP water surface elevation with five additional feet of height.

Figure 27 provides updated damage reaches on Little Papillion Creek. The damage reaches have been updated for use in the economic analysis that references unsteady flow hydraulic modeling. See Appendix B-P1 for more information on how the damage reaches were modified between steady flow to unsteady flow hydraulic analyses.

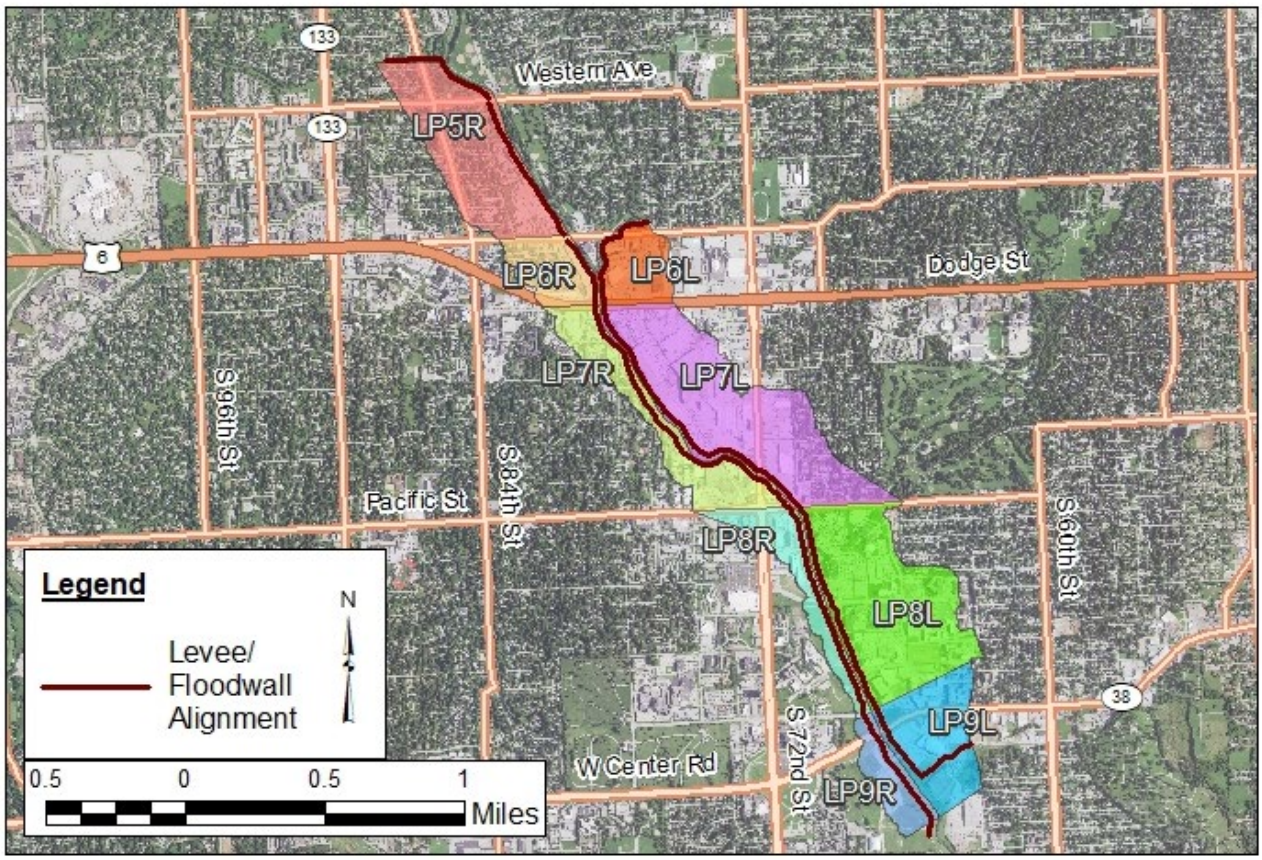



**Figure 27. Damage Reaches for the Optimized Levee/Floodwall Alternative on the Little Papillion**

The temporary HESCO closure structures were dropped from the further analysis due to concerns about deployment time. Hydrologic analysis for the design flood scenarios shows that there is typically less than an hour's duration between peak rainfall and peak flow at each of these crossings. This places tremendous risk on the levee sponsor for deploying and installing any temporary flood measures. Consequently, the HESCO closure structures were replaced with self-deployed closure structures, with the potential option of in-place manual deployable structures such as roller gates or swing gates at critical locations. Refer to Section 2.1 of the Structural Appendix for additional information pertaining to closure structures.

It was determined that due to the required elevation raises without a dam, that a new levee or floodwall project on Little Papillion Creek would only be feasible in conjunction with the construction of DS10. Therefore, the water surface elevations (WSE's) provided for optimization were the unsteady flow modeling results with DS10 constructed (Figure 28). The new levee/floodwall alignment on the Little Papillion is approximately 3.5 miles long and extends from Cole Creek to Saddle Creek on the left bank and from Charles Street to Spring Street on the right bank. The Conditional Non-Exceedance Probabilities are provided in Table 35 below.

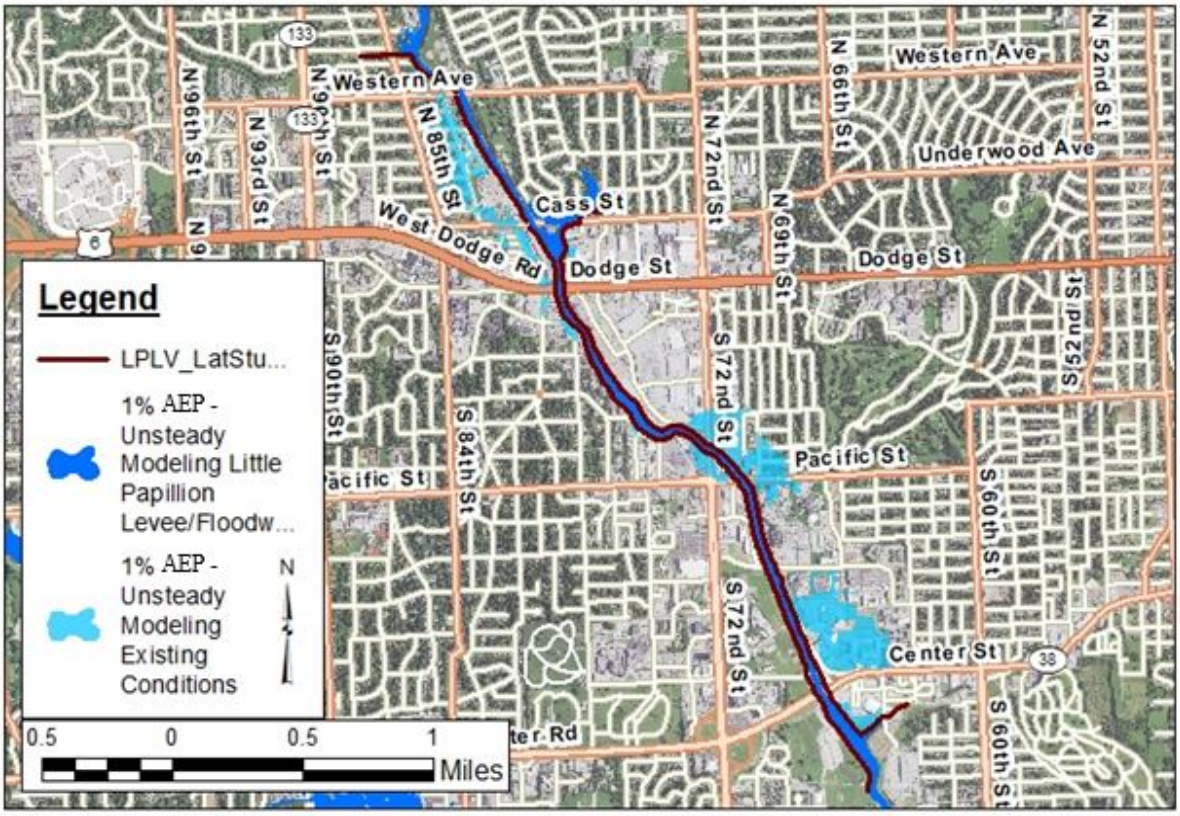



**Figure 28. 1% AEP Unsteady Flow Modeling Results for the Levee/Floodwall on Little Papillion**

**Table 35. Conditional Non-Exceedance Probabilities for the New Levee/Floodwall Alternative on Little Papillion Creek**

| Damage Reach* | CNP | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Existing Hydrology | | | | | Future Build-Out Hydrology | | | | |
| | 10% | 4% | 2% | 1% | 0.2% | 10% | 4% | 2% | 1% | 0.2% |
| LP5R | 1.0000 | 0.9965 | 0.9776 | 0.9337 | 0.7987 | 1.0000 | 0.9971 | 0.9779 | 0.9312 | 0.7569 |
| LP6R | 1.0000 | 0.9841 | 0.9188 | 0.7941 | 0.4698 | 1.0000 | 0.9844 | 0.9161 | 0.7765 | 0.4228 |
| LP6L | 1.0000 | 0.9841 | 0.9188 | 0.7941 | 0.4698 | 1.0000 | 0.9844 | 0.9161 | 0.7765 | 0.4228 |
| LP7R | 0.9999 | 0.9842 | 0.9202 | 0.799 | 0.5305 | 0.9999 | 0.9775 | 0.8994 | 0.7621 | 0.4649 |
| LP7L | 1.0000 | 0.9954 | 0.9765 | 0.9406 | 0.8608 | 1.0000 | 0.9937 | 0.97 | 0.9265 | 0.8266 |
| LP8R | 1.0000 | 0.9969 | 0.9839 | 0.9587 | 0.8986 | 1.0000 | 0.9952 | 0.9772 | 0.9457 | 0.8797 |
| LP8L | 0.9999 | 0.9868 | 0.9358 | 0.8383 | 0.6303 | 0.9999 | 0.9795 | 0.9104 | 0.7954 | 0.5613 |
| LP9R | 1.0000 | 0.9975 | 0.9842 | 0.9542 | 0.8552 | 1.0000 | 0.991 | 0.9549 | 0.8862 | 0.7299 |
| LP9L | 1.0000 | 0.9983 | 0.9876 | 0.9621 | 0.8666 | 1.0000 | 0.9911 | 0.9552 | 0.8867 | 0.7301 |

*Note: The damage reaches listed in this table have been updated for use in the economic analysis that references unsteady flow hydraulic modeling. See Appendix B-P1 for more information on how the damage reaches were modified between steady flow to unsteady flow hydraulic analyses.

The economic analysis (Table 38) determined the greatest net benefits and would be the recommended, optimal structural plan for Little Papillion Creek and its tributaries is the elevation of the 1 percent AEP energy grade line with an additional three feet. Benefits are realized as early as the 2 percent AEP event, and of the eight events modeled for both existing and future flow conditions, only the 0.2 percent AEP event was shown to overtop the proposed

levee at this height. Estimated average height raises and number of closures for each reach are shown in Table 36.

**Table 36. Summary Table by Reach in Little Papillion Creek**

| Reach | | LP5 | LP5 | LP6-1 | LP6-2 | LP7 | LP8 |
|---|---|---|---|---|---|---|---|
| Location | | Western Ave to Cass St | Cass St to Dodge St | Dodge St to 72nd St | 72nd St to Pacific St | Pacific St to Mercy Rd | Mercy Rd to Little Papillion/Saddle Creek Confluence |
| Left Bank | Length of Floodwall (ft) | 109 | 1309 | 3340 | 1027 | 2130 | 860 |
| | Length of Levee (ft) | 568 | 146 | 1008 | - | 1850 | 961 |
| | Avg. Height Raise (ft) | 4.6 | 4.9 | 3.7 | 6.1 | 5.7 | 9.8 |
| Right Bank | Length of Floodwall (ft) | 2233 | 1442 | 4831 | 711 | - | - |
| | Length of Levee (ft) | 2320 | - | - | - | 3601 | 2646 |
| | Avg. Height Raise (ft) | 2.6 | 3.5 | 5.1 | 4.5 | 3.5 | 2.8 |
| Number of Closures | | 1 | 1 | 2 | 1 | 2 | 1 |

Closure structures are required where a floodwall or levee is crossed by a bridge with a deck surface lower than the top of the floodwall or levee. Permanent closure structures are self-deploying closure structures and are used at all impacted roadways. See structural Appendix D for more information. The closure structures required for the Little Papillion Creek alternative are presented in Table 37, going upstream from Mercy Road. The height of the levee closure structures is determined by the energy gradient line plus an extra three feet.

**Table 37. Closure Structures on Little Papillion Creek**

| Crossing Name | Required Height (ft) | | Closure Structure Width (ft) |
|---|---|---|---|
| | Left Bank | Right Bank | |
| Mercy Road | 0.5 | 0.2 | 59 |
| Ped. Bridge 1 | 1.0 | - | 9.5 |
| Ped. Bridge 2 | 5.4 | 2.1 | 10.1 |
| Pacific St | 3.8 | 3.0 | 74.5 |
| 72nd St | 5.5 | 5.2 | 114 |
| Ped. Bridge 5 | 0.5 | 2.6 | 10.5 |
| Dodge St | 2.4 | 2.0 | 109.3 |
| Cass St | - | 1.8 | 78.5 |

**Table 38. Little Papillion Creek Levee/Floodwall Optimization Cost/Benefits (FY21 Price Level)**

| | DS10 & Levee at 1% AEP | DS10 & Levee at 1% AEP + 3 ft | DS10 & Levee at 1% AEP + 5 ft |
|---|---|---|---|
| Construction Cost | $15,650,787 | $27,900,043 | $33,492,726 |
| PED | $1,565,079 | $2,790,004 | $3,349,273 |
| S&A | $1,252,063 | $2,232,003 | $2,679,418 |
| Contingency | $5,634,283 | $10,044,015 | $12,057,381 |
| Total Construction Costs | $24,102,212 | $42,966,066 | $51,578,798 |
| LERRD | $32,716,971 | $32,729,424 | $32,739,567 |
| Mitigation | $45,100 | $45,100 | $45,100 |
| **Total First Costs** | **$56,864,283** | **$75,740,590** | **$84,363,465** |
| Interest During Construction (2.5%, 5yr, Mid) | $4,382,078 | $5,149,594 | $5,500,485 |
| Total Investment Costs | $61,246,361 | $80,890,184 | $89,863,950 |
| Annualized Investment Costs (2.5%) | $2,159,428 | $2,852,031 | $3,168,428 |
| Annual OMRR&R Costs | $190,814 | $190,814 | $190,814 |
| Total Annual Costs | $2,350,830 | $3,046,430 | $3,362,830 |
| Average Annual Benefits | $2,723,430 | $3,699,860 | $3,866,630 |
| Net Benefits | $369,900 | $653,430 | $503,800 |
| BCR | 1.16 | 1.21 | 1.15 |

*O&M costs based on $3,300 per mile of levee and $3,000 per mile of floodwall.

### 4.10.5 Big Papillion Creek Channel Widening

The Big Papillion Creek channel widening alternative (Figure 29) extends from Blondo Street at the upstream end down to 102nd Street near the vicinity of Pacific Street. Side slopes of 3H:1V were added and set to project to the existing ground surface and three different bench widths were considered for this alternative to determine which, if any, were economically justifiable.

The three bottom bench widths chosen were 150 feet, 170 feet, and 200 feet. An additional multi-width alternative was analyzed which had the goal of minimizing real estate takings. The same flows were used for each of these alternatives, any difference in water surface elevations were only due to the changes in the model geometry. A 15-foot-wide vegetation free zone would be added on the landside, measured from the landside toe, to establish real estate and/or easement boundaries. The updated hydraulic modeling from 1D to 2D updated the water surface elevations on Big Papillion Creek and reduced the economic benefits for this reach. The benefits did not exceed the costs (Table 39), therefore, the Big Papillion Creek channel widening alternative was dropped from further analysis.


**Figure 29. 1% AEP Unsteady Flow Modeling Results for Channel Widening on Big Papillion**

**Table 39. Big Papillion Creek Channel Widening Costs and Benefits (FY21 Price Levels)**

| Channel Widening Widths | 150 ft Bench | 170 ft Bench | 200 ft Bench |
|---|---|---|---|
| Construction Cost | $8,281,575 | $9,048,757 | $10,542,662 |
| PED | $828,158 | $904,876 | $1,054,266 |
| S&A | $662,526 | $723,901 | $843,413 |
| Contingency | $2,981,367 | $3,257,553 | $3,795,358 |
| Total Construction Costs | $12,753,626 | $13,935,086 | $16,235,699 |
| LERRD | $5,757,070 | $5,757,168 | $5,757,070 |
| Mitigation | $257,520 | $257,520 | $257,520 |
| Total First Costs | $18,768,216 | $19,949,774 | $22,250,289 |
| Interest During Construction (2.5%, 5yr, Mid) | $1,123,138 | $1,171,137 | $1,264,574 |
| Total Investment Costs | $19,891,353 | $21,120,911 | $23,514,864 |
| Annualized Investment Costs (2.5%) | $701,330 | $744,682 | $829,088 |
| Annual OMRR&R Costs | $4,809 | $4,809 | $4,809 |
| Total Annual Costs | $706,139 | $749,491 | $833,897 |
| Benefits | $383,350 | $488,040 | $591,260 |
| Net Benefits | -$322,790 | -$261,450 | -$242,640 |
| BCR | 0.54 | 0.65 | 0.71 |

### 4.10.6 Big Papillion Creek Levee Raise

The Big Papillion Creek levee raise alternative (Figure 30) started on both the Little and Big Papillion Creeks at the railroad embankment just downstream of Interstate 80 and had a downstream boundary at Harrison Street. Since there are existing levees along most of this section of the Big Papillion Creek, the existing levee centerline alignments were used as a baseline to construct the civil model. Within the civil model, templates for a full height levee prism and a full height floodwall wall were created for analysis (see the Geotechnical Appendix C for more details).

Fragility curves were developed for the Big Papillion levee alternatives only because Big Papillion has existing levees in place already. The consequences are evaluated for sections of the levees and this is generally based on cross section geometry along the drainage. The levees should be expected to perform well even if they are fully loaded by a flood event; the likelihood of failure resulting from a 100% loading flood event will remain relatively low. This low likelihood condition is an upper bound for a fragility curve regardless of how many failure modes are considered or how much analysis detail is developed. With low failure likelihood values at 100% loading conditions, analyses show that consequences for without project conditions are increased, but only slightly. Levee fragility is not critical to project justification because of the risk of failure being very low and overcome by the risk reduction of the levee performance (see the geotechnical Appendix C for further details).

Although benefits were seen with this alternative, economic analysis determined that justification was not achievable due to the costs of raising the existing levees shown in Table 40. Therefore, the Big Papillion Creek levee raise alternative was dropped from further analysis.

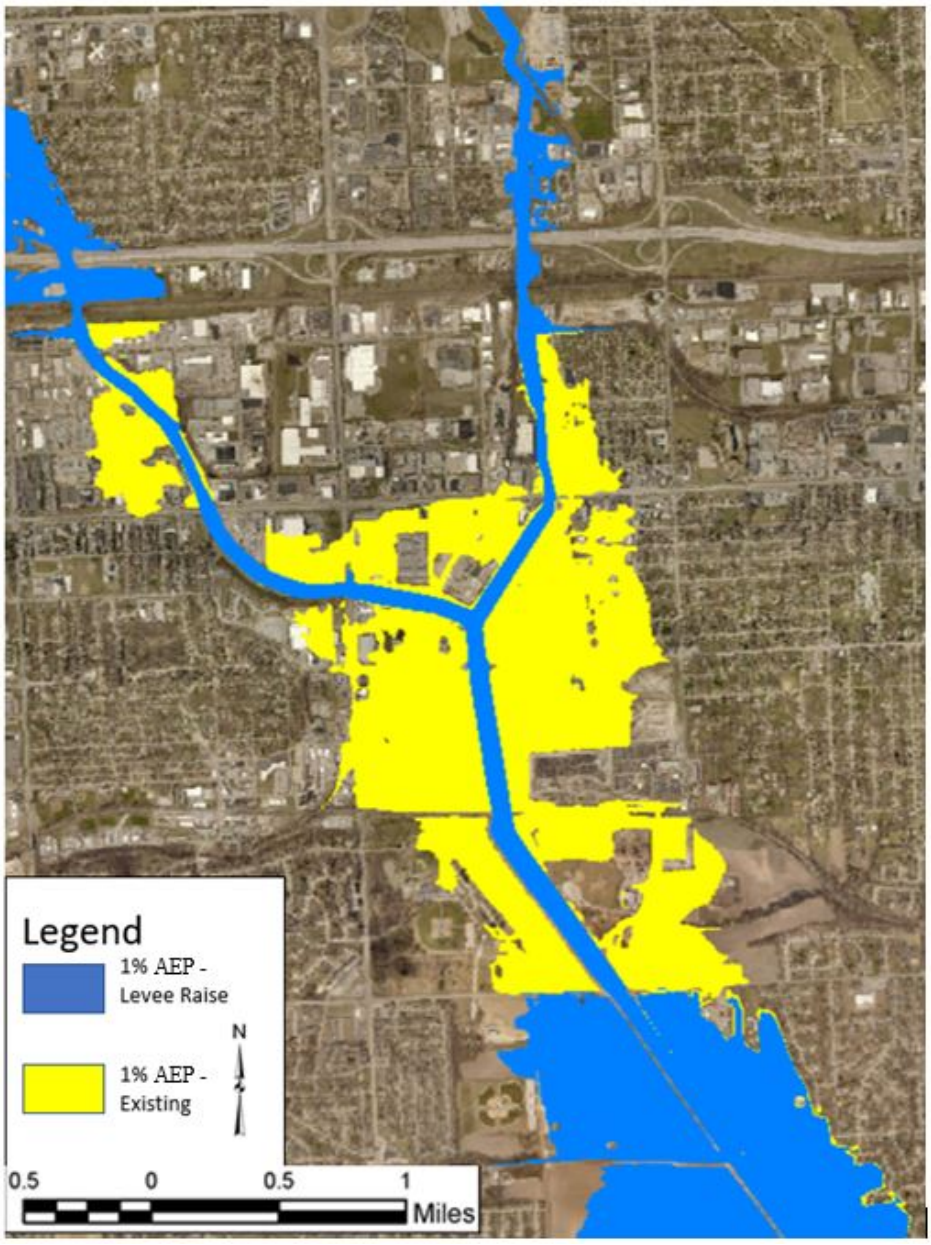



**Figure 30. 1% AEP Unsteady Flow Modeling Results for the Levee/Floodwall on Big Papillion**

**Table 40. Big Papillion Creek Levee Raise Costs and Benefits**

| | Levee at 1% AEP | Levee at 1% AEP + 3 ft | Levee at 1% AEP + 5 ft |
|---|---|---|---|
| Construction Cost | $24,904,266 | $38,791,271 | $47,815,276 |
| PED | $2,490,427 | $3,879,127 | $4,781,528 |
| S&A | $1,992,341 | $3,103,302 | $3,825,222 |
| Contingency | $8,965,536 | $13,964,858 | $17,213,499 |
| Total Construction Costs | $38,352,570 | $59,738,557 | $73,635,525 |
| LERRD | $8,054,222 | $8,057,141 | $8,074,036 |
| Total First Costs | $46,406,792 | $67,795,698 | $81,709,561 |
| Interest During Construction (2.5%, 5yr, Mid) | $2,395,310 | $3,264,280 | $3,830,511 |
| Total Investment Costs | $48,802,102 | $71,059,979 | $85,540,072 |
| Annualized Investment Costs (2.5%) | $1,720,667 | $2,505,437 | $3,015,977 |
| Annual OMRR&R Costs | $14,697 | $14,697 | $14,697 |
| Total Annual Costs | $1,735,364 | $2,520,134 | $3,030,674 |
| Average Annual Benefits | $1,496,880 | $1,729,570 | $1,753,000 |
| Net Benefits | -$238,480 | -$790,560 | -$1,277,670 |
| BCR | 0.86 | 0.69 | 0.58 |

*O&M costs based on $2,000 per mile channel widening; $1,000 per mile levee raise; $3,300 per mile new levee; $3,000 per mile new floodwall.

### 4.10.7 Updated Standalone Nonstructural Plan

After TSP, there were several refinements incorporated into the nonstructural analysis. These refinements include identifying critical facilities and incorporating future without-project hydrology. These updates typically increased the estimated flood depths assessed during TSP, and the following nonstructural alternatives were updated to incorporate these refinements. Nonstructural measures were considered for structures with the lowest floor below the 1 percent AEP flood event based on the updated modeling incorporating the future without-project hydrology. There are 693 structures meeting these requirements (Table 41).

Critical facilities in the study area include buildings such as fire stations, law enforcement facilities, schools, and medical facilities. None of these facilities are damaged at the 1 percent AEP flood event before or after implementation of the structural alternatives and therefore were not selected for nonstructural mitigation.

There are 36 structures located in the floodway. These structures would either have to be acquired or relocated to a flood-free site. These 36 structures were preliminarily evaluated and determined the economic justification of this measure was negative. Therefore, acquisition and relocation were dropped from further consideration.

During the refinements, the economic discount rate was also updated to the FY21 rate of 2.5 percent for a 50-year period analysis. The annual costs of 8 percent for engineering and design,

10 percent for supervision and administration, and a 25 percent contingency did not change from TSP.

The updated standalone nonstructural alternative shows 693 structures that incur expected flood damages from the 1 percent AEP flood event and whose first floor elevation of the structure is below the 1 percent AEP flood elevation (Figure 31). Updated results showed that the 1 percent AEP standalone plan is economically viable for all streams except Thomas Creek, however this plan does not incorporate the implementation of the optimized structural alternative affecting the water surface elevations within the basin (Table 39). Therefore, an additional analysis was performed to determine the structures still at flood risk after the optimized structural plan would be implemented.

**Table 41. Updated Standalone Nonstructural Alternative Costs and Benefits**

| Stream | Structures | Estimated Floodproofing Costs | Average Annual Costs | Average Annual Benefits | Net Benefits | BCR |
|---|---|---|---|---|---|---|
| Big Papillion Creek | 252 | $24,130,500 | $850,800 | $1,406,610 | $555,820 | 1.65 |
| Cole Creek | 1 | $18,370 | $650 | $1,120 | $470 | 1.73 |
| Little Papillion Creek | 259 | $21,518,170 | $758,690 | $1,681,100 | $922,410 | 2.22 |
| Papillion Creek | 12 | $1,043,940 | $36,810 | $139,360 | $102,550 | 3.79 |
| Saddle Creek | 56 | $4,369,550 | $154,060 | $751,530 | $597,470 | 4.88 |
| South Papillion Creek | 63 | $8,080,840 | $284,920 | $653,840 | $368,930 | 2.29 |
| Thomas Creek | 7 | $551,700 | $19,450 | $9,050 | -$10,400 | 0.47 |
| West Papillion Creek | 43 | $3,648,690 | $128,650 | $155,590 | $26,940 | 1.21 |
| **Total** | **693** | **$63,361,760** | **$2,234,010** | **$4,798,200** | **$2,564,190** | **2.15** |

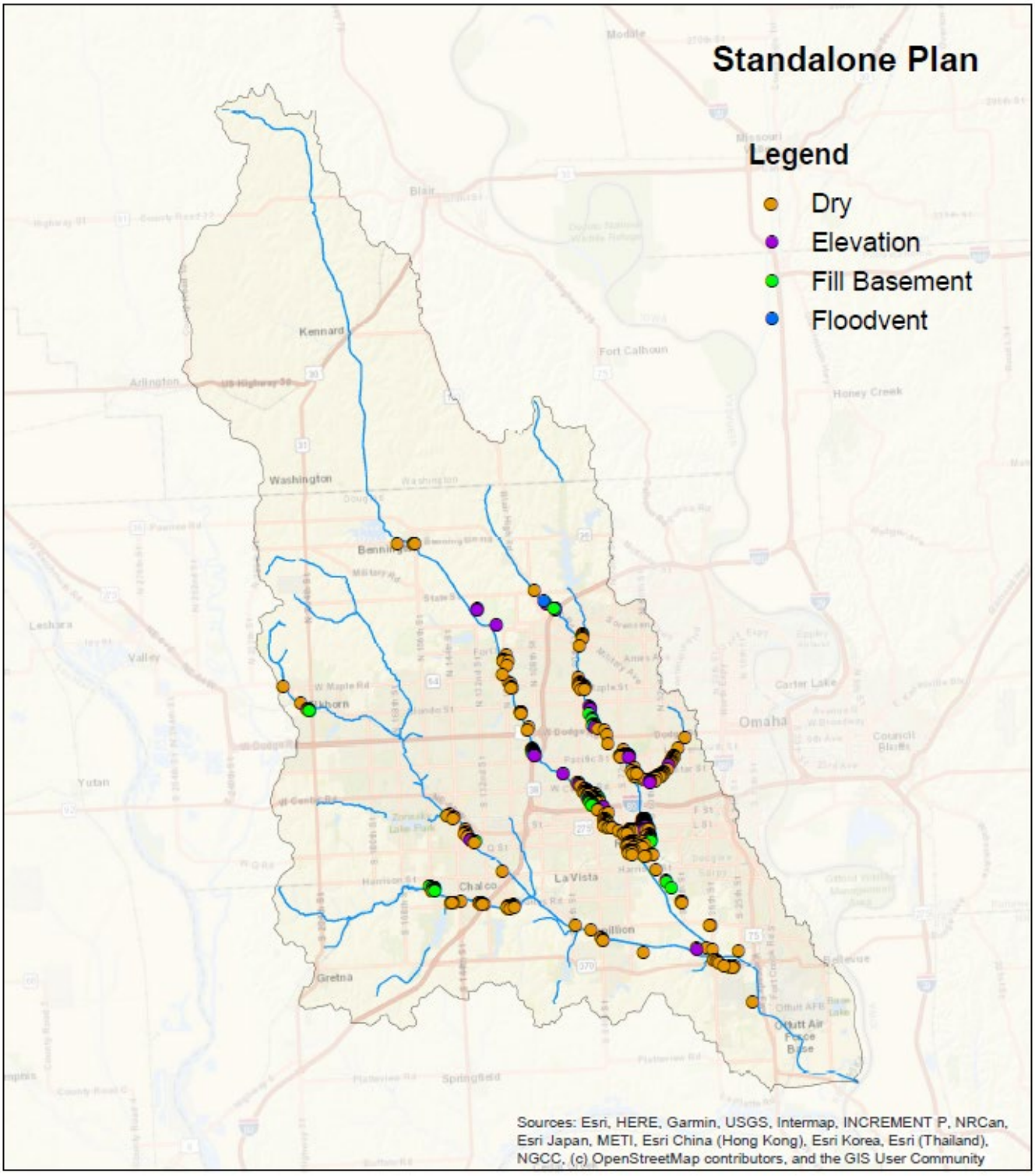



**Figure 31. Updated Standalone Nonstructural Alternative**

### 4.10.8 Updated Nonstructural Plan Combining with the Structural Recommended Plan

The nonstructural plan was developed using the updated WSE for the 1 percent AEP floodplain boundary with the optimized structural plan implemented. Nonstructural plans were developed by stream and cost estimates were completed for the updated floodproofing height incorporating from the structural alternatives.

The nonstructural plan was developed with the following planning criteria:

- Within the updated 1 percent AEP floodplain from the optimized structural plan
- Lowest floor below the 1 percent AEP flood elevation

From the above planning criteria, a nonstructural plan was developed to complement the structural plan based on initially investigated potential floodproofing of 554 structures (Figure 32). This plan covered all of the structures in the updated 1 percent AEP floodplain boundary incorporating the optimized structural plan. However, USACE policy requires that each added increment should (within reason) contribute positive net NED benefits and have a BCR of greater than 1.0, but based on the initial iteration, only the Big Papillion Creek, Papillion Creek, Saddle Creek, and South Papillion Creek tributaries individually showed economic viability for the all-inclusive 1 percent AEP standalone plan when combined with the optimized structural plan (Table 42). Therefore, further optimization of the nonstructural plan was investigated in the next section to include a portion of the remaining streams with negative net benefits for the standalone alternative to evaluate the potential for inclusion of a portion of the reaches.

**Table 42. Updated Standalone Nonstructural Alternative Combining with the Structural RP Costs and Benefits**

| Reach | Structures | Estimated Floodproofing Costs | Average Annual Costs | Average Annual Benefits | Net Benefits | BCR |
|---|---|---|---|---|---|---|
| Big Papillion Creek | 255 | $27,397,240 | $965,970 | $1,245,920 | $279,950 | 1.29 |
| Cole Creek | 1 | $18,870 | $670 | $660 | -$5 | 0.99 |
| Little Papillion Creek | 160 | $14,702,440 | $518,380 | $269,160 | -$249,220 | 0.52 |
| Papillion Creek | 9 | $763,670 | $26,930 | $124,680 | $97,750 | 4.63 |
| Saddle Creek | 56 | $4,399,740 | $155,130 | $744,260 | $589,130 | 4.80 |
| South Papillion Creek | 31 | $4,420,300 | $155,850 | $353,290 | $197,440 | 2.27 |
| Thomas Creek | 2 | $74,410 | $2,620 | $900 | -$1,720 | 0.34 |
| West Papillion Creek | 40 | $3,543,420 | $124,930 | $121,310 | -$3,620 | 0.97 |
| **Total** | **554** | **$55,320,100** | **$1,950,480** | **$2,860,180** | **$909,700** | **1.47** |

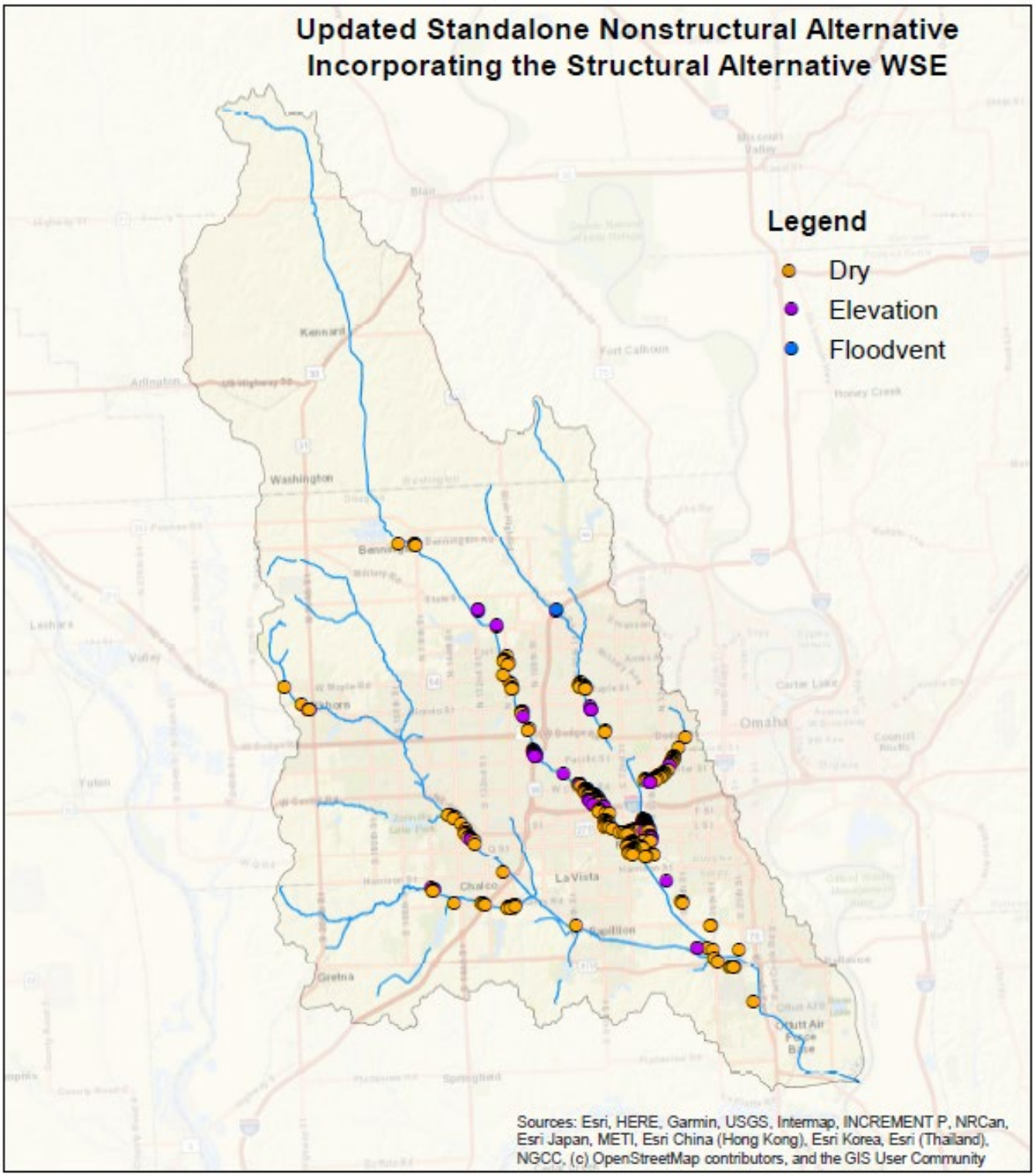



**Figure 32. Updated Standalone Nonstructural Alternative Incorporating the Structural Alternative WSE**

## 4.11 Recommended Plan

After optimization of each alternative and tributary was completed, a final NED plan that incorporates all feasible structural and nonstructural alternatives, as well as recreation features, was combined into the Recommended Plan. The sections below describe the risks to life safety, environmental mitigation, recreational features, real estate needs, total project costs, and risks and uncertainties for implementation of the Recommended Plan.

### 4.11.1 Recommended Structural Plan

#### 4.11.1.1 Combined Recommended Structural Plan

Once unsteady modeling and the corresponding economic analysis (Table 43 and Table 44) was completed for each alternative considered, the final optimized alternatives were modeled as one final plan (Figure 33). This included the DS19 wet dam with a sediment detention dam (details to be refined during design), the DS10 dry dam, and the new levee/floodwall on the Little Papillion from Mercy Road to Western Ave at the optimized height of a top elevation equal to the 1 percent AEP energy grade line with an additional three feet. Given irreducible uncertainties inherent in flood frequency analysis, the recommended plan will pass the 1 percent event with 76 percent assurance.

**Table 43. Structural Recommended Plan Costs (FY21 Price Levels)**

| Combined FRM Structural Plan | South Papillion DS19 | Thomas Creek DS10 | Little Papillion Levee / Floodwall | Total |
|---|---|---|---|---|
| Construction Cost | $10,153,189 | $8,679,148 | $20,568,254 | $39,400,591 |
| PED | $1,039,781 | $870,522 | $2,058,394 | $3,968,698 |
| S&A | $831,825 | $696,418 | $1,646,715 | $3,174,958 |
| Contingency | $3,803,519 | $3,184,371 | $7,529,606 | $14,517,495 |
| Total Construction Costs[1] | **$15,828,314** | **$13,430,459** | **$31,802,969** | **$61,061,742** |
| LERRD | $5,959,516 | $7,015,744 | $13,980,258 | $26,955,518 |
| Mitigation | $244,622 | $26,075 | $15,687 | $286,384 |
| **Total First Costs** | **$22,032,452** | **$20,472,278** | **$45,798,914** | **$88,303,644** |
| Interest During Construction (2.5%, 5yr, Mid) | $1,273,970 | $1,277,290 | $2,748,949 | $5,300,209 |
| Total Investment Costs | $23,306,422 | $21,749,568 | $48,547,863 | $93,603,853 |
| Annualized Investment Costs (2.5%) | $821,739 | $766,848 | $1,711,703 | $3,300,290 |
| Annual OMRR&R Costs | $179,307 | $179,307 | $15,092 | $373,707 |
| Annual Monitoring Costs | $729 | $82 | $73 | $885 |
| **Total Annual Costs** | **$1,001,775** | **$946,237** | **$1,726,869** | **$3,674,881** |

[1]Total Construction Cost includes the Facility/Utility Relocations total of $2,382,331 from the Real Estate Plan (Appendix J). Total Real Estate Costs = LERRD + relocations = $29,337,848.

**Table 44. Structural Recommended Plan Benefits (FY21 Price Levels)**

| Alternative | First Costs | Average Annual Costs | Average Annual Benefits | BCR | Net Benefits |
|---|---|---|---|---|---|
| Combined FRM Structural Plan | $88,303,640 | $3,674,880 | $4,822,420 | 1.31 | $1,147,540 |

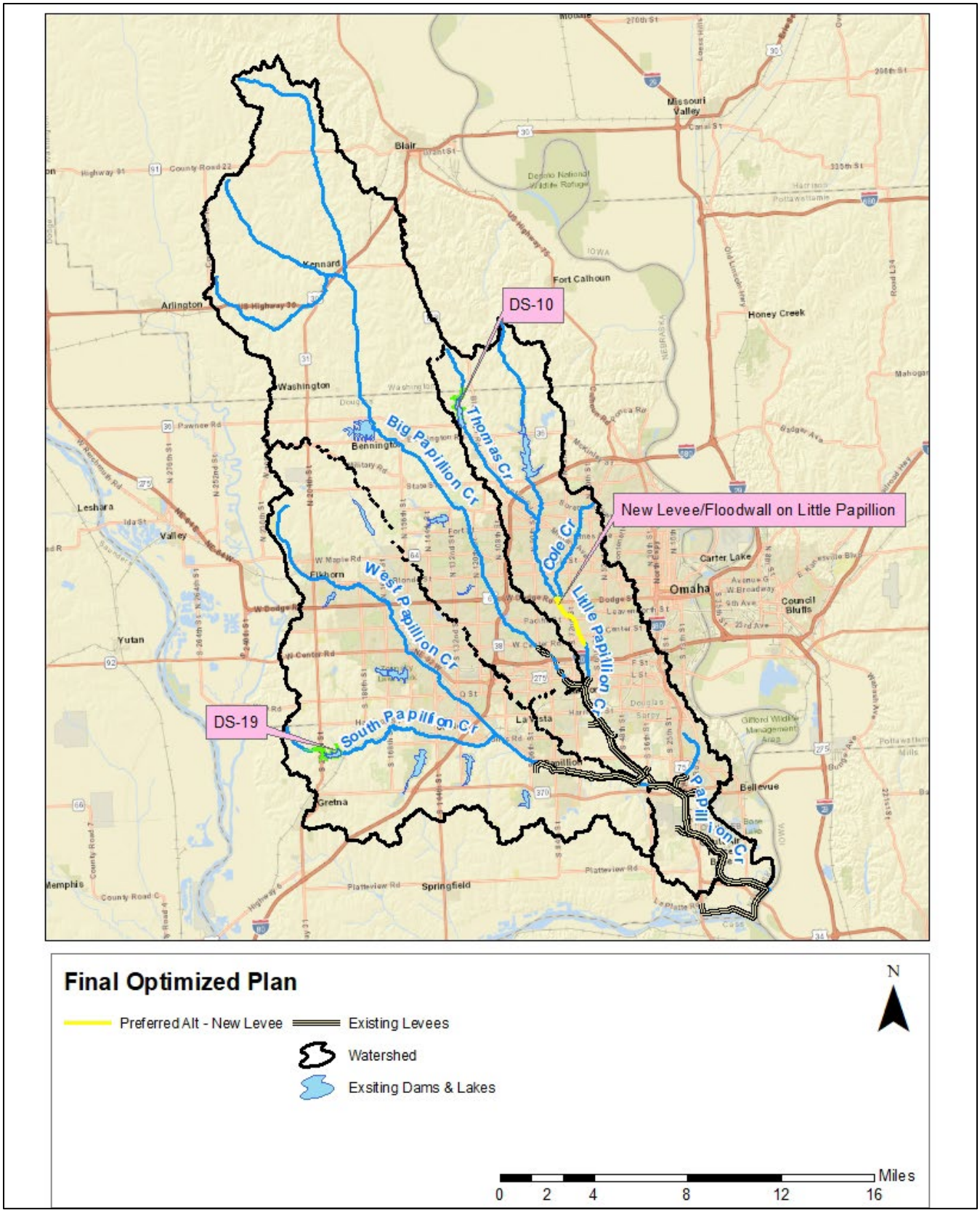



**Figure 33. Papillion Creek GRR Recommended Structural Plan**

### 4.11.2 Nonstructural Recommended Plan

Following the evaluation of the initial updated nonstructural plan, optimization of the nonstructural plan was performed to determine if a more economically viable plan could be identified in the 1 percent AEP floodplain boundary that produced more comprehensive flood risk management throughout the basin. Nonstructural alternatives, while justified on the basis of NED net benefits, should also give consideration to grouping plans around logical boundaries to provide community cohesiveness. Therefore, the optimized nonstructural plan was evaluated based on evaluating the initial plan, removing outlier reaches, and re-grouping the remaining reaches in the 1 percent AEP floodplain boundary to provide a plan that balances maximizing NED Benefits and providing a community-focused flood risk management. Thomas Creek was removed from the plan due to the very small number of structures, none of which were economically viable. Little Papillion Creek was also removed because none of the individual reaches were economically viable. For the remaining streams individual reaches were investigated by reach to develop community-based groupings of structures and then re-evaluated. This optimized nonstructural plan is also the recommended nonstructural plan with results summarized in Table 45, Table 46, and Figures 34-45. The plan includes 71 basement fills, 59 elevation of residential structures, and 256 dry floodproofing of commercial structures for a total of 386 structures in the plan which produced net benefits of $1,103,930 and has a BCR of 1.75. This plan is voluntary; thus, the homeowners/business owners will have to opt into the project for measures to be implemented.

Any elevation or dry floodproofing implemented will require a FEMA Floodproofing Certificate or FEMA Elevation Certificate as a part of the floodplain development permit process to ensure the construction of the measure is in compliance with the NFIP and local floodplain ordinances. Dry floodproofed structures will require an annual exercise plan to ensure all the project components work properly and repair any components not operating as intended.

None of the nonstructural measures evaluated would allow the buildings to be safely occupied during flooding. Community outreach initiatives, such as providing flood information flyers and updating the flood warning system, can increase the awareness of flood risk among residents, which can lead to better response time in the event of a flood. Implementation of the project would include the development of a flood preparedness and evacuation plan paired with the existing flood warning system, and encourage residents to sign up for the wireless emergency alert system that Omaha uses, this system will send alerts directly to people's cellphones in the vicinity of the hazard. There are existing emergency action plans for the existing dam sites in the study area, and with the construction of the recommended plan's structural components new emergency action plans will be developed for those sites as well.

**Table 45. Recommended Nonstructural Plan Costs and Benefits**

| Stream | Structures Mitigated | Estimated Floodproofing Costs | Average Annual Cost | Average Annual Benefits | Net Benefits | BCR |
|---|---|---|---|---|---|---|
| Big Papillion Creek | 255 | $28,623,760 | $1,012,340 | $1,245,920 | $233,580 | 1.23 |
| Papillion Creek | 9 | $797,860 | $28,220 | $124,680 | $96,460 | 4.42 |
| Saddle Creek | 56 | $4,596,710 | $162,570 | $744,260 | $581,690 | 4.58 |
| South Papillion Creek | 31 | $4,618,180 | $163,330 | $353,290 | $189,960 | 2.16 |
| West Papillion Creek | 35 | $3,253,750 | $115,080 | $117,320 | $2,240 | 1.02 |
| **Total** | **386** | **$41,890,270** | **$1,481,540** | **$2,585,470** | **$1,103,930** | **1.75** |

**Table 46. Recommended Plan Nonstructural Measures Breakdown**

| Nonstructural Measure Type | Number of Structures |
|---|---|
| Fill Basement | 71 |
| Elevate Residential Structure | 59 |
| Dry Floodproof Commercial Structure | 256 |
| **Total** | **386** |

Planning Bulletin 2019-03 recommends the use of participation rate sensitivity analysis for voluntary nonstructural measures to understand the impacts if not every structure in the plan participants in the project. Since there was no clear evidence from the non-Federal sponsor on the success of a large number of nonstructural measures implemented in the past, the participation rate sensitivity analysis was conducted on feedback received from the non-Federal sponsor and the public during public meetings. The nonstructural measure of filling basements was the least supported measure and unlikely that these structures would participant in the project, therefore the recommended nonstructural plan was evaluated without this measure. The recommended plan included 386 structures total, when the fill basement measure was removed from the plan, there remained 315 structures total for the remaining elevations and dry floodproofing measures. With removing fill basement measure only, the costs decreased about 2 million dollars and net benefits increased slightly, see Appendix G for further details.

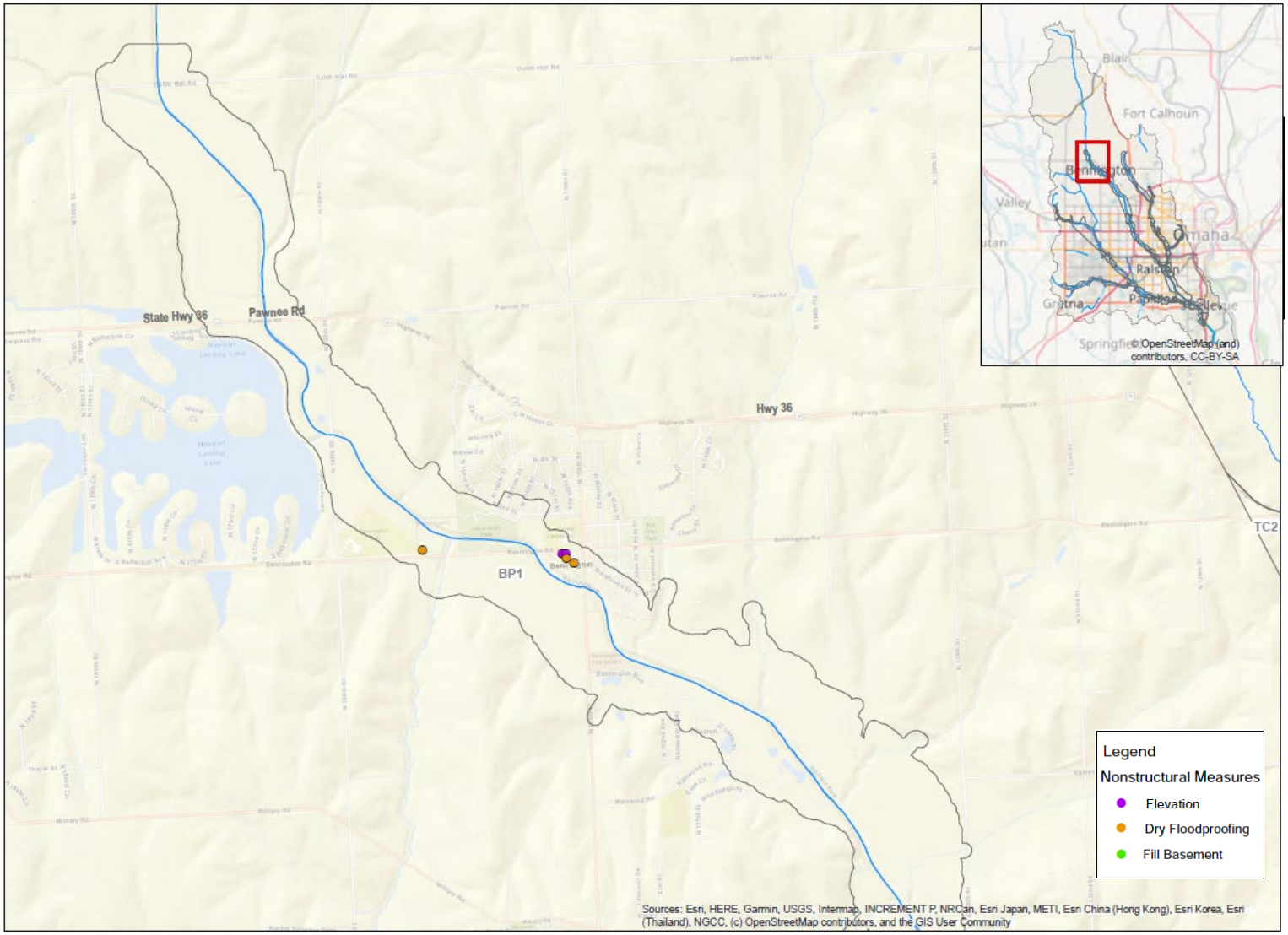



**Figure 34. Recommended Plan for Nonstructural Measures: Big Papillion Creek Reach 1**

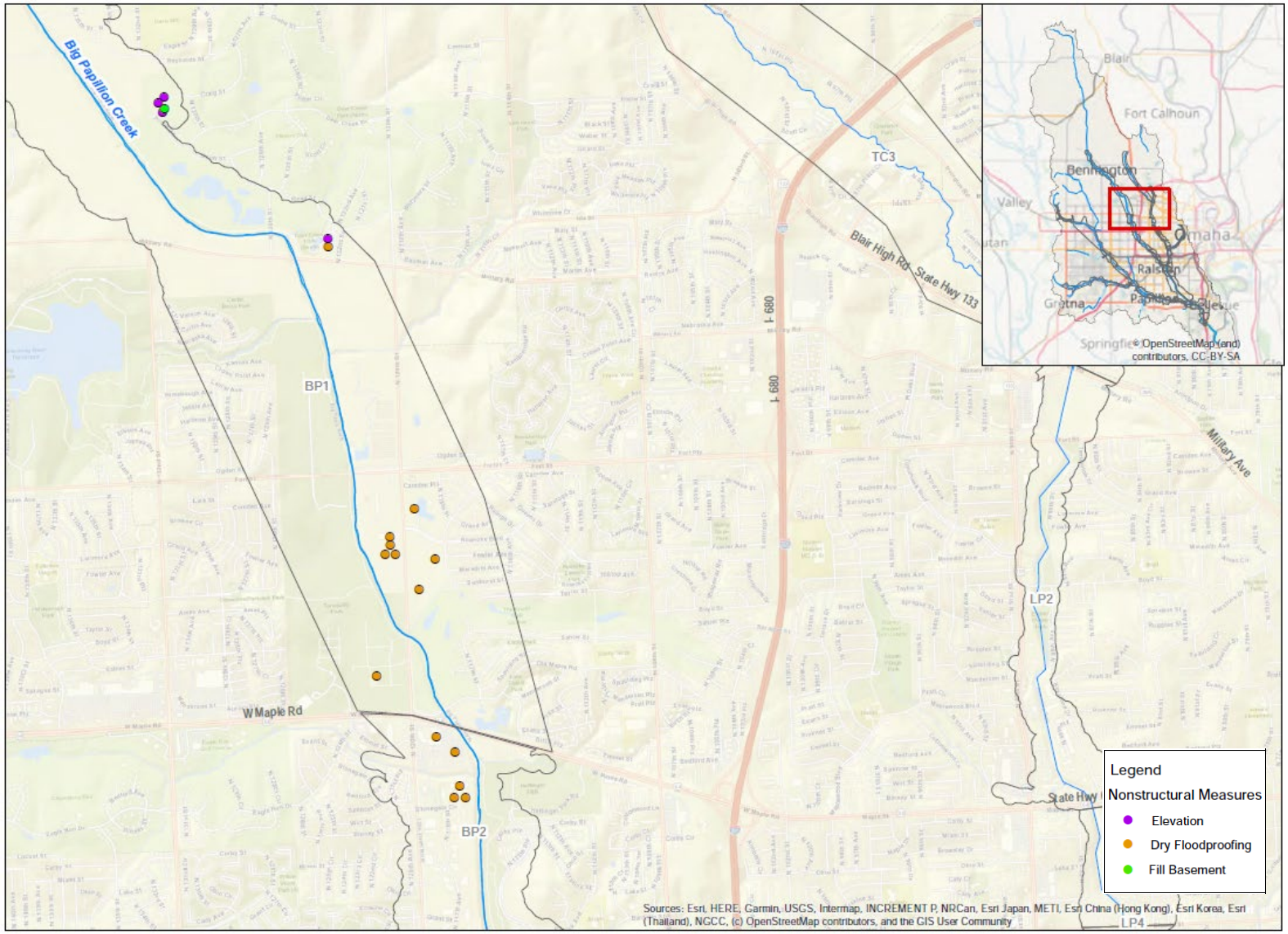



**Figure 35. Recommended Plan for Nonstructural Measures: Big Papillion Creek Reach 1 and 2**

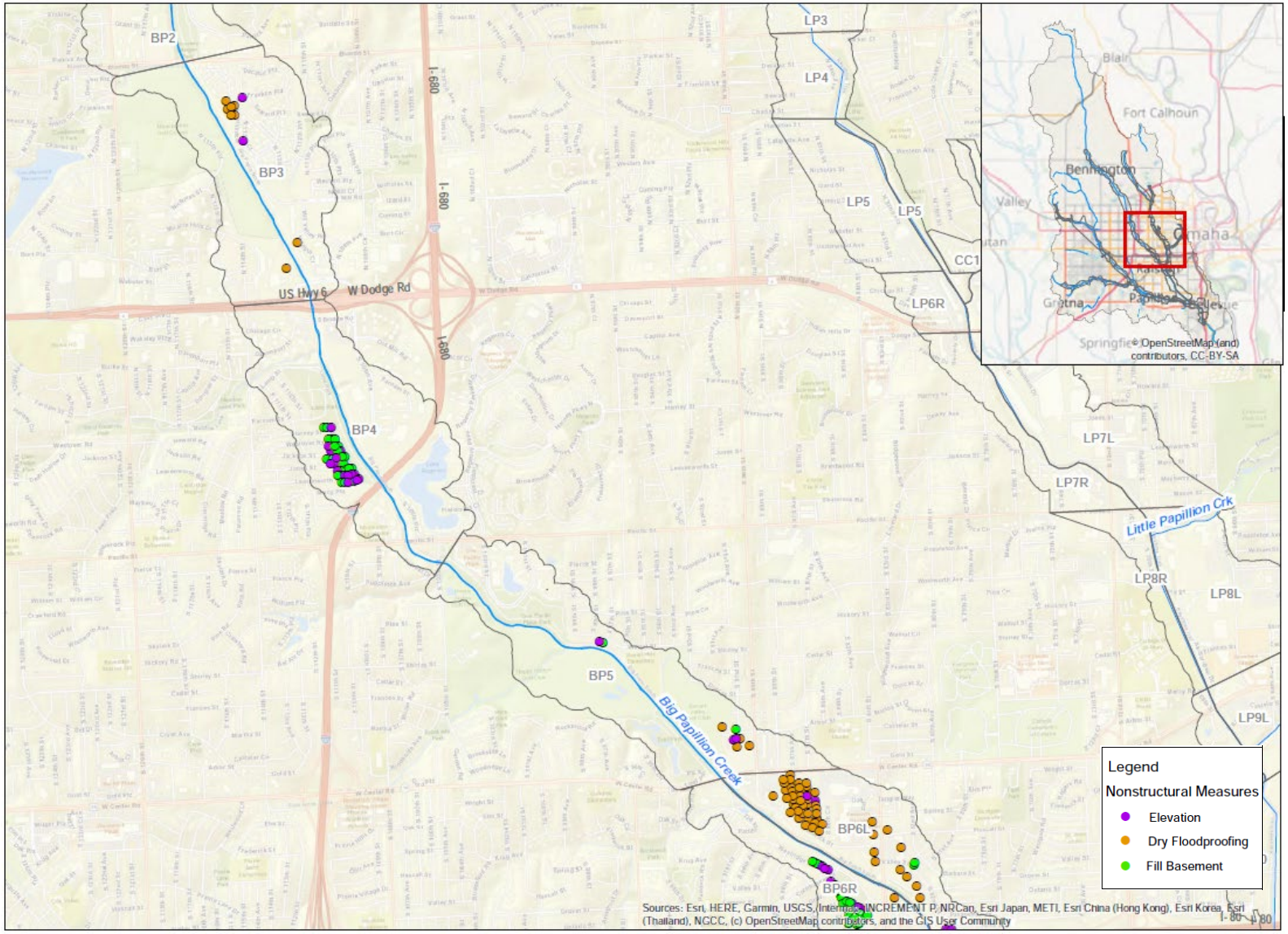



**Figure 36. Recommended Plan for Nonstructural Measures: Big Papillion Creek Reach 3, 4, 5, 6L, and 6R**

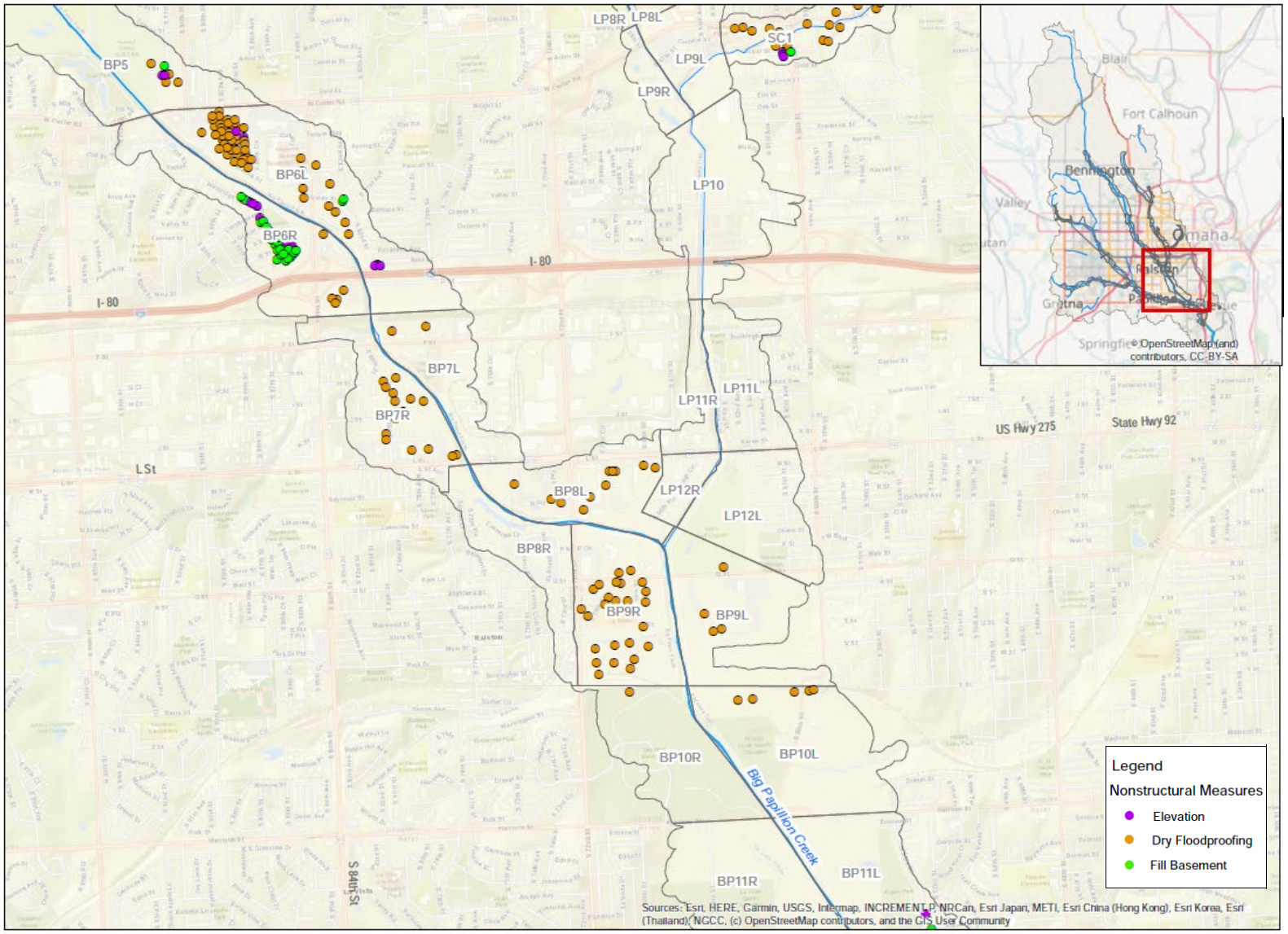



**Figure 37. Recommended Plan for Nonstructural Measures: Big Papillion Creek Reach 6L, 6R, 7L, 7R, 8L, 8R, 9L, 9R, 10L, and 10R**

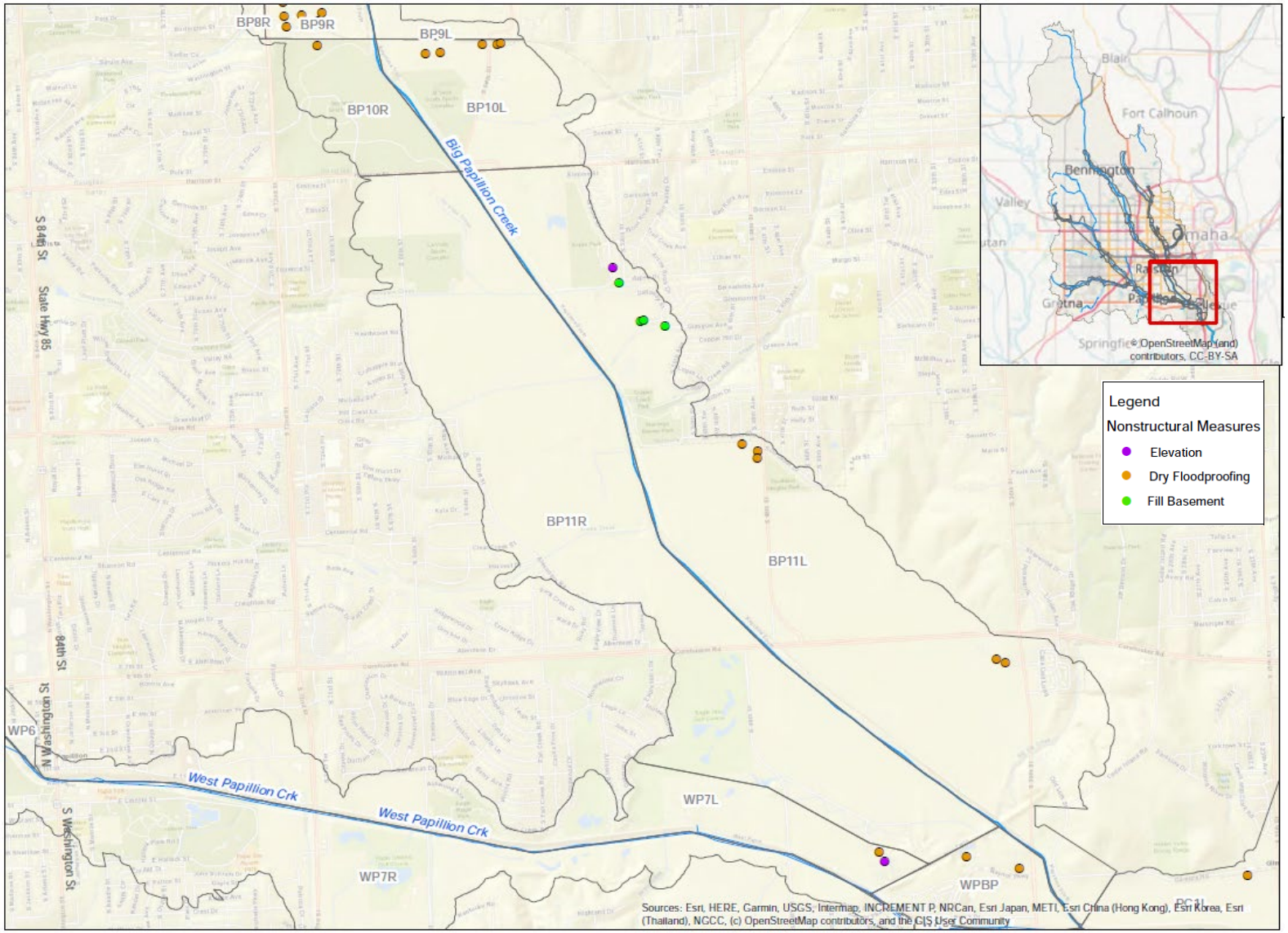



**Figure 38. Recommended Plan for Nonstructural Measures: Big Papillion Creek Reach 11R and 11L**

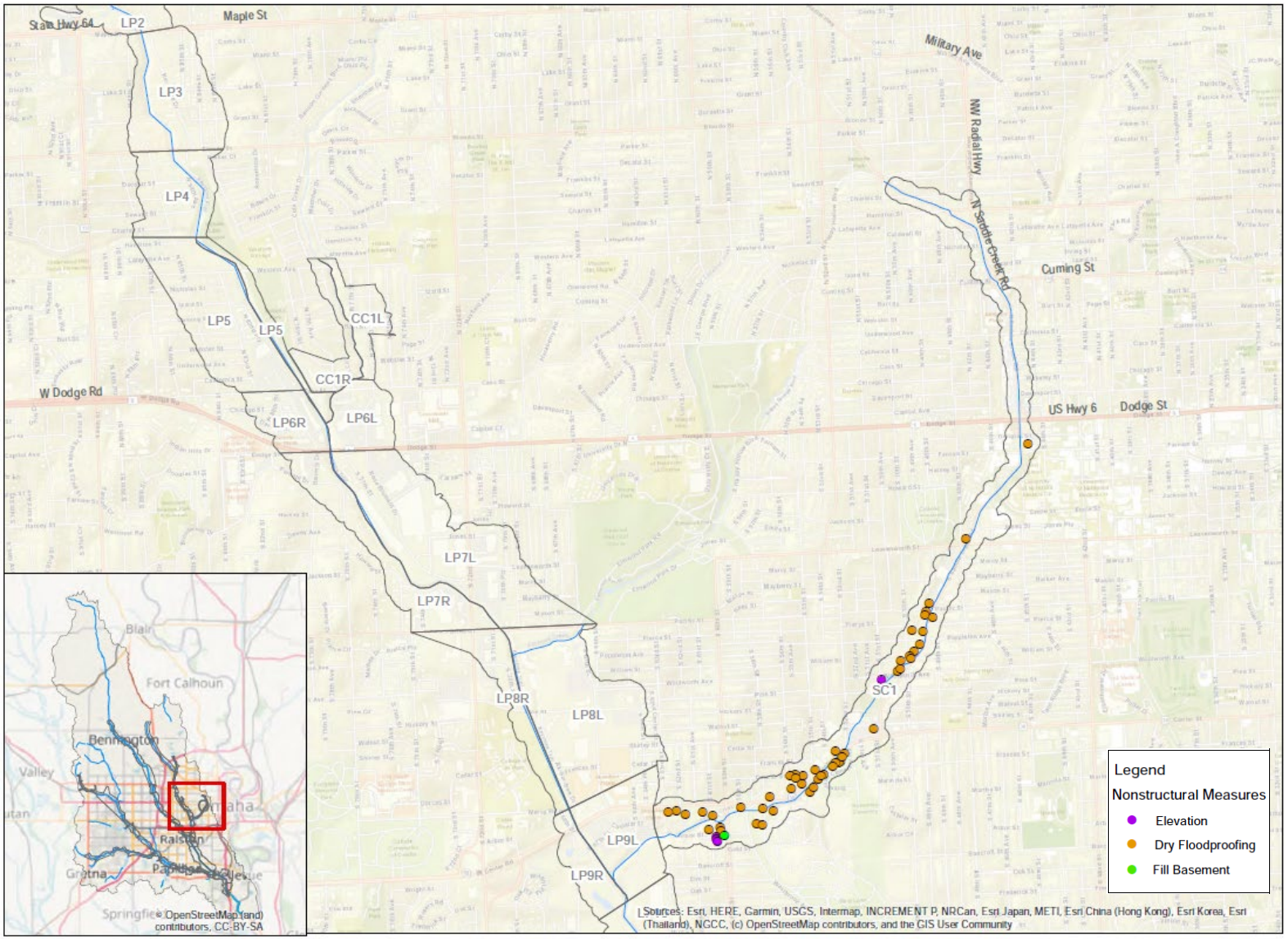



**Figure 39. Recommended Plan for Nonstructural Measures: Saddle Creek**

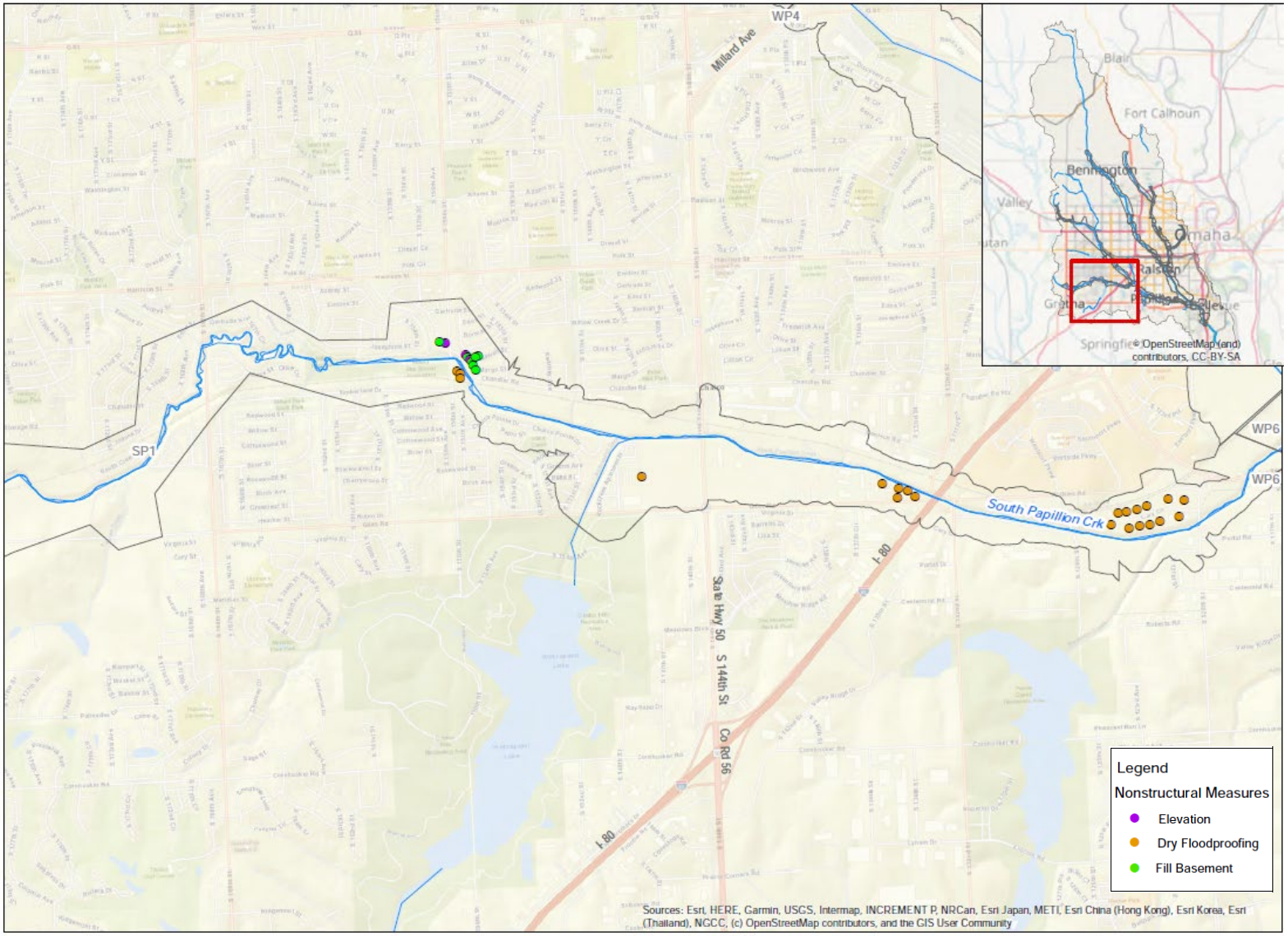



**Figure 40. Recommended Plan for Nonstructural Measures: South Papillion Creek**

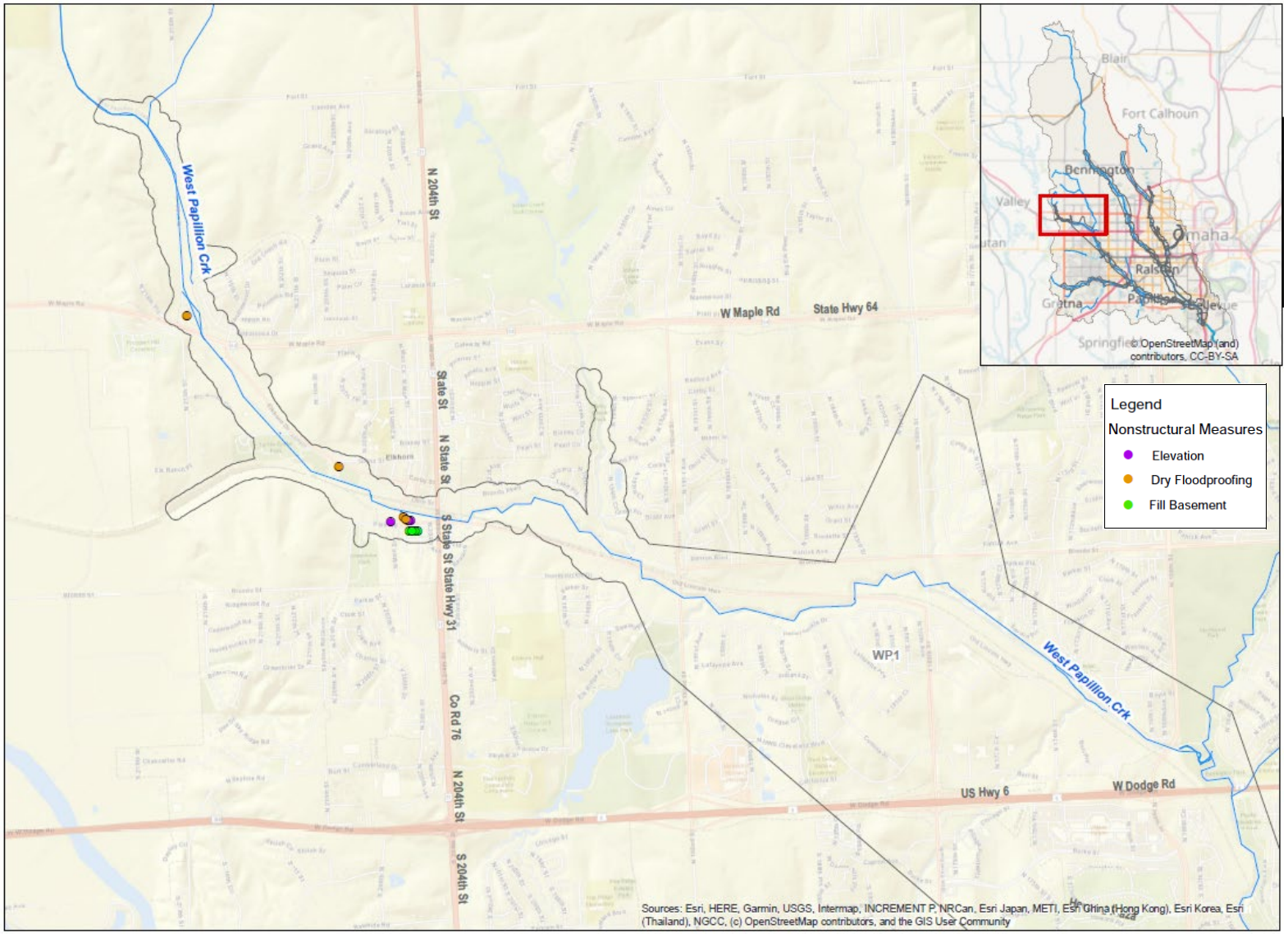



**Figure 41. Recommended Plan for Nonstructural Measures: West Papillion Creek Reach 1**

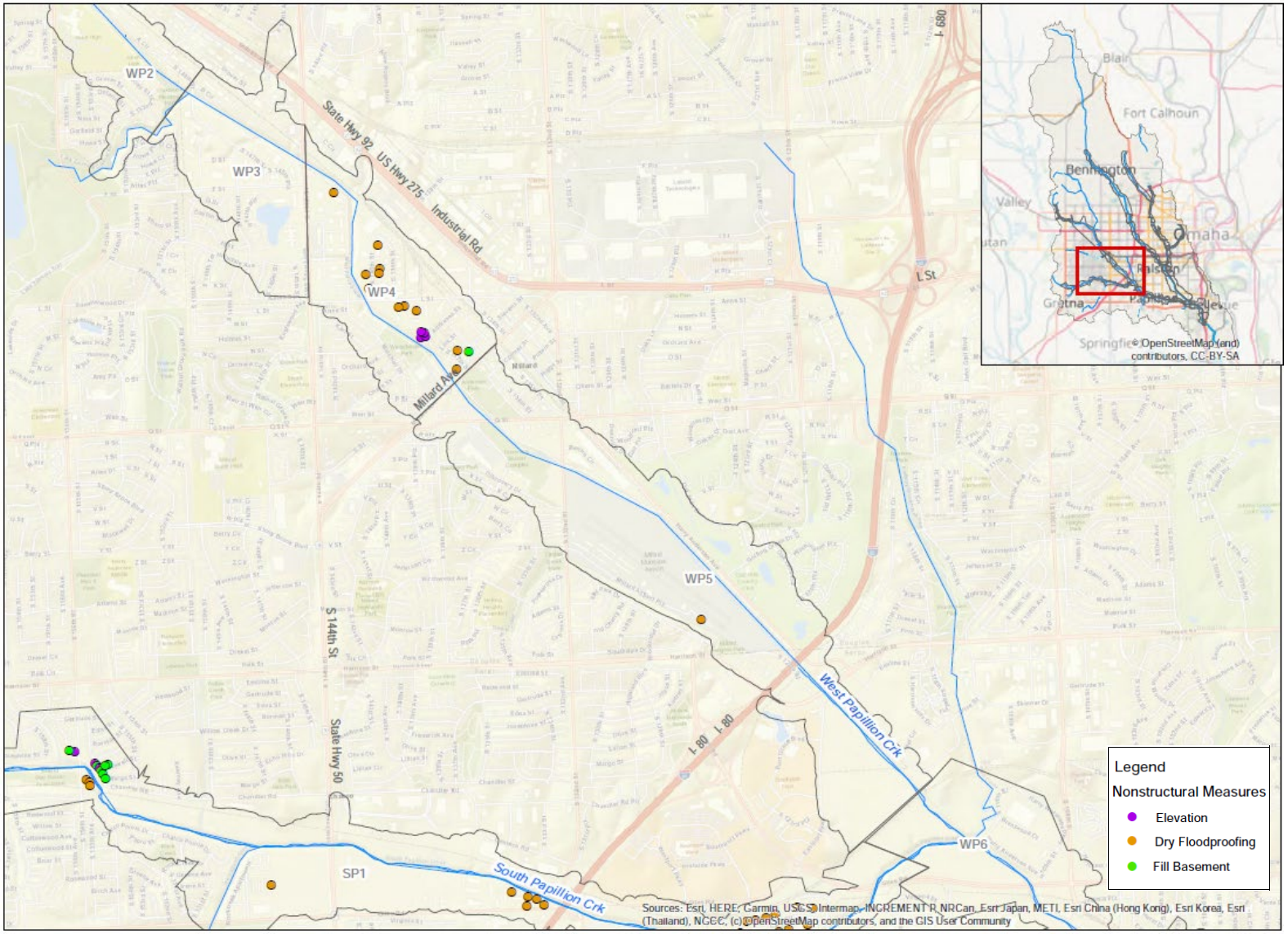



**Figure 42. Recommended Plan for Nonstructural Measures: West Papillion Creek Reach 4 and 5**

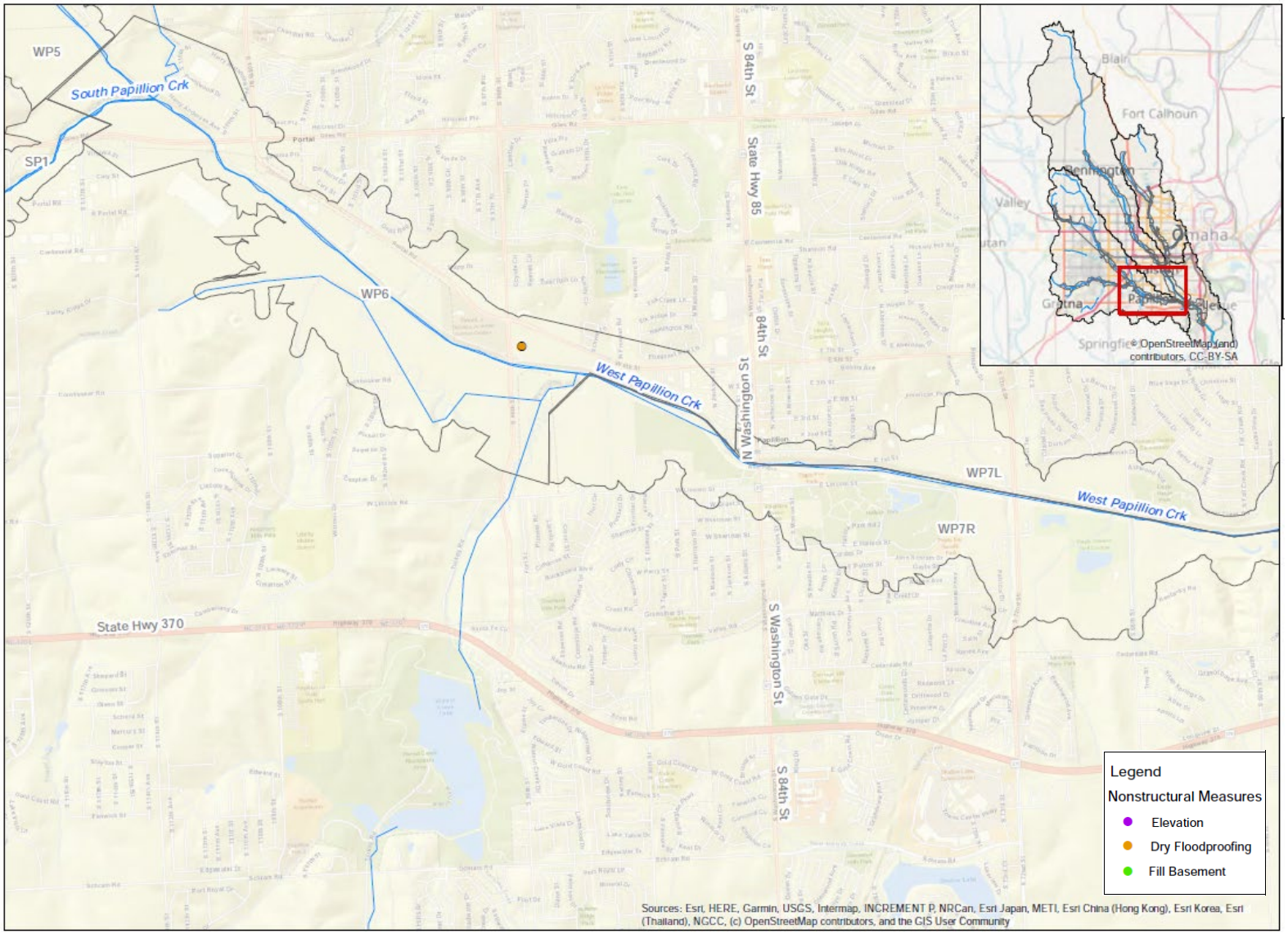



**Figure 43. Recommended Plan for Nonstructural Measures: West Papillion Creek Reach 6**

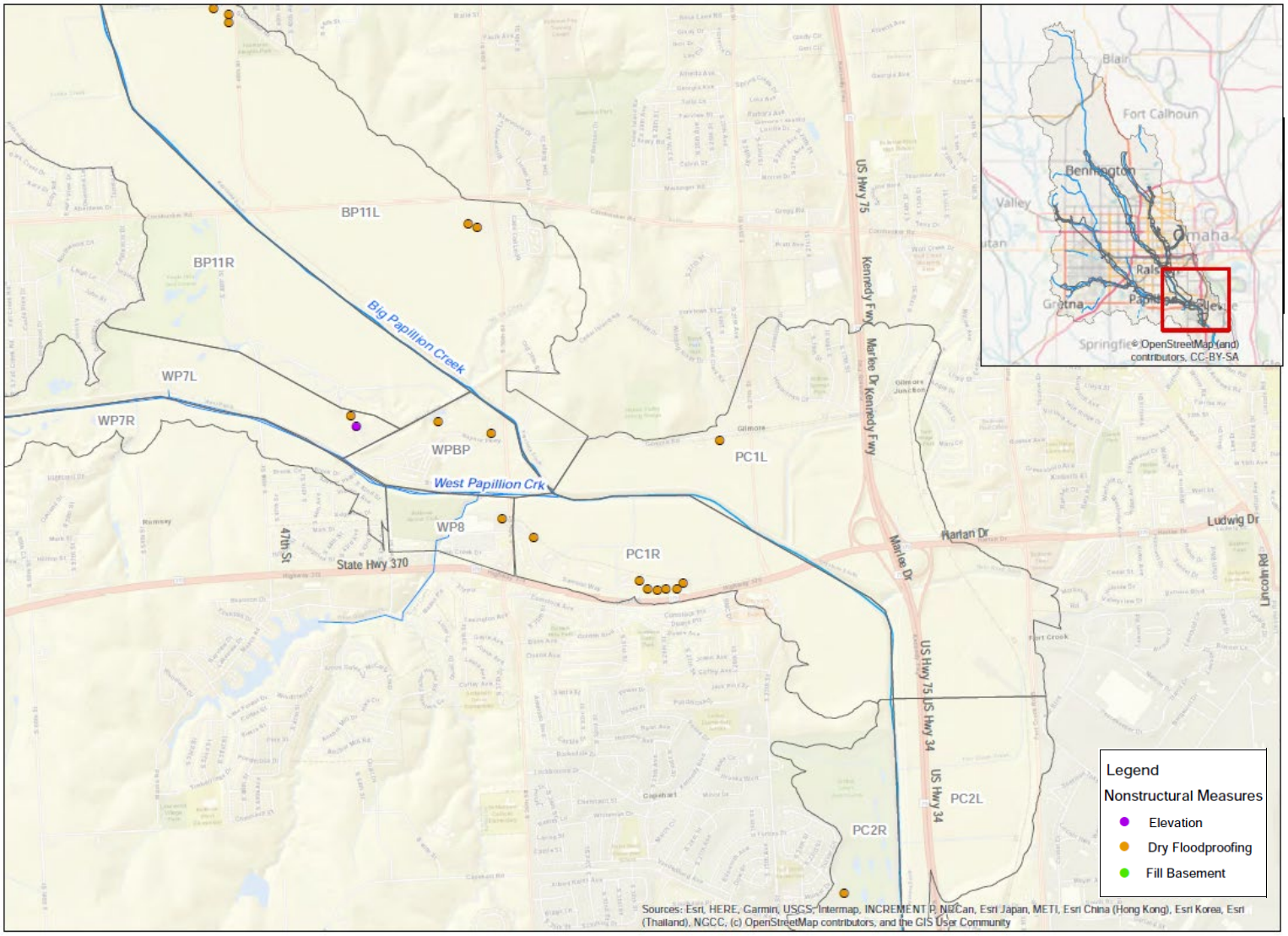



**Figure 44. Recommended Plan for Nonstructural Measures: Papillion Creek**

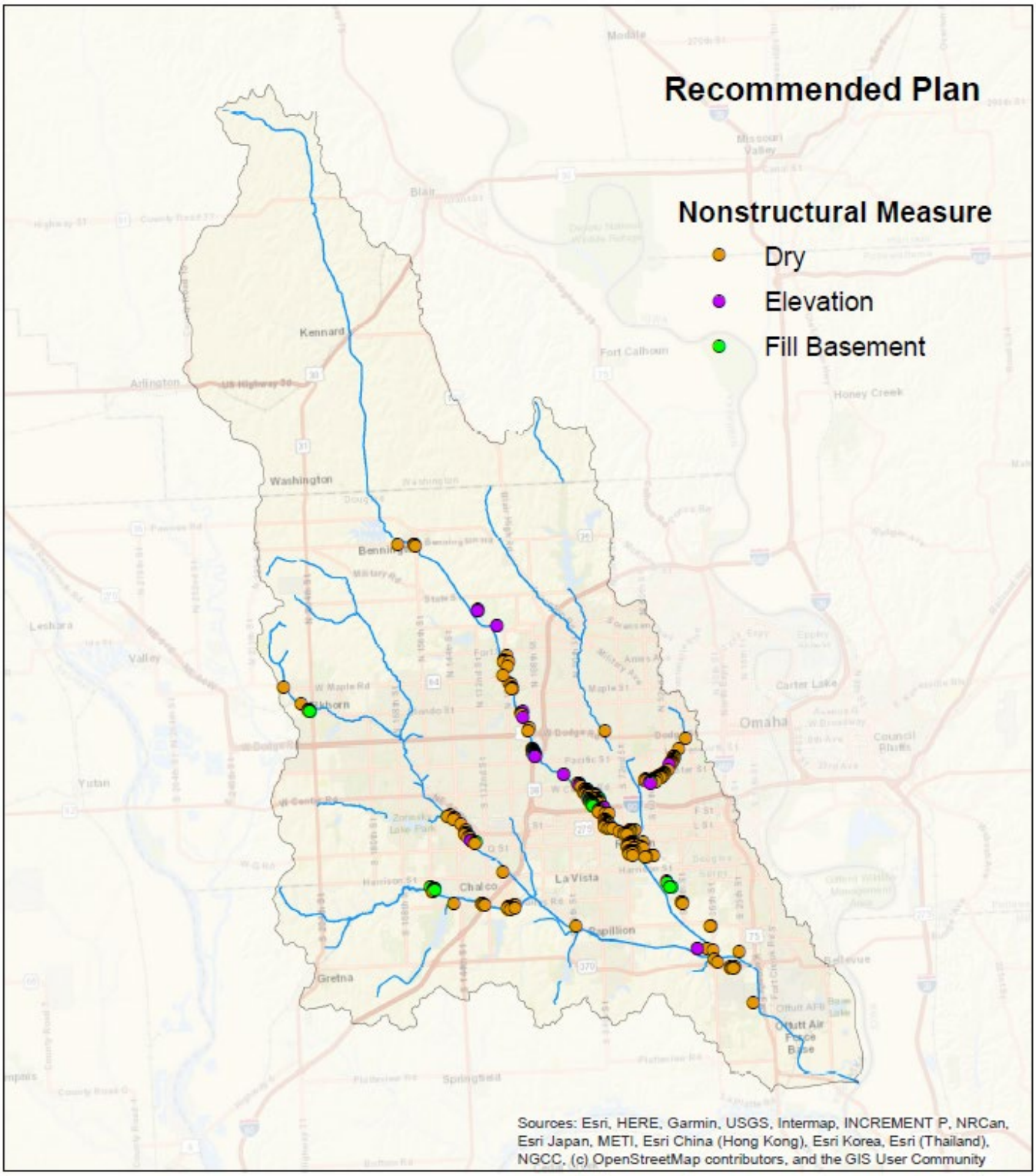



**Figure 45. Recommended Nonstructural Plan – Overall Map**

### 4.11.3 Life Safety Performance of the Recommended Plan

To investigate the life safety performance considerations of the proposed project, the Omaha District updated the LST life safety performance risk assessment from the TSP for the Little Papillion Levees and Floodwall and conducted an abbreviated semi-quantitative risk assessment (SQRA) for Dam Sites 10 and 19. The SQRA on the dams involved deliberate consideration of a wide array (25 total) of potential failure modes (PFMs) that could lead to breaching of a dam, mapping the chain of events that would lead to failure under each PFM to determine the likelihood of that failure mode to occur (probability), and economic modeling of potential life loss along the stream corridor which could occur as a result of a dam failure. The following paragraphs present the results of the life safety analysis for each component of the recommended flood risk management plan.

#### 4.11.3.1 Little Papillion Levees and Floodwalls

The purpose of this life safety analysis for the new floodwall and levee sections on the Little Papillion Creek is to determine the life loss associated with the proposed levee and floodwall designs vs the existing conditions. In order to do this, features and assumptions used in the Levee Screening Tool (LST) were updated from the TSP analysis and used to quantify life loss for the selected alternative. The existing condition life loss was calculated using the LST depth fatality curve. The primary inputs used to calculate loss of life in the LST are the delineated leveed area and the annual probability of inundation due to overtopping and breach prior to overtopping. The LST provides a simplified method to calculate annualized life loss given a population at risk and frequency at which the levee will be loaded and overtopped. Estimation of specific breach parameters, location of the breach, and the breach hydraulics are not considered in the LST analysis.

Results from the LST show that the life safety risk for LP5, LP6, and LP7 all result in life loss of less than 1. The overtopping failure mode for damage reaches plots essentially right on the threshold for societal life safety risk and above the individual risk line (Figure 46). It should be noted that this analysis assumes life loss would not occur until the levee was breached since the flashy flows would not overtop the levee for a long enough duration to create significant ponding depths that would impact the PAR and/or the population would have little time to evacuate, as the system is flashy and populated areas would be impacted within minutes of overtopping.

Once the project is approved and moves into design and implementation, additional design and operational changes should be investigated that could improve the resiliency of the levees to reduce the probability of levee breach during overtopping and contribute to improving life safety risk. The only structural option to further reduce residual risk would be to raise the levee higher (reducing the probability of overtopping), but that is not practical or cost-effective due to real estate and closure structure size/height constraints. The probability of overtopping failure mode plots above the individual risk line (which is a common occurrence for levee projects). If the breach due to overtopping probability is reduced, then levee life safety performance would plot further below the societal risk guideline by adjusting the probability of failure; and if improvements to evacuation effectiveness can be realized (improved evacuation plans and flood warning effectiveness), the project would plot further below the societal risk guideline by

reducing the average life loss (consequences). In conclusion, the currently proposed alternatives (selected based upon NED benefits) appear to address TRG 1 and 4 to the extent practicable with opportunities for additional performance improvements during design.

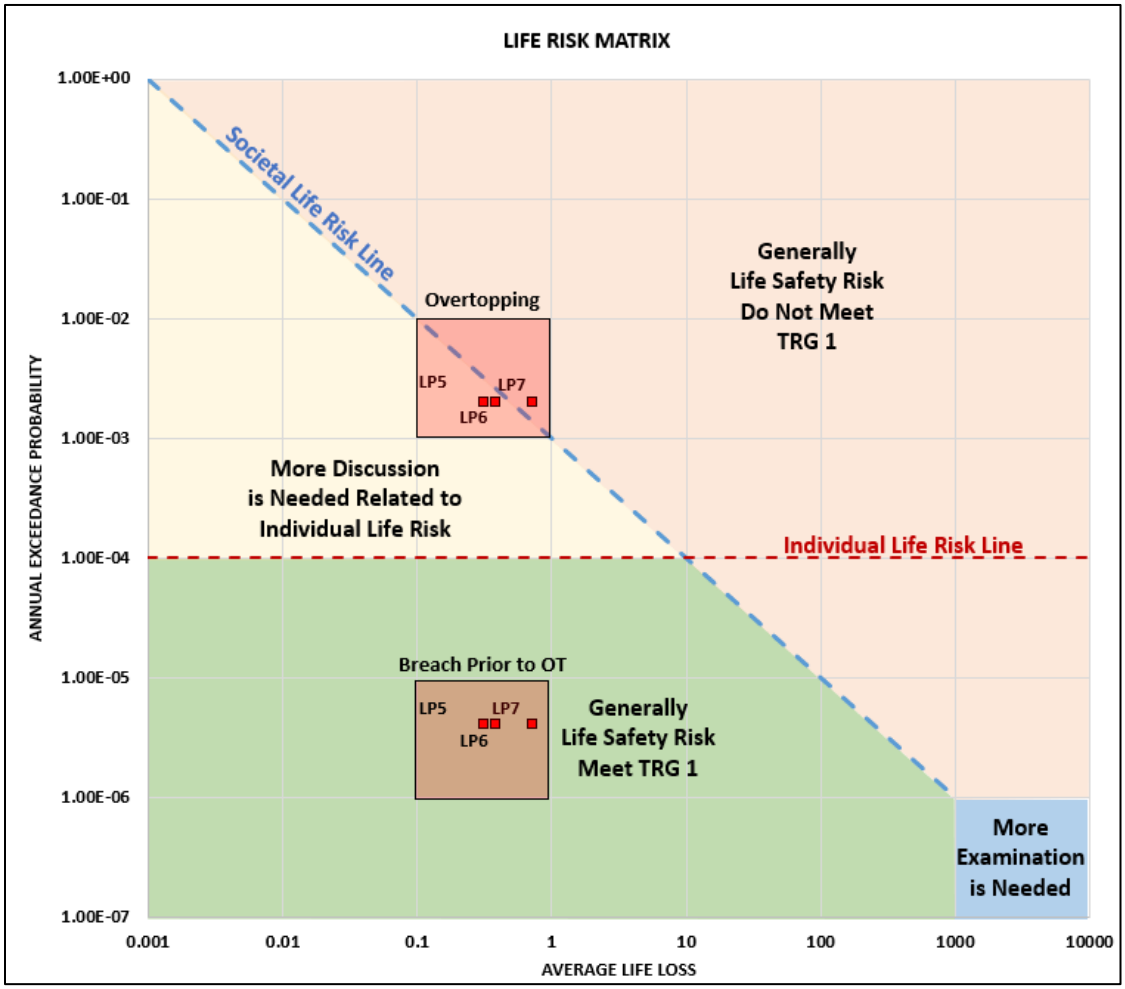



**Figure 46. Life Risk Matrix – Selected Little Papillion Creek Levee/Floodwall**

### 4.11.3.2 Dam Site 10

The abbreviated Semi-Qualitative Risk Assessment (SQRA) performed by the Omaha District did not identify any potential failure modes that would prevent Papillion Creek Dam Site 10 dry dam from meeting the tolerable risk and essential USACE guidelines. It should be noted that significant design changes, incorporating a permanent reservoir pool or changing the embankment, outlet works or spillway design will require an updated dam safety SQRA to determine whether the design changes result in significant changes to risks of the project.

Of the 25 potential failure modes identified in preliminary brainstorming of possible performance issues, only two were carried forward for development and consideration as "primary risk drivers" for the dry dam. These potential failure modes are: (1) backwards erosion piping (BEP) in the glacial till foundation at the outlet works (PFM 14); and (2) spillway erosion

(PFM 15). Each of these potential failure modes is summarized here but additional detail can be found in Appendix L.

For PFM 14, there is the potential that during construction of the dam a fine grained, cohesionless sand stratum in the left abutment could be encountered which could introduce a potential seepage zone and path for foundation soils to be eroded and carried away, undermining the stability of the dam embankment. However, seepage is driven by the duration of loading during when the pool is at its highest "critical" max high pool (MHP). For dry dam site 10, the frequency of the MHP is very rare (AEP 1/450,000) and even under that loading condition, the pool duration is relatively short (41 hours). Based on the geology, global gradients through the foundation (0.08 ft/ft at MHP) are too low to initiate and progress BEP to the point of breaching the dam so the probability of this failure mode is extremely low.

For PFM 15, there is risk the unlined, earth-cut emergency spillway could erode during flows due to high velocities of the flow (up to 12.2 ft/sec). However, erosion would have to cut through approximately 1,285 feet of abutment soil within a relatively short duration (12.5 hours) to breach the spillway crest. In addition, hydraulic modeling of the breach showed that the resulting breach discharge has minimal incremental inundation and loss of life consequences compared to design spillway flows which would have already been occurring prior to the breach (non-breach).

Results from the SQRA are presented on the f/N Life Safety Risk Matrix shown as Figure 47. PFM 14, PFM 15, and Total Risk all plot off of the chart due to the probabilities all being less than $1 \times 10^{-7}$. In addition, the SQRA team made several recommendations to address deficiencies in the preliminary design for DS10 including: perform additional site characterization and lab testing; require blanketing or filtering of sand seams; armor the intake and outfall; fill the drainage ditch downstream of the spillway; construct upstream impervious blankets at the abutments; and prioritize routine maintenance. The goal is to incorporate the recommendations in the preconstruction engineering and design to reduce the risk of the project to the downstream population.

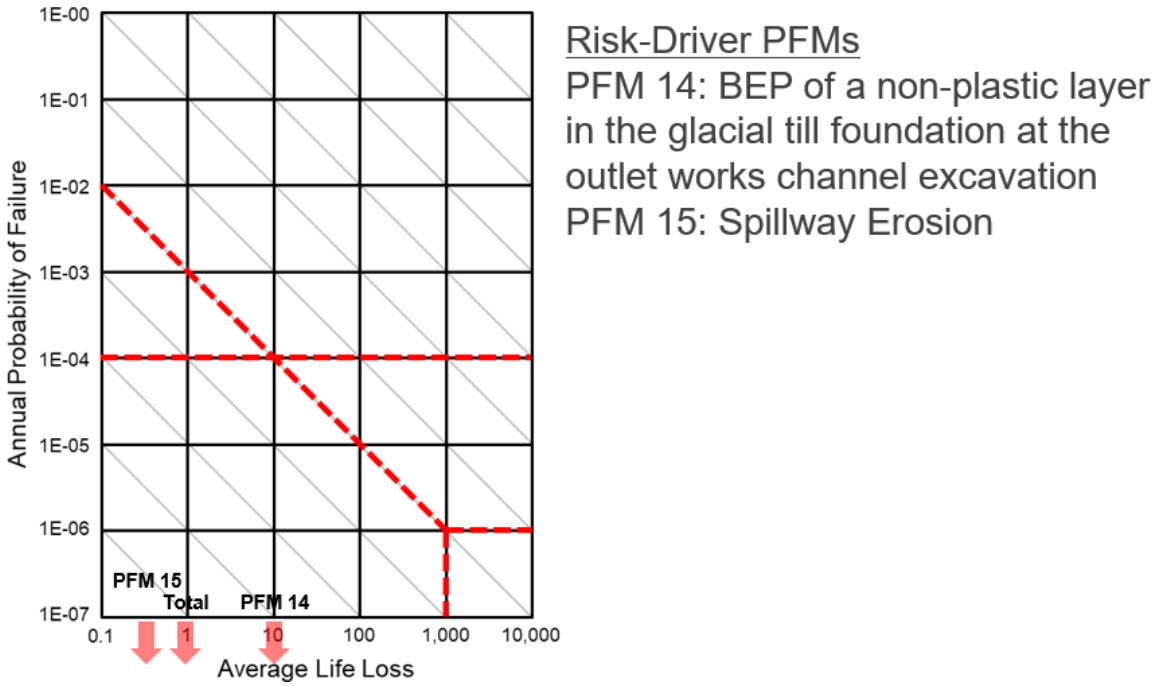



**Figure 47. DS10 Life Safety Risk Matrix**

#### 4.11.3.3 Dam Site 19

The abbreviated SQRA performed by the Omaha District did not identify any potential failure modes that would prevent Papillion Creek Dam Site 19 from meeting the tolerable risk and essential USACE guidelines. It should be noted that significant design changes, changes in the permanent reservoir pool or changing the embankment, outlet works or spillway design will require an updated dam safety SQRA to determine whether the design changes result in significant changes to risks of the project.

As with dry Dam Site 10, only two of the 25 potential failure modes identified in preliminary brainstorming of possible performance issues were carried forward for development and consideration as "primary risk drivers" for the DS19 dam. These potential failure modes are: (1) backwards erosion piping (BEP) in the Red Cloud Formation through the left abutment (PFM 14); and (2) spillway erosion (PFM 15). Each of these potential failure modes is summarized here but additional detail can be found in Appendix L.

For PFM 14, there is a potential that during construction of the dam the excavation for the outlet works stilling basin could remove enough of the Kansan glacial till to cause blowout of the confining layer or exposure of a foundation layer composed of poorly graded sands or silty sands susceptible to BEP. However, it is unlikely that there is an upstream exposure of the Red Cloud Formation, limiting the flow required for progression of BEP, and since the duration of the pool loading is relatively short (2 days and 14 hours above the NHP). Based on the geology, global gradients through the foundation (0.09 ft/ft at TAS) are too low to initiate and progress BEP to breaching the abutment so the probability of this failure mode is very low.

For PFM 15, there is risk the unlined, earth-cut emergency spillway could erode due to high flow velocities (up to 15 ft/sec). However, erosion would have to cut through approximately 1,072

feet of abutment soil within a relatively short duration (12 hours) to breach the spillway crest. In addition, hydraulic modeling of the breach show that the resulting breach discharge has minimal incremental inundation and loss of life consequences compared to design spillway flows which would have already been occurring prior to the breach (non-breach).

Results from the SQRA are presented on the f/N Life Safety Risk Matrix shown as Figure 48. PFM 15 plots off of the chart due to the probability being less than 1 x $10^{-7}$, and PFM 14 and Total Risk plot at the bottom of the chart. In addition to performing the SQRA assessment, the SQRA team made several recommendations to address deficiencies in the preliminary design for DS19 including: perform additional borings, site characterization and lab testing; require blanketing or filtering of sand seams; armor the stilling basin; install additional piezometers; prioritize routine maintenance; and construct upstream impervious blankets at the abutments.

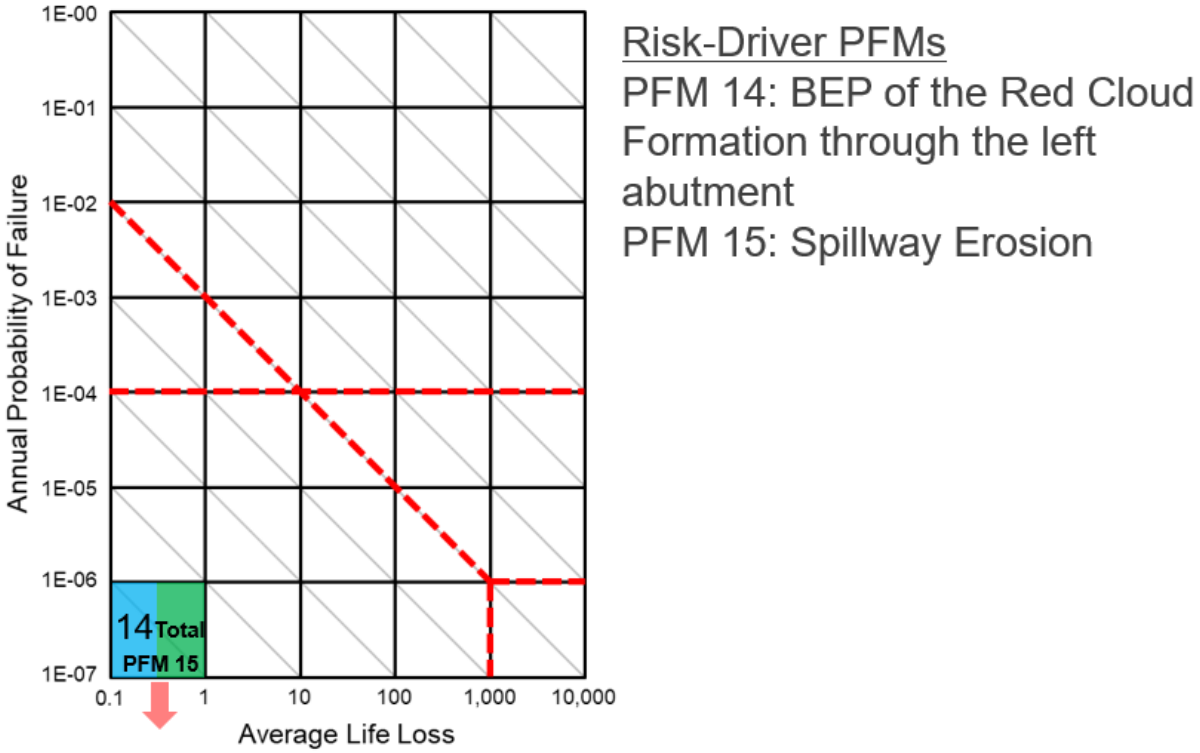



**Figure 48. DS19 Life Safety Risk Matrix**

### 4.11.4 Environmental Mitigation Plan

The Recommend Plan necessitates the removal of 23.5 acres of riparian forest habitat for dam construction, reservoir inundation and levee/floodwall construction and would require replacement. 31.8 acres of tree plantings would occur within the boundaries of the normal operating pool and maximum operating pool of DS19 and 3 acres of trees would be planted at DS10. Estimated costs for mitigation of the total 34.8 acres of riparian forest habitat were calculated to approximately $405,264. Additionally, 0.35 acres of palustrine emergent (PEM) wetlands would be directly filled from embankment construction of DS19, resulting in the restoration of 1.4 acres of PEM wetlands through the excavation of shallow areas connected to

the edge of the normal pool area of DS19. Costs associated with PEM wetland mitigation are estimated at $54,147 for excavation and seeding. Impacts from converting a stream to a lacustrine system would also require mitigation; this would be accomplished by planting a 100-foot wide buffer of native prairie and wetland plants along each side of the Little Papillion creek for 1,000 feet and planting a 100-foot wide buffer along both sides of South Papillion Creek for 1,200 feet. This would result in 10.1 mitigation acres for stream impacts at an estimated cost of $151,480. Total mitigation costs were estimated at $610,891 (Table 47). Mitigation requirements were determined through analysis utilizing the Nebraska Stream Condition Assessment Procedure and the Brown Thrasher Habitat Evaluation Procedure and may be found in Appendix H1. A "Green Sheet" outlining the environmental commitments of the project to ensure all required environmental compliance and mitigation requirements are carried forward through design and construction is available in Appendix H6.

**Table 47. Environmental Mitigation Plan**

| Impact Location | Habitat Type Impacted | Acres Impacted | Acres Replaced | Mitigation Location | Cost / Acre | Total RE Cost | Excavation Cost ($9.09/CY) | Seeding / Planting Cost/Acre | Total Implementation Cost | Total Mitigation Cost |
|---|---|---|---|---|---|---|---|---|---|---|
| DS10 | Stream | 4.6 | 4.6 | DS10 | $18,392 | $84,603 | | $1,800 | $8,280 | $92,883 |
| DS10 | Riparian Forest | 2 | 3 | DS10 | $18,392 | $55,176 | | $10,060 | $30,180 | $85,356 |
| DS19 | Stream | 5.5 | 5.5 | DS19 | $8,854 | $48,697 | | $1,800 | $9,900 | $58,597 |
| DS19 | Riparian Forest | 19.5 | 29.5 | DS19 | | | | $10,060 | $296,770 | $296,770 |
| DS19 | PEM Wetland | 0.35 | 1.4 | DS19 | | | $50,413 | $2,667 | $3,734 | $54,147 |
| Little Papio | Riparian Forest | 2 | 2.3 | DS19 | | | | $10,060 | $23,138 | $23,138 |
| **Total** | | **33.95** | **46.3** | | | **$188,476** | | | **$372,002** | **$610,891** |

### 4.11.5 Monitoring and Adaptive Management

After initial construction activities are complete, monitoring and adaptive management are necessary to address uncertainties and ensure project success. Success criteria were defined based on specific hypotheses, which were formed based on the goals of the project. Monitoring activities were identified to determine whether the project has met these success criteria and adaptive management actions were designed to redirect the restoration effort in the event the restored areas do not perform as predicted.

The goal of monitoring is to assess project performance and to determine if the goals of the project are being attained. Monitoring methodology, measures for ecological successes, and other information are available in greater detail in Appendix H5.

Monitoring is estimated to cost $5,400 per year for the five-year monitoring period for an estimated total of $27,000 needed for five years of post-construction monitoring. This is

part of the total project cost shared between the USACE and the non-Federal sponsor. Implementation responsibilities for the monitoring plan will be identified in the Project Partnership Agreement developed for the design phase.

The adaptive management (contingency) plan assumes potential minor project adjustments, in accordance with the moderate scale of the project. The nature and cost of potential adjustment measures assumes replanting failed vegetation, approximately 5 percent of the total mitigation implementation costs ($372,002), at a cost of approximately $18,600. These costs will be further refined in the Design and Implementation phase. Adaptive management for mitigation for the Papillion GRR may anticipate potential re-planting costs in the event of failed establishment, or potentially the need to refine grading within the wetland areas. There is minimal concern for requiring significant adaptive management measures for plantings.

These adjustment measures would be dependent on appropriations from Congress and on the rules applicable at that time regarding funding of adjustment measures. Corps project closeout would occur 4 to 5 years after completion of construction, under the expected scenario that monitoring indicates that ecological success had been reasonably achieved. See Appendix H5 for additional detail.

### 4.11.6 Recreation Features for the Recommended Plan

The construction of DS19 would provide recreational opportunities in addition to flood risk management (Figure 49). The recreational features and opportunities associated with DS19 would be similar to those at other existing reservoir sites in the Papillion Creek watershed. Recreational opportunities would include fishing, canoeing, hiking, biking, and picnicking. A conceptual design of the recreational features is shown in the mockup from HDR provided by the NRD. There would be 74 acres available for boat fishing and canoeing. There would also be two public access areas at the site: South Access Area and Giles Road Access Area. The South Access Area Road can be accessed from 192nd Street and is located on the west side of 192nd Street and south of Giles Road. The Giles Road Access Area is located south of Giles Road across from the 194$^{th}$ Street intersection and via a separate entrance from a public frontage road. Recreational features at the South Access Area and Giles Road Access Area include the following:

**South Access Area**

- Concrete lot with 20 boat trailer and 30 vehicle parking stalls
- 2-lane, concrete boat ramp, extending to below normal pool (slope varies, with maximum of 13 percent), with a removable boat access dock mounted on rails between lanes of boat ramp
- Picnic shelter and tables
- Vault restroom
- Photocell solar lighting

**Giles Road Access Area**

- Concrete lot with 6 kayak trailer and 15 vehicle parking stalls
- Vault restroom
- Photocell solar lighting

**Recreation Trail**

A 10-foot wide, 2.5-mile loop multi-purpose recreational trail would be designed around the pool for walking, running, and biking. New signage, directional signs, and interpretive features would be displayed throughout the site.

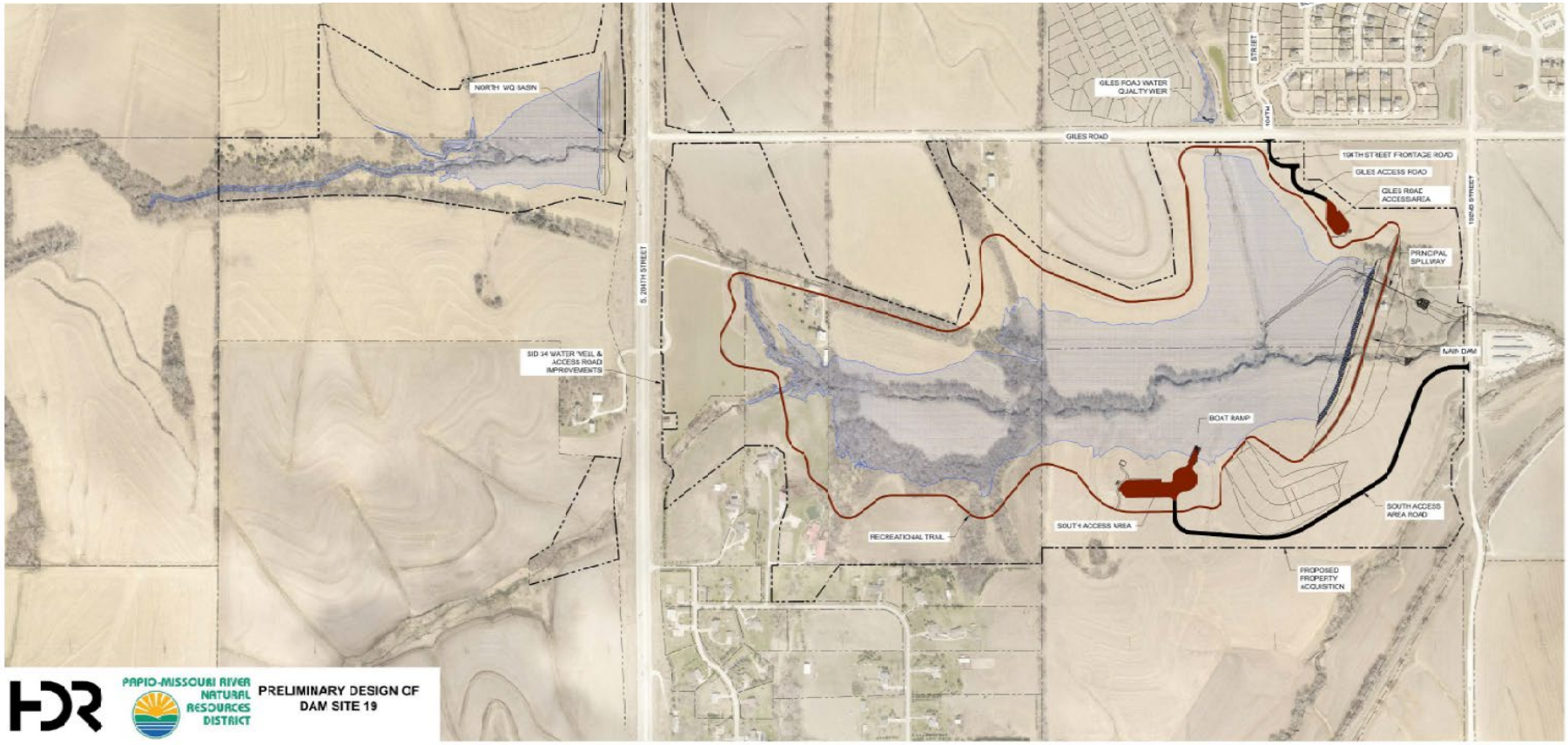



**Figure 49. Preliminary Recreational Concept at Dam Site 19**

### 4.11.7 Real Estate Requirements for the Recommended Plan

The Real Estate Plan (see Appendix J) has been prepared in accordance with Chapter 12 of ER 405-1-12 and will identify and describe all lands, easements, relocations, rights-of-way, and disposals (LERRDs) for the construction, operation, and maintenance of each of the three composite project areas that make up the overall study area. The Real Estate Plan is for planning purposes as of this study and the final real property acquisition lines and the real estate cost estimates provided are subject to change as the project is approved and moves into design and construction. It is anticipated there will be displaced persons, residences, farms, or businesses entitled to relocation assistance as defined in the Uniform Relocation Assistance and Real Property Acquisitions Policies Act of 1970, as amended (P.L. 91-646) required for this project. The project areas requiring real estate needs are the Little Papillion Creek from Western Ave to Saddle Creek and two proposed reservoirs, DS10 and DS19.

- **New Levee/Floodwall on Little Papillion Creek –** A new levee and floodwall are being proposed from Western Ave. to Saddle Creek along Little Papillion Creek as shown in Figures 50 - 55. The length of this alternative is 3.67 miles (right bank) and 2.98 miles (left bank). The new levee/floodwall would cover 3.54 acres of fee and 26.69 acres of levee/floodwall easements from 95 property owners. There will be fee acquisitions for parcels due to loss of economic use and mitigation and permanent flowage easements required for this work. Environmental impacts to riparian forest habitats along the corridor of the new levee/floodwall will require mitigation on an additional 2.3 acres of fee which will be located in the DS19 alternative footprint.
- **DS10 –** A new dry dam is being proposed that will be located to the northwest of the intersection of Highway 36 and Highway 133 in Douglas and Washington Counties as shown in Figure 56. The dry dam would cover 48.48 acres in fee and 336.09 acres in permanent flowage easements from 46 property owners. There are 9 parcels within the flood control pool that will be acquired due to the project. These 9 parcels are map numbers 1, 2, 6, 8, 9, 14, 21, 22, and 23 on Figure 56. During the design phase, further refinements will be evaluated to reduce the impacts to these properties as much as possible. Environmental impacts to wetlands and riparian forest habitats in the footprint of the dam and spillway will require mitigation on an additional 7.6 acres of fee lands covered in the DS10 project footprint.
- **DS19 –** A new wet dam is being proposed that will be located to the southwest of the intersection of 192$^{nd}$ Street and Giles Road in Sarpy County as shown in Figure 57. The wet dam would cover 214.61 acres in fee of which 41.8 are for the dam and spillway, 187.17 for the permanent reservoir pool, and 59.96 acres in permanent flowage easements from 51 property owners. Environmental impacts to wetlands and riparian forest habitats in the footprint of the dam and in creation of a multipurpose reservoir will require mitigation on 38.7 acres of fee lands. A total of 33.2 acres of the 38.7 acres of required mitigation would occur on land between the multipurpose pool and the top of the floodpool that would already be acquired in fee for construction of the dam and reservoir. Included in the 33.2 acres of mitigation is the 2.3 acres of mitigation required for riparian forest impacts that would occur along Little Papillion Creek as a result of the new levee/floodwall construction. The remaining 5.5 acres of mitigation at DS19 would occur

on an additional 5.5 acres of fee that would not otherwise be acquired for construction of the dam and reservoir.

Shapefiles of existing utilities were provided by Metropolitan Utilities District (MUD) and Omaha Public Power District (OPPD). MUD handles water and natural gas services in the Omaha area and OPPD provides electrical services. Information on sanitary sewer and stormwater sewer systems was not provided. While the available data may not be all inclusive of the existing utilities in and near the project footprint, they were used to determine a best estimate of the utilities that will be encountered during construction. However, due to the uncertainty in the presence of existing utilities, this concern was added as a risk in the CSRA. Some of these utilities may be able to be relocated outside the project footprint, while others may need to be addressed and incorporated during the design phase of the project.

No utilities were found in the construction areas for DS10 or DS19 to be considered for relocation. Water, gas, and electrical lines were found in the Little Papillion project footprint and will be avoided or relocated. For the levee and floodwall, seepage, slope stability, bearing capacity, and uplift were evaluated (see the geotechnical Appendix C for further details). Modifications to existing interior drainage culverts was not considered at this stage of the process. During the design phase, the surface runoff and interior drainage will need to be evaluated which may result in the modification of existing culverts or additional of new drainage culverts. Closure structures are planned to provide continuous risk reduction across the roadways. See Appendix D – Structural for more information on closure structures.

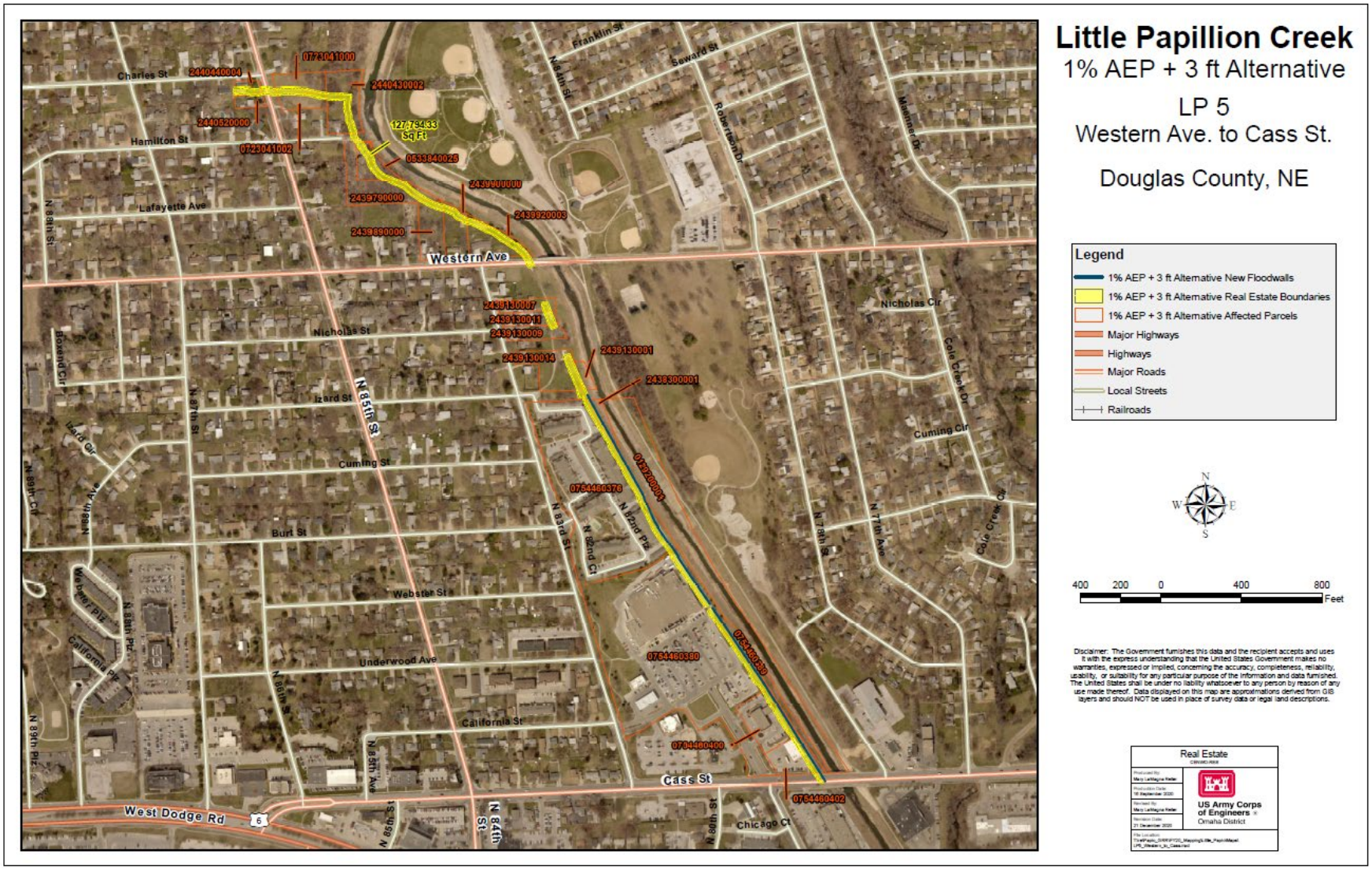



**Figure 50. Required Real Estate for Little Papillion – Western Ave to Cass St**

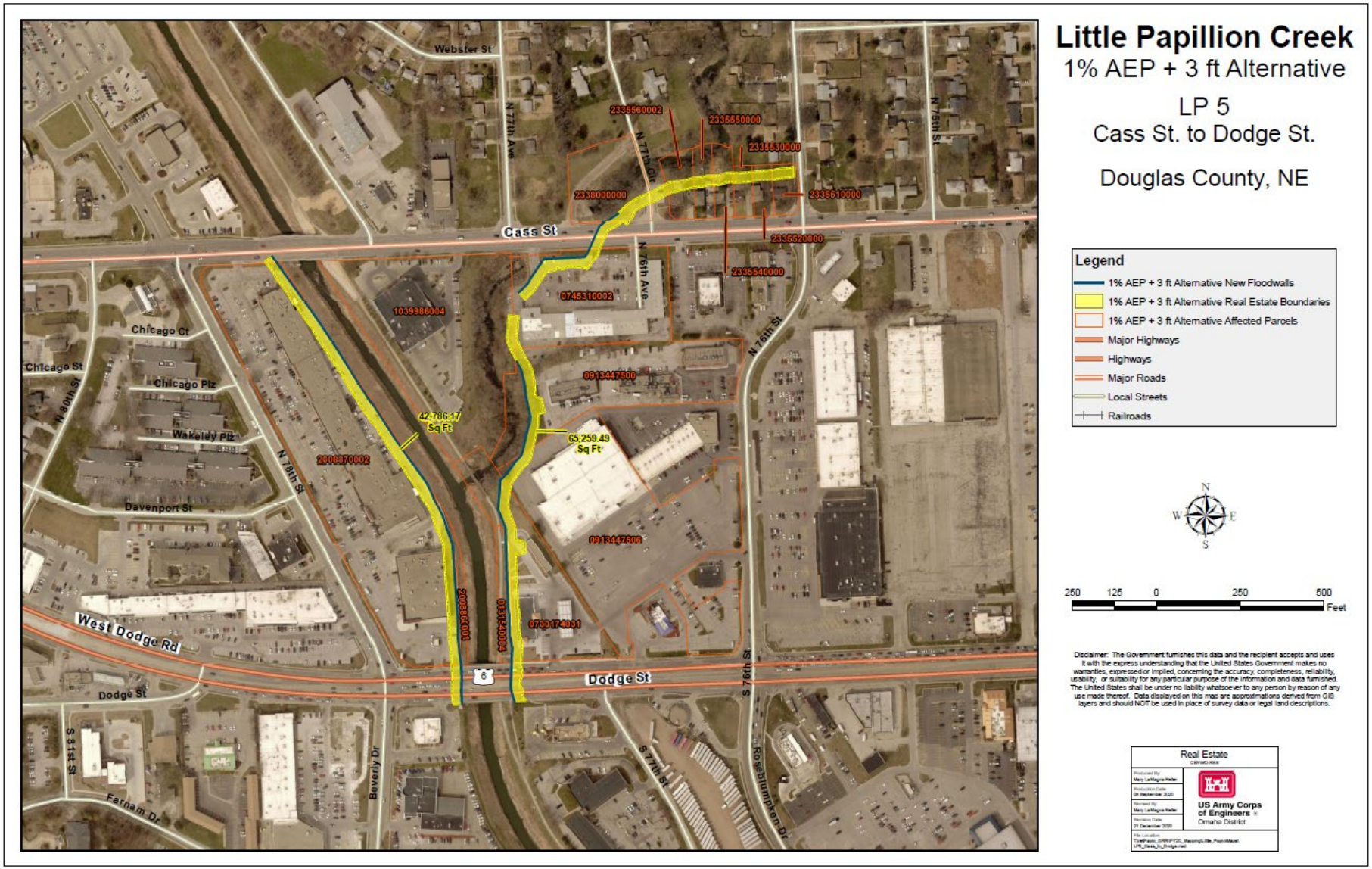



**Figure 51. Required Real Estate for Little Papillion – Cass St to Dodge St**

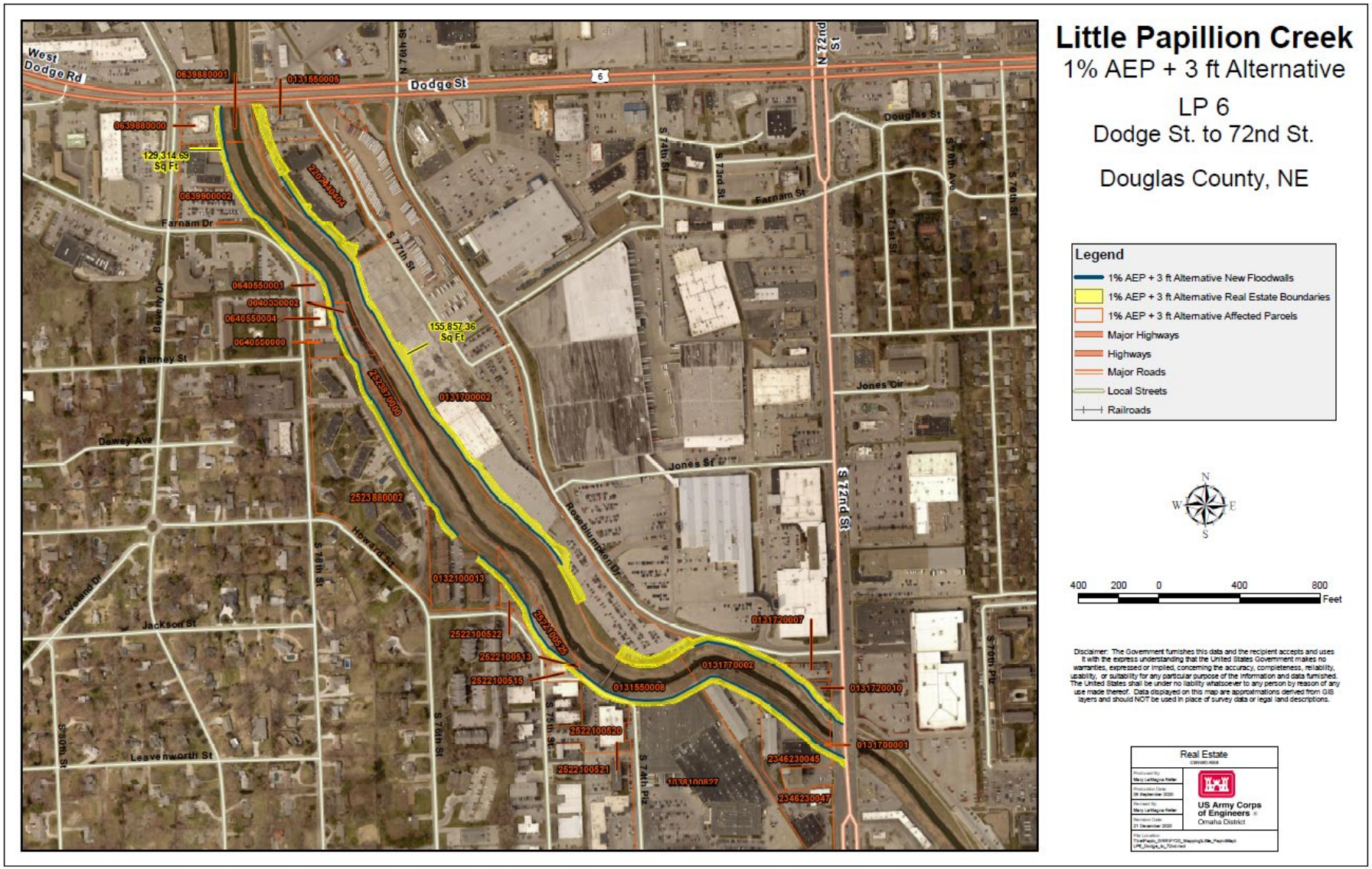



**Figure 52. Required Real Estate for Little Papillion – Dodge St to 72nd St**

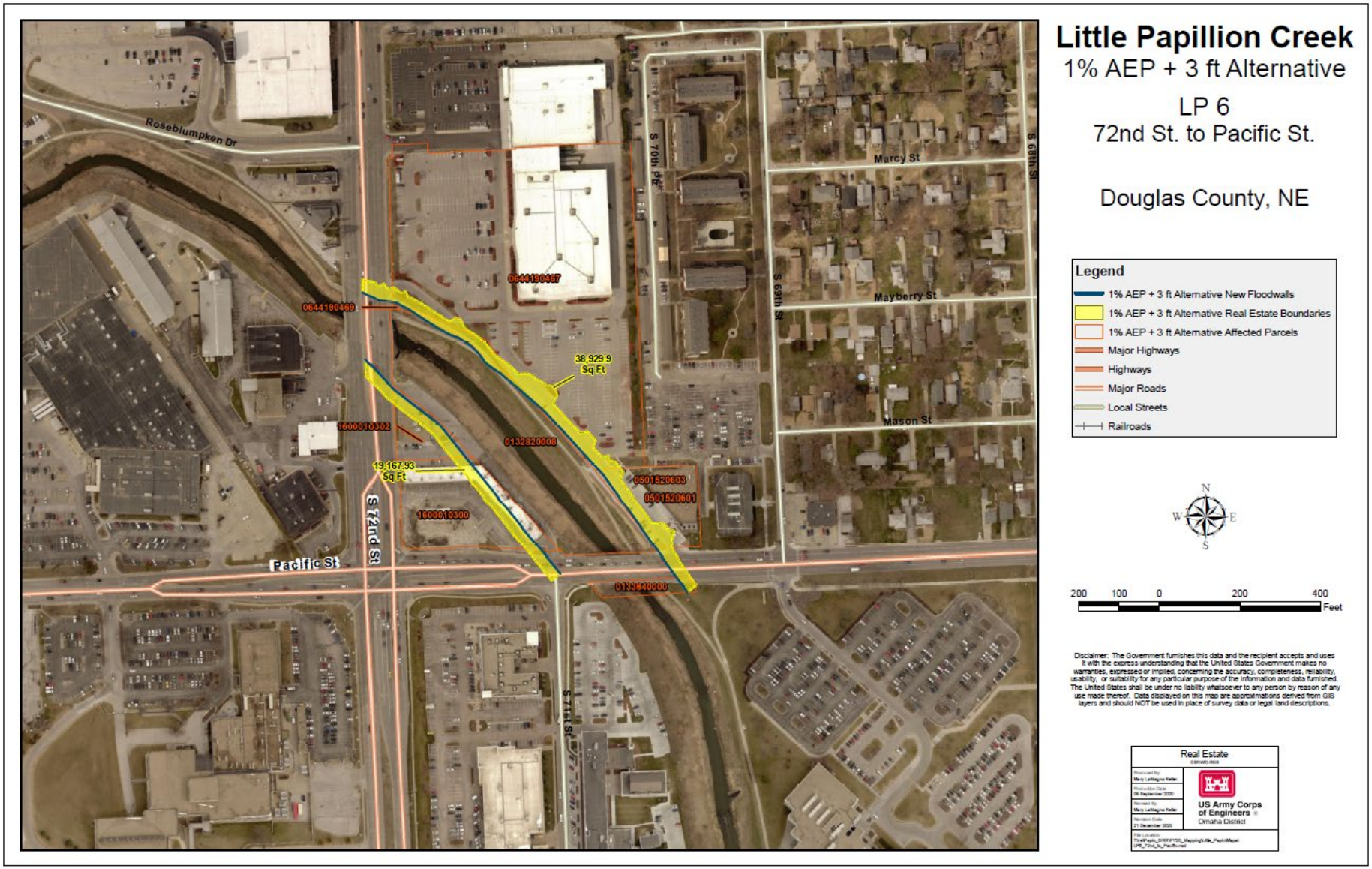



**Figure 53. Required Real Estate for Little Papillion – 72nd St to Pacific St**

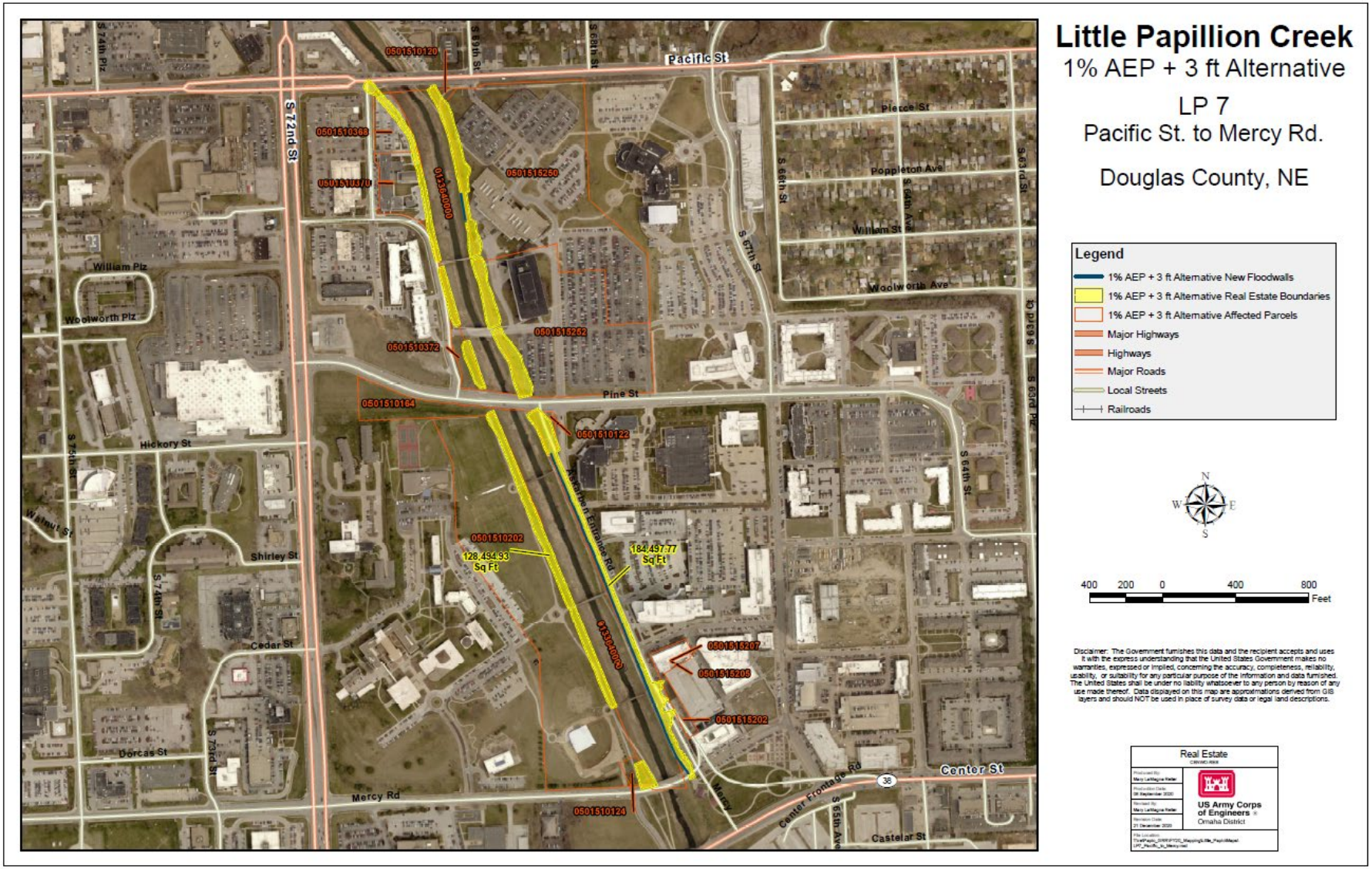



**Figure 54. Required Real Estate for Little Papillion – Pacific St to Mercy Rd**

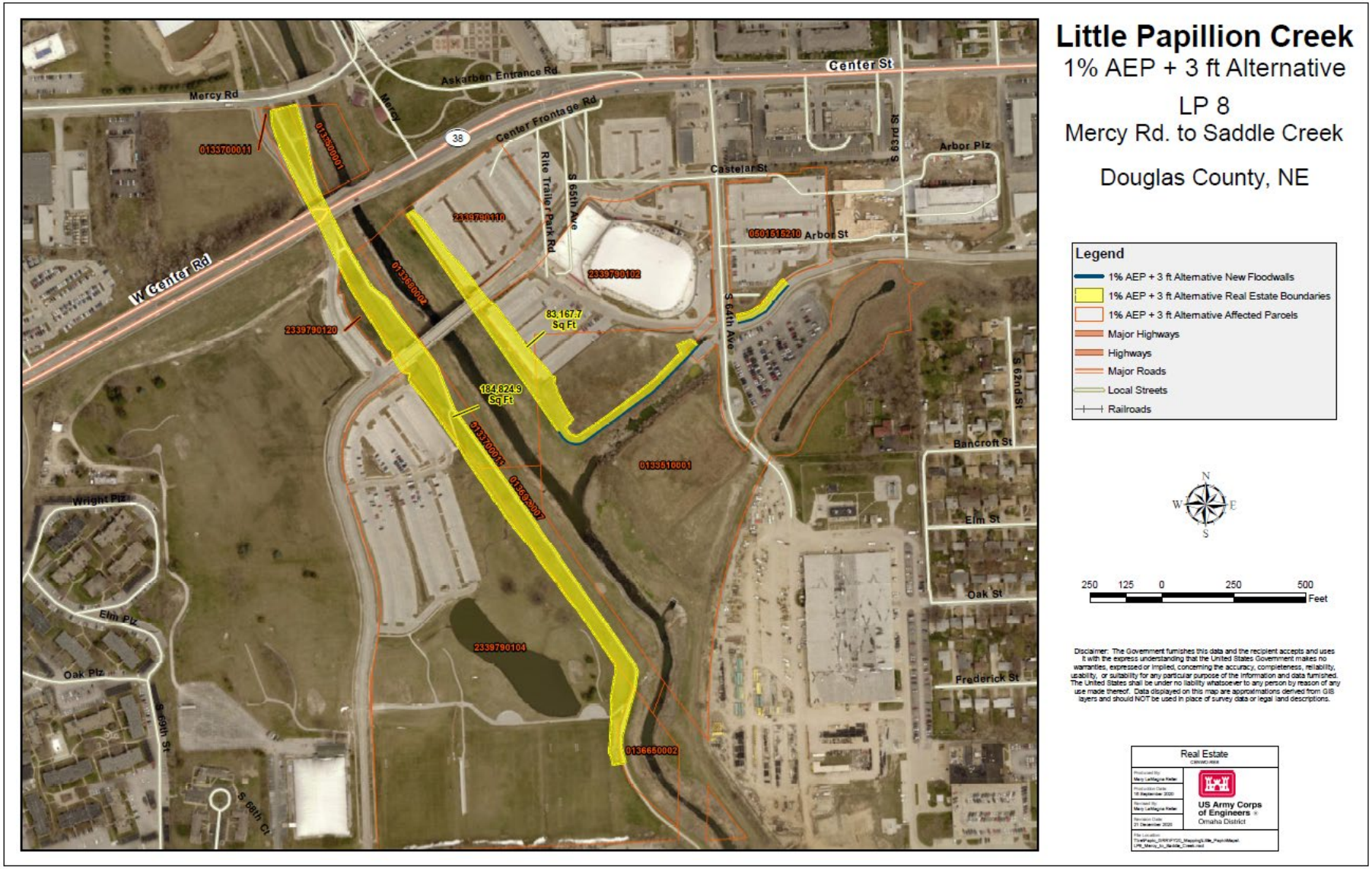



**Figure 55. Required Real Estate for Little Papillion – Mercy Rd to Saddle Creek**

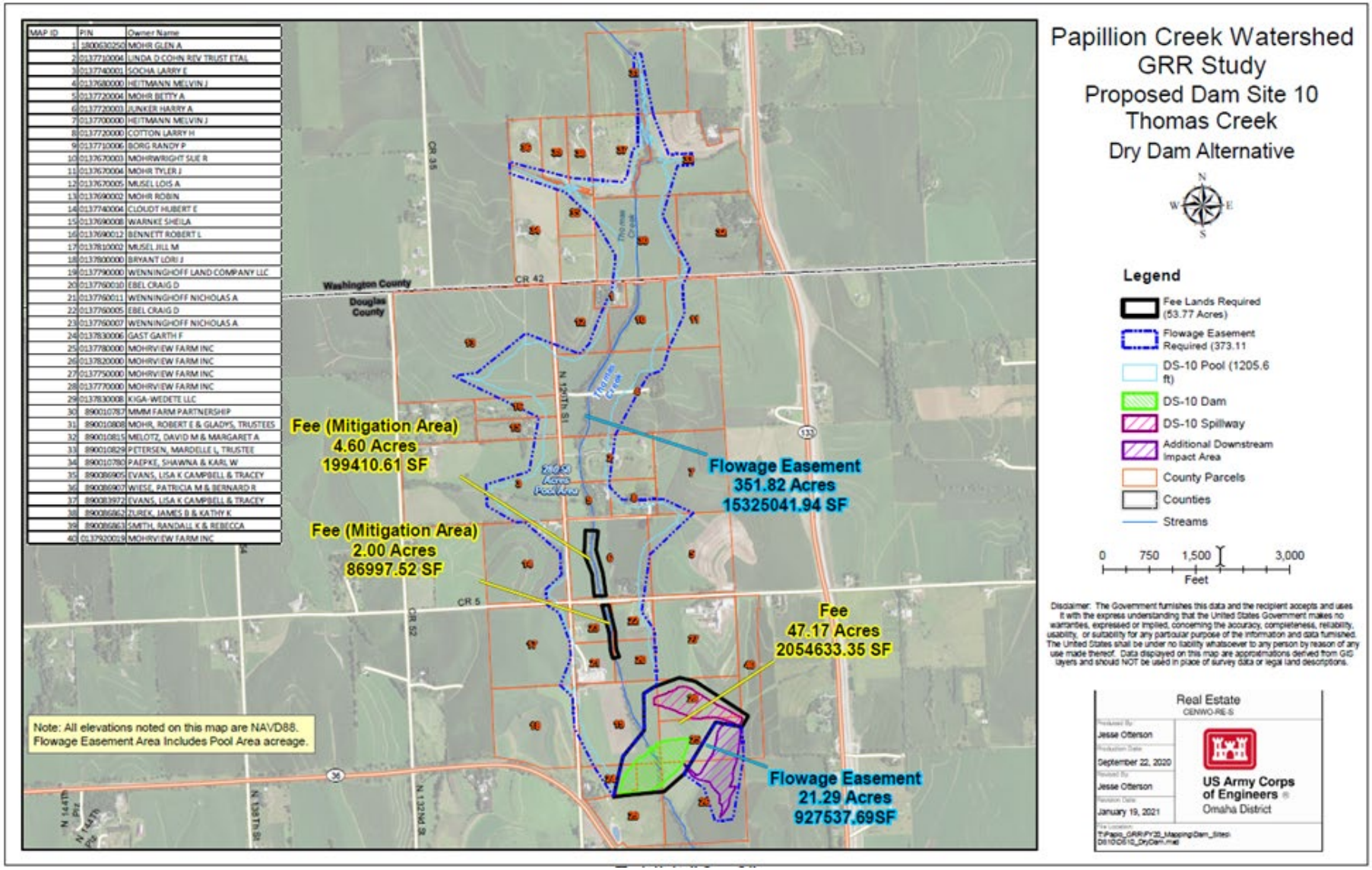
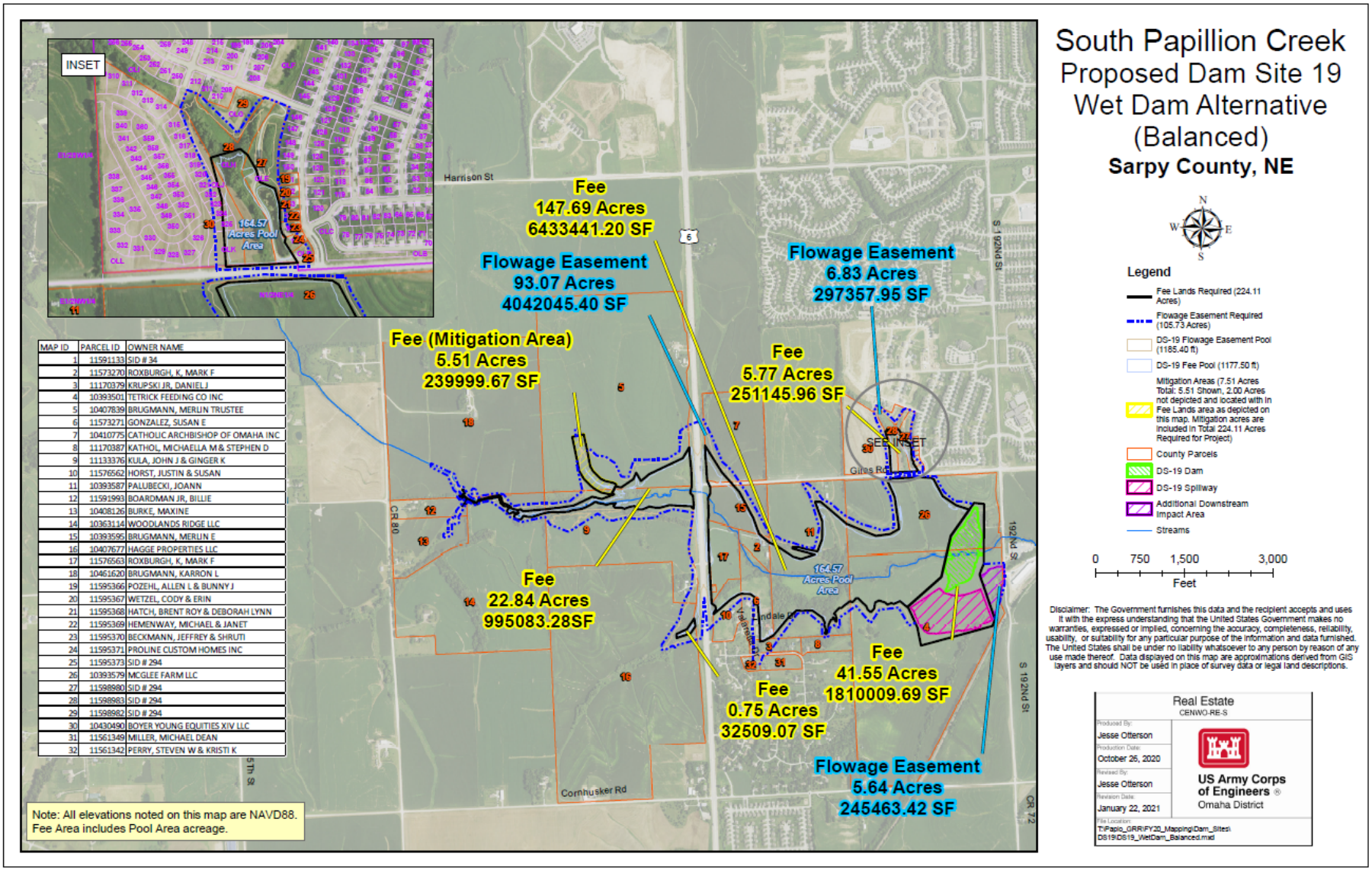



**Figure 56. Required Real Estate for DS10**




| MAP ID | PARCEL ID | OWNER NAME |
|---|---|---|
| 1 | 11591133 | SID # 34 |
| 2 | 11573270 | ROXBURGH, K, MARK F |
| 3 | 11170379 | KRUPSKI JR, DANIEL J |
| 4 | 10393501 | TETRICK FEEDING CO INC |
| 5 | 10407839 | BRUGMANN, MERLIN TRUSTEE |
| 6 | 11573271 | GONZALEZ, SUSAN E |
| 7 | 10410775 | CATHOLIC ARCHBISHOP OF OMAHA INC |
| 8 | 11170387 | KATHOL, MICHAELLA M & STEPHEN D |
| 9 | 11133376 | KULA, JOHN J & GINGER K |
| 10 | 11576562 | HORST, JUSTIN & SUSAN |
| 11 | 10393587 | PALUBECKI, JOANN |
| 12 | 11591993 | BOARDMAN JR, BILLIE |
| 13 | 10408126 | BURKE, MAXINE |
| 14 | 10363114 | WOODLANDS RIDGE LLC |
| 15 | 10393595 | BRUGMANN, MERLIN E |
| 16 | 10407677 | HAGGE PROPERTIES LLC |
| 17 | 11576563 | ROXBURGH, K, MARK F |
| 18 | 10461620 | BRUGMANN, KARRON L |
| 19 | 11595366 | POZEHL, ALLEN L & BUNNY J |
| 20 | 11595367 | WETZEL, CODY & ERIN |
| 21 | 11595368 | HATCH, BRENT ROY & DEBORAH LYNN |
| 22 | 11595369 | HEMENWAY, MICHAEL & JANET |
| 23 | 11595370 | BECKMANN, JEFFREY & SHRUTI |
| 24 | 11595371 | PROLINE CUSTOM HOMES INC |
| 25 | 11595373 | SID # 294 |
| 26 | 10393579 | MCGLEE FARM LLC |
| 27 | 11598980 | SID # 294 |
| 28 | 11598983 | SID # 294 |
| 29 | 11598982 | SID # 294 |
| 30 | 10430490 | BOYER YOUNG EQUITIES XIV LLC |
| 31 | 11561349 | MILLER, MICHAEL DEAN |
| 32 | 11561342 | PERRY, STEVEN W & KRISTI K |

**Figure 57. Required Real Estate for DS19**

### 4.11.8 Cost and Benefit Summary of the Recommended Plan

The Recommended Plan includes structural alternatives of South Papillion Dam Site 19 (wet dam), Little Papillion Creek Dam Site 10 (dry dam) and levee/floodwall; nonstructural alternatives addressing 386 structures on Big Papillion Creek, Little Papillion Creek, Papillion Creek, Saddle Creek, South Papillion Creek, and West Papillion Creek; and recreation features on DS19. All costs include IDC computations that assume a 5-year construction period, except for the nonstructural component which assumes a 3-month construction period as required by Planning Bulletin 2019-03. All costs reflect an FY 2021 price level, the current Federal discount rate of 2.5%, and a 50-year period of analysis. Annual costs for OMRR&R are added to the annualized investment and IDC costs to determine the total average annual costs. Total annual costs are $5.4M (Table 48). These numbers are estimated at the fully funded cost of the project through completion. The benefits show positive net annual benefits of $2.9M and a BCR of 1.52 for the combined structural plan, nonstructural plan, and recreations features shown in Table 49.

**Table 48. Recommended Plan with Recreation Costs (FY21 Price Level)**

| Recommended Plan with Recreation | South Papillion DS19 (with Recreation) | Thomas Creek DS10 | Little Papillion Levee / Floodwall | Nonstructural | Total |
|---|---|---|---|---|---|
| Construction Cost | $12,697,337 | $8,679,148 | $20,568,254 | $27,099,412 | $69,044,151 |
| PED | $1,294,196 | $870,522 | $2,058,394 | $2,709,941 | $6,933,054 |
| S&A | $1,035,357 | $696,418 | $1,646,715 | $2,167,953 | $5,546,443 |
| Contingency | $4,734,169 | $3,184,371 | $7,529,606 | $9,912,965 | $25,361,110 |
| Total Construction Costs | **$19,761,058** | **$13,430,459** | **$31,802,969** | **$41,890,271** | **$106,884,757** |
| LERRD | $5,959,516 | $7,015,744 | $13,980,258 | $0 | $26,955,518 |
| Mitigation[1] | $244,622 | $26,075 | $15,687 | $0 | $286,384 |
| **Total First Costs[2]** | **$25,965,196** | **$20,472,278** | **$45,798,914** | **$41,890,271** | **$134,126,659** |
| IDC | $1,434,063 | $1,277,290 | $2,748,949 | $129,579 | $5,589,881 |
| Total Investment Costs | $27,399,259 | $21,749,568 | $48,547,863 | $42,019,850 | $139,716,540 |
| Annualized Investment Costs | $966,045 | $766,848 | $1,711,703 | $1,481,538 | $4,926,134 |
| Annual OMRR&R Costs | $301,767 | $179,307 | $15,092 | $0 | $496,167 |
| Annual Monitoring Costs | $729 | $82 | $73 | $0 | $885 |
| **Total Annual Costs** | **$1,268,541** | **$946,237** | **$1,726,869** | **$1,481,538** | **$5,423,185** |

Notes: 2.5% discount rate

[1] Includes PED, S&A, and Contingency

[2] [1]Total Construction Costs include the Facility/Utility Relocations total of $2,382,331 from the Real Estate Plan (Appendix J). Total Real Estate Costs = LERRD + relocations = $29,337,848.

**Table 49. Recommended Plan with Recreation Benefits**

| Alternative | First Costs | Average Annual Costs | Average Annual Benefits | BCR | Average Annual Net Benefits |
|---|---|---|---|---|---|
| Final Plan with Recreation | $134,126,660 | $5,423,590 | $8,213,690 | 1.51 | $2,790,510 |

### 4.11.9 Recommended Plan Accomplishments

In reviewing the planning objectives developed for this feasibility report, all objectives were met in formulation of the Recommended Plan. Problems were identified and potential structural and nonstructural alternatives that would alleviate flooding risks within the study area were developed and evaluated. Coordination efforts with NRD took place throughout the study, considering the non-Federal sponsor's goals, to identify the Recommended Plan. Based on NRD's input and Omaha District evaluations, the social and economic effects of the Recommended Plan will continue to be positive. The most important effect of implementation of the Recommended Plan would be reduced flood risk for 181 square miles of mostly urban development, which includes a total of 4,300 structures and a population of 207,000. It is important to note that the economic analysis completed as part of this study evaluated NED benefits from flood risk management only before adding recreation benefits.

#### 4.11.9.1 National Economic Development (NED)

The Recommended Plan reduces equivalent annual damages from $14,434,470 under future without-project conditions to $7,026,580 with project. The difference between the future without project and with project condition represents total annual benefits of $7,407,890 resulting from the proposed structural and nonstructural flood risk management measures. When compared to total annual costs of $5,156,420 the resulting benefit-cost ratio is 1.44. The combined flood risk management plan measures, which are individually justified, generate a benefit-to-cost ratio above unity, and produce $2,251,470 in annual net benefits to the Nation. Therefore, the Recommended Plan is economically viable and is also the NED plan for flood risk management.

The Dam Site 19 reservoir component of the Recommended Plan also includes complementary recreation features. The annual benefits from these features total $805,801. Compared against $266,765 in the total annual costs required to construct and maintain these features, the recreation component is also economically viable producing $539,036 in net annual benefits and a benefit-cost ratio of 3.02; and is the NED plan for recreation.

The final combined Recommended Plan, including recreation, produces $8,213,690 average annual benefits. When compared against the average annual costs totaling $5,423,190, the Recommended Plan results in a total of $2,790,510 in annual net benefits to the Nation with a benefit-cost ratio of 1.51. The Recommended Plan is also identified as the NED Plan.

### 4.11.9.2 Environmental Quality (EQ)

A summary of potential impacts on natural resources for each stream was identified based on the Recommended Plan to ensure that the EQ Account is taken into consideration for the NED and not adversely impacted.

South Papillion Creek: Implementation of DS19 would result in permanently converting approximately 9,100 linear feet of stream to an open water resource when the dam would be operated at the maximum pool level. This would alter hydraulic conveyance, sediment transport dynamics, in-stream habitat and surrounding riparian vegetation.

Thomas Creek: Construction of DS10 would alter hydraulic conveyance and sediment transport dynamics, as well as in-stream habitat and adjacent riparian vegetation.

Little Papillion Creek: New levee and floodwall construction on the Little Papillion Creek would result in the removal of a strip of vegetation up to 70 feet wide and running the entire length of the proposed levee/floodwall alignment on both sides of the creek. It should also be noted that there are several areas along the Little Papillion Creek where the new levee footprint could extend into areas that are currently concrete parking lots or sidewalks. Levee construction in these areas would result in more vegetated grassy areas and reduce impervious surfaces adjacent to the creek.

NeSCAP and HEP environmental analysis procedures were used to determine potential impacts to the environment of the Papillion Creek basin that would occur with the construction of the Recommended Plan. Based on these analyses it was determined that the impacts to stream condition and function, riparian forest habitat, and wetlands resultant from construction of the Recommended Plan would require mitigation and a compensatory mitigation plan is included as part of the Recommended Plan. Total mitigation acreages by alternative location are shown below.

**Table 50. Total Mitigation Acreages**

| Impact Location | Habitat Type Impacted | Acres Impacted | Acres Replaced |
|---|---|---|---|
| DS10 | Stream | 4.6 | 4.6 |
| DS10 | Riparian Forest | 2 | 3 |
| DS19 | Stream | 5.5 | 5.5 |
| DS19 | Riparian Forest | 19.5 | 29.5 |
| DS19 | PEM Wetland | 0.35 | 1.4 |
| Little Papio | Riparian Forest | 2 | 2.3 |
| **Total** | | **33.95** | **46.3** |

With mitigation, the Recommended Plan is not anticipated to cumulatively degrade the habitat or current resources within the basin due to its present, altered condition. Other adverse effects associated with the Recommended Plan are expected to be short-term and minor, primarily limited to construction activities.

#### 4.11.9.3 Regional Economic Development (RED)

The Principles and Guidelines (1983) established the RED account to register changes in the distribution of regional economic activity that result from each alternative plan. In addition to the benefits accounted for within the NED account, the implementation of the Recommended Plan would result in local economic activity which is accounted for within the RED account.

The USACE Regional Economic System (RECONS) is a regional economic impact modeling tool that was developed to provide accurate and defendable estimates of regional economic impacts associated with USACE spending. It is the only USACE certified Regional Economic Development model for agency wide use. RECONS incorporates impact area data, as well as multipliers, direct ratios (jobs to sales, income to sales, etc.), and geographic capture rates to estimate jobs, labor income, and other critical impacts to the local, state, and national economy.

The Recommended Plan is expected to result in approximately $107,170,094 in construction expenditures across the region. These expenditures are expected to occur during construction of the project. These construction expenditures are expected to support approximately 1,697 local jobs and approximately $114,061,171 in local value added within local impact area.

#### 4.11.9.4 Other Social Effects (OSE)

Other social effects for the recommended plan include public safety, public health, risk to vulnerable populations, threats to redevelopment, and threats to critical infrastructure. Table 51 summarizes the without and with-project other social effects based on the recommended plan.

A risk assessment was conducted on the recommended Little Papillion Creek levee/floodwall, DS19, and DS10 to inform potential life safety risks associated with their construction. A levee safety assessment of the existing and new levee/floodwall was conducted using the Levee Screening Tool (LST). The purpose of this analysis is to assess the risks of life loss associated with the recommended levee/floodwall compared to existing conditions. The existing conditions expected annual life loss in Little Papillion Creek reaches LP5-LP8 is 0.2860. With inclusion of the recommended levee/floodwall, the expected annual life loss in these reaches is reduced to 0.0021, a reduction of 0.2829 or 99.3 percent.

The abbreviated SQRA performed by the Omaha District did not identify any potential failure modes that would prevent DS10 from meeting the tolerable risk guidelines. The incremental life loss modeled in HEC-LifeSim for a MHP failure from backwards erosion piping ranged from 11 to 14 depending on warning time and exposure with an annual probability of failure between 1E-10 and 1E-09.

The abbreviated SQRA performed by the Omaha District did not identify any potential failure modes that would prevent Papillion Creek Dam Site 19 (DS19) from meeting the tolerable risk guidelines. The incremental life loss modeled in HEC-LifeSim for a TAS failure from backwards erosion piping was 0 for all warning times and exposure with an annual probability of failure between 1E-07 and 1E-06.

**Table 51. Social Factors Comparison**

| Social Factor | No Action | Recommended Plan |
|---|---|---|
| 1. Health and Safety | *Moderate negative effects.* Residents would feel less safe and more apprehensive about living in the study area in the aftermath of a flood. Potential for vector-borne diseases increases during flood events. There is a potential for trauma from extreme flooding events. | *Moderate beneficial effects.* The recommended plan reduces the risk to life safety. The recommended plan reduces the risk of contaminated drinking water and direct harmful contact with contaminated surface water that may occur if flood water inundation mixes with sewer and hazardous industrial substances. Residents may also see reduced chronic stress from worrying about future flooding that can affect mental, emotional, and physical health. |
| 2. Economic Vitality | *Moderate negative effects.* Disruption to the economy, business losses and loss of wages may drag the economy down for some time after flood and contribute to a gradual deterioration of the economy | *Moderate beneficial effects.* In the long-term, the recommended plan's level of risk reduction should improve the confidence of residents and businesses and generate additional interest in redevelopment of storm-damaged neighborhoods. There is also the potential for reductions in onerous flood insurance premiums for those properties that are no longer included in FEMA's 1 percent AEP floodplain. |
| 3. Social Connectedness | *Minor negative effects.* Disruption and loss of valued personal relationships may create feelings of loss and disconnectedness from neighborhoods. | *Minor beneficial effects.* Community's social networks within which individuals interact; these networks provide significant meaning and structure to life |
| 4. Identity | *Minor negative effects.* Flood losses and dislocation may disrupt persons' sense of cultural security and identity and further create negative patterns of disconnectedness. | *Minor beneficial effects.* Community members may become more grounded with a lower risk of flood losses and dislocation leading to a stronger sense of self as members of the community.<br><br>*Minor negative effects.* If the project ultimately requires structures to be bought or relocated outside of the community, those impacted could feel a loss of identity |
| 5. Social Vulnerability and Resiliency | *Minor negative effects*. Elderly, poor, disabled, minorities, and children may suffer greater relative harm and be less likely to bounce back from future floods. | *Minor beneficial effects.* The recommended plan lowers the actual and perceived risk to minority and/or low-income population groups within the study area, who might otherwise consider relocation, thereby increasing the potential for continued community cohesion. |
| 6. Participation | *Negligible effects.* Local modes of decision making, and participation may clash with flood-recovery bureaucratic approaches, leading to mistrust and recriminations | *Negligible effects.* Development of flood damage reduction strategies offers opportunities for increasing local participation and creation of trust. |
| 7. Leisure and Recreation | *Minor negative effects.* Leisure and recreation activities and opportunities may be disrupted by floods. | *Significant beneficial effects.* The amount of leisure time and recreational pursuits would be significantly increased with the recreational features proposed as part of the recommended plan. |

#### 4.11.9.5 Tolerable Risk Guidelines (TRG)

Sections 4.7 and 4.11.3 provide the results of life safety analyses performed on the initial array of alternatives as well as the Recommended Plan. Appendix L, Life Safety Assessment includes a detailed description of the full analysis and results which are summarized here. USACE policy requires all flood risk management projects to analyze how the proposed projects contributes to meeting the four TRGs. Generally, the TRGs represent a method to assess the life safety risks that society is willing to live with in order to secure certain benefits. The Recommended Plan reasonably meets all four TRGs to the extent practicable as outlined below.

TRG 1: The Recommended Plan plots on or below the societal risk line for the Little Papillion Creek levee/floodwall and well below the societal risk line for Dam Site 19 and the dry dam at Dam Site 10. Additional consideration of refinements that contribute to additional levee/floodwall resiliency in the event of overtopping and/or improved warning and evacuation effectiveness will be considered for cost-effectiveness when the project moves into design.

TRG 2: The NRD is very active in working with USACE, FEMA, the National Weather Service, and the USGS to spread awareness of available mapping and maintains a comprehensive electronic flood warning system throughout the Papillion Creek Basin.

TRG 3: The NRD is one of the most active and responsive non-federal levee and dam sponsors in the Omaha District portfolio. They have continuously maintained good status in the levee Rehabilitation and Inspection Program, and quickly respond to correct any deficiencies identified during inspections.

TRG 4: The sponsor actively pursues making their levees NFIP compliant and building non-federal structural and nonstructural flood risk management projects. The NRD developed a long-range implementation plan (LRIP) to help prioritize funding and implementation of flood risk management projects and updates that plan every five years. In addition, they, along with the City of Omaha, have adopted the 2016 Multi-Jurisdictional Hazard Mitigation Plan (HMP), which is a community-guided document that identifies both vulnerability to natural and man-made hazards, and mitigation measures to reduce or eliminate this vulnerability.

### 4.11.10 Residual Risk

Although floodplain users and occupants may desire total protection from flooding, it cannot be overemphasized that this is an unachievable goal. No flood risk management project can guarantee total elimination of flood risk since it is a function of probability and consequences so even though a project may significantly reduce the probability of a flood or the consequences that would result (or possibly both) there is always some chance that an extreme or unforeseen issue results in a flood occurring. Therefore, it is important for floodplain users and occupants to be aware of the level of flood risk that remains even after implementation of a proposed flood risk management project.

The selected plan has substantial economic benefits and reduces without- equivalent annual damages (EAD) by 51 percent throughout the study area. However, several of the tributary streams have much higher reductions ranging from 69 to 78 percent. Even so, there are

significant residual EADs of $1 million to over $3 million in some parts of the basin. The residual EADs and EAD reduction percentages by reach are presented in Table 52.

**Table 52. With Project Residual Equivalent Annual Damages**

| Stream | Without-Project Equivalent Annual Damages | With Structural Only Equivalent Annual Damages | With Combined Project Equivalent Annual Damages | With Project Total Equivalent Annual Damages Reduced | With Project EAD Reduced (Percent) |
|---|---|---|---|---|---|
| West Papillion Creek | $2,120.78 | $1,749.37 | $1,632.06 | $488.71 | 23.0% |
| South Papillion Creek | $1,115.30 | $663.11 | $309.82 | $805.48 | 72.2% |
| Little Papillion Creek | $4,480.16 | $1,011.40 | $1,011.40 | $3,468.77 | 77.4% |
| Thomas Creek | $40.93 | $8.92 | $8.92 | $32.00 | 78.2% |
| Cole Creek | $28.04 | $38.69 | $38.69 | -$10.65 | -38.0% |
| Saddle Creek | $1,077.83 | $1,074.61 | $330.34 | $747.49 | 69.4% |
| Big Papillion Creek | $4,598.13 | $4,314.75 | $3,068.86 | $1,529.29 | 33.3% |
| Papillion Creek | $973.30 | $751.19 | $626.51 | $346.80 | 35.6% |
| **Total** | **$14,434.47** | **$9,612.04** | **$7,026.58** | **$7,407.89** | **51.3%** |

Notes: $1,000s; FY21 price level; 2.5% discount rate

The recommended plan reduces the probability of a damaging flood occurring in a given year throughout the study area, but especially in the reaches downstream of both dam sites and in the reaches of Little Papillion Creek with a levee/floodwall alternative. However, in the rare instance that the project is exceeded by a particularly extreme event, most of the areas inside the levees would be affected due to the flat floodplain topography in these areas. Flash flooding on the Papillion Creek basin generally is of a short duration, but if enough water gets through or over the levees significant flood depths could occur resulting in high damages. Evacuations of leveed areas may be necessary, and because portions of several streets and railroads would be closed and/or inundated, effective emergency planning and flood warning and preparedness would help to protect those communities and minimize the damage from these rare flood events.

### 4.11.11 Risks and Uncertainty

A risk and uncertainty analysis, which is an analysis that integrates the uncertainty from the engineering, costs, economics, and other aspects of the project into the plan formulation process, was performed. Due to the future oriented and conceptual nature of planning, planning efforts are inherently about making decisions when not all of the information is available. This means it is fundamentally important to capture the risks and uncertainty associated with decisions made throughout the life of a planning study, so that this information can be reviewed and recalibrated as more information becomes available both throughout the iterative-life of a planning study and when the study moves beyond the planning phase into design, implementation, and eventually operation and maintenance. During the study effort, there have been several sources of

uncertainty and risk identified, many of these sources have either been resolved or they were avoided. Additionally, as a planning study progresses through its life, the identified risks begin to shift from risks that could impact the study effort to risks that could impact the implementation of the recommended plan. With this in mind, detailed below are the cost and schedule risks that the study team has identified for implementation of the recommended plan as well as erosion and grade stabilization concerns.

#### 4.11.11.1 Cost Risks

Cost risks are identified risks that could have significant impacts on the overall cost of the recommended plan when it is implemented. The USACE team, in collaboration with the non-Federal sponsor, other local stakeholders, and a team from the Walla-Walla Mandatory Cost Engineering Center of Expertise, conducted a Cost and Schedule Risk Analysis (CSRA) on the preliminary recommended plan for this study. This CSRA effort involved qualitatively assessing each of the major components of the recommended plan, determining which components the team believes could have the largest impacts on the cost of the implementation of the plan. The components that were found to have "medium" or "high" risks were then quantitatively assessed using the CrystalBall Software Package. From this quantitative assessment it was determined that the following two components presented the most substantial cost risks during implementation.

- Defined Acquisition Strategy – the estimate is built on the assumption that this will be an Invitation for Bid (IFB), if the acquisition strategy changes it may impact the current cost estimate.
- Levee/Floodwall Quantities – the final design of the levees and floodwalls may result in different quantities.

#### 4.11.11.2 Schedule Risks

During the CSRA, the team also assessed which components of the project could present the largest risks in terms of the recommended plan's implementation schedule. Similar to the cost risks, they were both qualitatively and quantitative assessed leading to a determination of which risks could have substantial impacts on the implementation schedule, or delays of more than a year on the schedule. The following two risks were identified as having the potential to cause such impacts on the schedule.

- Real Estate Acquisition – real estate acquisitions may contain unforeseen risks. Relocating tenants may cause schedule impacts.
- Construction Schedule – detailed construction schedule was developed; however approval and funding limitations could change the estimated schedule.

#### 4.11.11.3 Erosion Protection and Grade Stabilization

There have been several flood mitigations projects within the Papillion Creek watershed. Because these projects have performed well over the years, riprap requirements for the proposed features were modeled after them. It was assumed that riprap protection would be needed at drainage structure outlets, through bridges, in locations of active erosion, and on the upstream

face of DS19 at the normal pool elevation. However, areas that have been included in previous Federal projects that fall under previous O&M requirements were excluded.

The proposed project on the Little Papillion Creek is entirely contained within a previous Federal channel widening and realignment project. It was assumed that rock had been placed and continues to be maintained at all existing outfalls, through bridges, and in areas of current or expected erosion as detailed in the O&M manual and that these areas must be maintained by the local project sponsor. It was also assumed that any new outfalls or modifications to bridges since the Federal project's construction would have been designed with adequate protection. Therefore, the only areas requiring riprap protection in conjunction with the proposed project are in sections where there is an expected increase in high velocities.

Grade stabilization was also considered at this time. Areas downstream of the proposed projects were investigated for regions of active downcutting. A concrete flume currently exists below the Union Pacific Railroad bridge 0.4 miles downstream on Little Papillion Creek from the proposed levee/floodwall. This flume was constructed during the Little Papillion Federal channel improvement project. The concrete flume is 266 feet long and includes sheet pile cutoff walls on the upstream and downstream ends. It is anticipated that this structure will continue to stabilize the grade below the proposed project and, therefore, grade stabilization was determined unnecessary for design in this area.

# 5 ENVIRONMENTAL CONSEQUENCES

Environmental consequences of the alternatives in the Recommended Plan have been integrated with the affected environment to show the degree of potential impacts to individual resources; these impacts may either be positive or negative in nature. The probable consequences (i.e., adverse and beneficial effects) of the proposed action and its alternatives on selected resource categories are described in the Environmental Assessment Appendix H. An assessment of the environmental consequences provides the scientific and analytic basis for alternative comparison. The affected environment in the proposed project area was assessed through site visits, aerial photographs, and literature searches.

To enable quantifying and qualifying various impacts to the physical environment, existing ecological services were modeled with the Nebraska Stream Condition Assessment Procedure (NeSCAP) to ensure no net loss of stream habitat function as a result of the Recommended Plan. As applicable, modeling analysis demonstrates adverse and beneficial impacts to assessed resource categories. For the complete NeSCAP modeling results, reference Environmental Appendix H1.

## 5.1 PHYSIOGRAPHY AND TOPOGRAPHY

The topography of the Papillion Creek watershed is generally moderate to steeply sloping hills, with overland slopes ranging from 0% to approximately 30%. Deep, narrow valleys with relatively steep valley slopes also characterize the study area. The Papillion Creek watershed is situated in the Missouri River basin and is generally distinguished by two major landform divisions; the uplands which formed in loess and glacial till and the floodplains which formed

from alluvium along the Missouri River. The uplands include hills and bluffs adjacent to the Missouri River and rolling loess topography. Floodplains are flat and exist approximately 100 to 300 feet below the uplands. Elevations vary from 850 feet mean sea level (msl) to approximately 1400 ft msl near the Little Papillion Creek in Washington County (NDEQ, 2018).

### 5.1.1 No Action

Under the No Action alternative, no Federally funded construction activities related to flood risk management would occur within the Papillion Creek basin; there is minor potential for some flood risk management measures to continue to be implemented within the basin by non-Federal sponsors, however there are currently no identified actions in any City or County Master Plans. It is not anticipated that any impacts would directly occur to topography as a result of the No Action Alternative. The No Action Alternative will not address the purpose and need of the project. Indirect impacts as a result of the No Action Alternative may include localized changes to topography within the floodplain from continued bank sloughing and erosion that could continue to occur without stabilization and sediment management measures.

### 5.1.2 Recommended Plan

Under the Recommended Plan, some moderate, long-term localized changes to topography would occur as a result of dam, levee, and floodwall construction. These changes are described below.

#### 5.1.2.1 South Papillion Creek

Along the South Papillion Creek, DS19 would involve the construction of a 1,450-foot earthen dam across the South Papillion Creek to create a 74-acre lake within the existing creek valley. Approximately 74 acres of terrestrial habitat and agrarian areas would be converted to an open water resource. A sediment retention structure would also be constructed just upstream of the lake pool.

#### 5.1.2.2 Little Papillion Creek

To reduce flood risk along the Little Papillion Creek, Dam Site 10 would be constructed along Thomas Creek, which is a tributary to the Little Papillion Creek. A 1,450-foot long dam would be constructed across the creek to form a dry dam within the creek valley. Because it would be a dry dam, the only changes to topography would be associated with the dam itself and the spillway. New levees and floodwalls ranging in height from 2.9 to 7.4 feet would be constructed along both banks of the Little Papillion Creek from Blondo Street downstream to south of West Center Rd (Saddle Creek confluence).

## 5.2 CLIMATE

The study area is marked by wide seasonal variations with hot summers and generally cold winters. Nebraska experiences a continental climate type; typical characteristics include large temperature variability with warm summers dominated by convective thunderstorms and cold winters influenced by snow and wind from mid-latitude cyclones. Moisture in the eastern portion

of the state, where the study area is located, is received from southerly winds coming across the Gulf of Mexico (Shulski et al., 2013).

Human activities have caused an approximate 1˚C (33.8˚F) increase in global temperatures above pre-industrial levels with a likelihood of increasing to 1.5˚C (34.7˚F) between 2030 and 2052 should no action be taken (IPCC, 2018). According to the National Climate Assessment, the Great Plains Region is susceptible to changes in crop growth cycles due to warming winters and alterations in the timing and magnitude of rainfall events. Rising temperatures will also lead to an increased demand for water and energy, this will continue to strain development, stress natural resources and increase competition for water among communities, agriculture, energy production and ecological needs (Shafer et al., 2014).

In the region including the Papillion Creek watershed, observed temperatures and precipitation have seen a mild increase with time. Future temperatures are projected to increase for all seasons with the largest increases in summer and fall. Future precipitation is projected to increase for the spring season but trends for other seasons lack consensus in results.

Streamflow trends are more complex to forecast. There is some evidence within projected streamflow records, albeit lacking consensus, that peak flows may be trending upward.

At the scale of the Papillion Creek watershed, observed precipitation and temperature over time for a sampled gauge (Eppley Airfield) showed no statistically significant trend of increasing or decreasing with time.

### 5.2.1 No Action

While the No Action alternative would have no direct effect on climate, the No Action Alternative would not address the project Purpose and Need to address flood risk to the local community. Some scientific evidence indicates continued increases in precipitation and surface runoff in this region. Should no action be taken to address flood risk, it is likely that flooding events will continue to increase in frequency and intensity threatening public health and safety and causing significant property damage.

### 5.2.2 Recommended Plan

The Recommended Plan would have no direct effect on climate; as discussed in the *Climate Change Assessment for Water Resources Region 10*, statistically significant evidence indicates mild increases in temperature, precipitation and surface runoff for the lower basin of Region 10 where the Papillion Creek Basin is located. As such, it is feasible to assume that continued and increasing flood risk is present. The Recommended Plan would assist in proactively addressing current and potential future flood risk to the surrounding community. This includes addressing potential increases in stream flow through monitoring and implementation of adaptive management as needed through the planning horizon of the project. Risk due to climate change is possible but not very likely given current data and analysis.

## 5.3 SOILS

The soils in the upper portions of the basin are generally deep, well-drained silt loam to silty clay loam formed in loess. Permeability is moderate, and the available water capacity is high. Bottomland soils, or soils in the lower portions of the basin, generally consist of poorly drained silty clay to fine sandy loam. Permeability is moderate and the available water capacity is low.

Generally, soil composition tends to be dominated by silty clays and silty clay loams. Parent materials generally consist of clayey alluvium or silty alluviums. The soil type with the highest presence along the three streams are variations of Udorthents and Udarents Urban Land complexes. Kezan- and Calmo- dominated complexes have hydric soil ratings and are fairly present throughout the study area. Some areas of prime farmland are intermittently present throughout the study area as well as soils of statewide importance, and soils classified farmland if drained; however, a majority of soils within Douglas and Sarpy counties have been converted to urban, residential or open space land use and would likely already not be utilized for agriculture purposes (NRCS, 2019).

### 5.3.1 No Action

Under the no action alternative, there would be no construction activity, so there would be no impacts to soils.

### 5.3.2 Recommended Plan

Prime Farmland soils are present at DS19 on South Papillion Creek, and at DS10 on Thomas Creek. Prime Farmland Soils present include Kennebec Silty Loam, and Judson Silty Clay Loam. At DS19, there is also one soil type (Contrary-Marshall Silty Clay Loam) that is classified as having statewide importance. Approximately 79 acres of Prime Farmland soils that are currently farmed at DS19 on South Papillion Creek would be permanently converted into a dam and lakebed and would no longer be farmable. There are approximately 71 acres of Prime Farmland soils within the footprint of the floodpool at DS10 on Thomas Creek, however, because DS10 would be a dry dam, most of these acres would remain farmable. The footprint of the dam and the spillway at DS10 would permanently convert approximately 18

acres of prime farmland soils into the dam and spillway structures, so they would no longer be farmable. The Natural Resources Conservation Service (NRCS) in Nebraska was coordinated with on multiple occasions via email beginning in January of 2020. Farmland Conversion Impact Rating Forms were prepared for DS10 and DS19 and submitted to the NRCS for review. An email was received from the NRCS on January 21, 2020 stating that the proposed projects at DS10 and DS19 were found to be cleared of Farmland Protection Policy Act Concerns. See Appendix H2 for the completed Farmland Conversion Protection Rating Forms, and the January 21, 2020 email from the NRCS.

Other minor and temporary impacts associated with the Little Papillion Creek Alternative include the excavation, hauling, and grading that would occur to construct the proposed levees and floodwalls. Typical earth-moving equipment would be used to dig, grade, trench and shape the soils during construction activities. Erosion control best management practices (BMPs), such

as silt fencing and erosion control blankets would be utilized during construction. Immediately following construction activities, disturbed areas would be seeded with a native seed mixture or levees would be seeded with a stabilizing seed mixture and the newly seeded areas would be mulched to control erosion. Ground disturbing activities would be kept to a minimum.

## 5.4 LAND USE

Land use within the study area is generally heavily urbanized in Sarpy and Douglas Counties and primarily agrarian in Washington County. Areas of herbaceous open space are sporadically present within the Papillion Creek basin in all three Counties while wooded/forested areas and wetlands are notably lacking throughout the entire basin. Land use at the two proposed dam sites (DS19 in Sarpy County and DS10 in Douglas and Washington counties) is primarily agricultural.

### 5.4.1 No Action

Under the No Action alternative, there would be no Federally funded construction. There is potential that non-Federal sponsors may continue to implement flood risk reduction measures; however, it is likely that a non-federal project would take significantly longer as funding would be derived from the local community. Should no measures be taken to address flood risk within the Papillion Creek basin, residential, urban, and agricultural land use categories may all be adversely impacted as a result of continued flooding.

### 5.4.2 Recommended Plan

Implementation of the Recommended Plan would result in a number of localized land use changes along the Little Papillion, South Papillion, and Thomas Creeks associated with levee and floodwall construction, and construction of the two proposed dam sites. These land use changes would occur along each of the included Papillion Creek tributaries as described below.

#### 5.4.2.1 South Papillion Creek

The Recommended Plan would result in the construction of DS19 on the South Papillion Creek in Sarpy County. Real estate acquisition for dam site construction would result in a permanent land use change on over 214 acres of primarily agricultural land that would be located below the maximum flood pool elevation. Approximately 74 of the 214 acres would be located below the normal pool elevation and would likely be continuously flooded. The area between the normal pool elevation and the maximum flood pool elevation (approximately 135 acres) would be converted from agricultural land to recreation facilities and wildlife habitat. In addition, a proposed stream habitat mitigation site on an unnamed tributary to the South Papillion Creek would permanently convert approximately 5.5 acres of land that is currently farmed into wildlife habitat.

#### 5.4.2.2 Little Papillion Creek

Under the Recommended Plan, DS10 would be constructed on Thomas Creek to provide flood risk management benefits along the Little Papillion Creek. Because DS10 is proposed to be a dry dam, the required level of real estate acquisition for the land within the flood pool would primarily consist of flowage easements. Under flowage easements, farming would be allowed to

continue where feasible, however no habitable structures would be allowed within the easements. Also located within the flood pool footprint, approximately 6.6 acres of primarily farmland would be acquired in fee for habitat mitigation. Construction of the dam and spillway would convert approximately 18 acres of farmland into flood risk management structures. Construction of the levees and floodwalls along the Little Papillion Creek would require the removal of two houses along the Cole Creek levee tie off. These houses and their driveways and patios would be removed to construct the levee. The previously impervious surfaces would be replaced by grass cover on the levee and the 15-foot buffer next to the levee. There are several other locations along the proposed levee and floodwall where impervious surfaces like parking lots and portions of some buildings would be removed and replaced with grass covered levees. A total of approximately 2.53 acres of impervious surfaces would be replaced by pervious grass covered surfaces associated with levee construction.

#### 5.4.2.3 Nonstructural

Typical nonstructural measures that would be implemented under the Recommended Plan include elevating structures, dry floodproofing, and filling basements. These measures would not change the land use where the work would be performed. However, there are some structures located in the floodway. The only viable nonstructural measure to address structures in the floodway is acquisition. The structure would be purchased from the owner and the structure would be removed from the floodway. This would change the land use where the structure was located from commercial or residential to open green space with no structures.

## 5.5 Hazardous, Toxic, and Radioactive Waste

A Phase I Environmental Site Assessment (ESA) of potential work areas was conducted in accordance with ER 1165-2-132 during the optimization of the plan and is included in Appendix N. The purpose of the Phase I assessment is to identify any Hazardous, Toxic, or Radioactive Waste (HTRW) that may be encountered within the project footprint. The assessment includes an initial review of database search reports, followed by site visits suitable for feasibility phase determinations. Based on a preliminary review of existing information there is a low risk that the project will encounter any HTRW sites that would significantly affect the plan.

### 5.5.1 No Action

Under the No Action alternative there would be no ground disturbing activities associated with construction, so there would be no impacts to buried hazardous, toxic, or radioactive waste.

### 5.5.2 Recommended Plan

Currently, there are no known hazardous, toxic, or radioactive waste sites within the proposed project area. The Recommended Plan would involve acquisition by the sponsor of all lands, easements, and rights-of-ways necessary to construct the proposed levees, floodwalls, and dam sites included in the plan. As part of the acquisition process, environmental condition of property surveys would be conducted on each parcel proposed for acquisition. The purpose of the environmental condition of property surveys is to screen each parcel for the potential presence of hazardous, toxic, or radioactive waste prior to purchasing the property. If a survey

reveals the potential presence of hazardous, toxic, or radioactive waste, the property would not be acquired unless the owner cleans up the site. For these reasons, the Recommended Plan is not likely to disturb or otherwise adversely impact any hazardous, toxic, or radioactive waste sites.

## 5.6 Stream Habitat Function

The Recommended Plan would modify portions of the beds and/or banks of the South Papillion Creek, Little Papillion Creek, and Thomas Creek, which is a tributary to the Little Papillion Creek. Impacts to stream habitat function resulting from construction within or along the banks of a stream or conversion of a stream into a lake or reservoir must be quantified and mitigated appropriately.

### 5.6.1 Nebraska Stream Condition Assessment Protocol (NeSCAP)

The Nebraska Stream Condition Assessment Procedure (NeSCAP) was the selected habitat assessment tool to assess baseline environmental conditions for the Papillion Creek General Reevaluation Report Feasibility Study. This model was reviewed by the USACE Ecosystem Planning Center of Expertise (ECO-PCX) and received approval for regional use on July 11, 2019.

NeSCAP is a hydrogeomorphic assessment method that measures thematic variables for the major physical, ecological, and anthropogenic factors that can strongly influence stream and adjacent riparian systems. The minimum assessment area used for this method includes the bankfull stream channel and active floodplain. One sampling location (data point) was established in each river reach where construction is proposed on each of the three streams. The extent of each river reach was determined primarily by the type of construction proposed for each reach, but they were further defined laterally as segments of stream channel and adjacent riparian ecosystem that are relatively homogenous in terms of geomorphology, soils, hydrology, channel morphology, vegetation and cultural alteration.

Site visits were conducted on May 17, 22, and 29, 2019 to collect data for the model. At each location, a hand diagram was drawn of the stream channel, photographs were taken, estimates of bankfull depth and floodprone depth were recorded, and the types of vegetation present were identified. Google Earth Pro was used to measure top of bank width and bankfull width, characterize adjacent land use, quantify land use within the 100-foot from top of bank assessment zone, and measure acreage of different land cover types. This information was then used to develop existing condition scores for each of the NeSCAP variables for each sampling location. The scores for each variable were then entered into the NeSCAP spreadsheets to determine the existing conditions SCI score for each sampling location. The spreadsheets also calculate the SCI area for each sampling location and multiply it by the SCI score to produce project impact units. Refer to Environmental Appendix H1 for a full explanation of the NeSCAP procedure.

### 5.6.2 NeSCAP Results

Future with-project stream condition index scores were developed for each river reach in the Recommended Plan and entered into the NeSCAP calculation spreadsheets. Future with-project

scores were developed by considering the footprint of the proposed work in each river reach and determining how vegetation, land use, stream morphology, and riparian buffers would be affected by the proposed construction. Aerial imagery from Google Earth Pro and real estate maps depicting the proposed project footprints were utilized to aid in developing scores.

The NeSCAP calculation spreadsheets compare the existing condition SCI scores with those of the predicted future with-project SCI scores to determine whether the proposed project would produce total positive (beneficial) or negative (adverse) impacts to the condition of the river reach being analyzed. The degree of positive or negative impacts to each river reach are presented as either a positive or negative project impact unit score.

Due to the relatively poor condition of the streams in this study area, the future with-project condition only resulted in relatively minor negative project impact unit scores to some of the reaches of Little Papillion Creek during the NeSCAP analysis. Overall, the future with-project condition resulted in net positive project impact units when the results for all of the reaches in the Little Papillion Creek were combined. The beneficial impacts to some of the reaches of the Little Papillion Creek are primarily the result of converting concrete or otherwise un-vegetated areas to grass or other perennial cover due to the expansion of the project footprint resulting from construction of new levees. Floodwalls were used in areas where high value properties or other real estate constraints prevented the acquisition of sufficient property to provide enough space for levee construction. The floodwalls have a much smaller footprint than levees and require less real estate. This resulted in less conversion of concrete surfaces or buildings to grass cover or expansion of the vegetated buffers along the river reaches where floodwalls are proposed. As a result, project impact unit scores in river reaches where floodwalls are proposed either did not change between the without-project and future with-project condition, or they resulted in slightly negative scores. Negative scores for reaches that primarily included floodwalls were also related to the decrease in floodplain connectivity that would result from construction of floodwalls.

Conversion of over 4,843 feet of South Papillion Creek to lacustrine habitat at DS19 would result in negative project impact units. Since the NeSCAP model assesses impacts to streams, converting a stream to a lake results in negative project impact units that will require mitigation. Construction of a dry dam at DS10 on Thomas Creek would not convert the creek to a lake, however, it would impact the function of the stream enough to require mitigation of negative project impact units.

According to the results of the NeSCAP modeling for the Recommended Plan, construction of the two proposed dam sites would result in a combined total negative project impact unit score, while the total beneficial impacts of the remainder of the proposed actions (levees/floodwalls) along Little Papillion Creek would result in a beneficial (positive) project impact units. Overall, this results in net negative project impact units. The negative project impact units that result from construction of DS10 and DS19 are partially compensated for by the positive project impact units produced by the remainder of the proposed construction activities along Little Papillion Creek in the Recommended Plan. Therefore, based on the NeSCAP modeling results, the net negative impacts to stream condition that would occur as a result of construction of the two dam sites under the Recommended Plan would need to be mitigated.

### 5.6.3 Mitigation of Stream Habitat Function

Negative impacts to Thomas Creek caused by the proposed project would be mitigated by acquiring a total of 4.6 acres of land straddling both sides of a 1,000-foot long segment of the creek just upstream of Pawnee Road. This segment is located within the floodpool of the proposed dry dam. However, because a dry dam with no permanent pool is being proposed, this segment would be suitable for mitigation. Stream mitigation would primarily consist of planting a 100-foot wide buffer of native prairie and wetland plants along each side of the creek for 1,000 feet. Stream impact mitigation at DS 19 would be accomplished by acquiring 5.5 acres of land straddling both sides of a 1,200-foot long segment of an unnamed tributary to the South Papillion Creek located west of Highway 6. This segment of the tributary is located just outside the edge of the floodpool on the upstream end of the proposed reservoir. Similar to the mitigation proposed at DS10, a 100-foot wide buffer of native prairie and wetland plants would be planted along both sides of the creek channel for a distance of 1,200 feet. The type and amount of stream mitigation proposed was determined through use of the mitigation tool in the NeSCAP calculation book.

Stream mitigation costs at each dam site would include the cost of fee title real estate acquisition, purchase of native seed mixes, and planting the seed. A mix of native grasses, forbs, and wetland plants would be used. The seed mix is estimated to cost about $150/pound, and it would be applied at a rate of 12 pounds/acre for a total cost of $1,800/acre. The proposed mitigation site at DS10 is located along Thomas Creek within the floodpool area behind the dam. Because DS10 would be a dry dam, flowage easements would be obtained within the floodpool footprint rather than obtaining fee title to the land. Land used for mitigation in USACE projects must be owned in fee. Therefore, the real estate cost attributable to mitigation would be the cost of acquiring the land in fee over and above the value of the flowage easement that would be needed to construct the dam. The proposed mitigation site for DS19 is located outside the fee acquisition boundary required for the proposed reservoir, so full value would have to be paid to acquire fee title to the land. Land in the proposed mitigation area has been appraised at approximately $133,300 for 10.1 acres.

## 5.7 WATER QUALITY

In accordance with the Clean Water Act (33 U.S.C. §1251), states, Tribes, or the EPA must develop standards for their jurisdiction. Pursuant to the CWA, water quality consists of three components: 1) designated and existing uses, 2) water quality criteria necessary to protect these uses, and 3) an anti-degradation policy (40CFR Part 131.6). Designated uses for waterbodies and streams within the Papillion Creek basin include primary contact recreation, water supply for agriculture, aquatic life, warmwater A and B classifications and aesthetics.

In accordance with Section 303(d) of the CWA, states must identify surface waters that do not meet EPA-approved water quality standards. Primary pollutants identified in the Papio-Missouri River Basin Water Quality Management Plan (2018) include nutrients, pesticides, sediment, and bacteria. Streambank instability and bed degradation are prevalent throughout the system from channelization, armoring, damming and increased surface runoff. Waterbody impairments for the Papillion Creek basin are associated with primary contact recreation and aquatic life designated

uses. Impairments and pollutants of concern include excessive chlorophyll, total phosphorus, total nitrogen, sediment, mercury, algal blooms, turbidity, pH, low dissolved oxygen, E. coli bacteria and "unknown" which is likely associated with the loss of habitat for the aquatic community (NDEQ, 2018).

### 5.7.1 No Action

Under the No Action Alternative, no Federal project would be constructed within the Papillion Creek Tributaries Basin. Potential minor adverse impacts to water quality may occur should the Papillion Creek system continue to flood out of bank. As floodwaters move across the urbanized and agrarian areas of the floodplain, contaminants such as pesticides, road treatment chemicals, sediment, refuse and debris may accumulate and be transported into the Papillion Creek system.

### 5.7.2 Recommended Plan

Should the Recommended Plan be implemented, spillage of contaminants from the construction site into waterways is a potential effect that would be minor and short term. The CWA requires preparation and submission of a general stormwater permit and preparation of a Stormwater Pollution Prevention Plan (SWPPP) before construction activities can begin. The SWPPP would be based on BMPs such as seeding and mulching bare slopes as soon as practicable and measures to contain spillage of any contaminants into waterways. In the long term, there would essentially be no change to the water quality in these creeks from implementation of the Recommended Plan and none of the beneficial uses assigned to the Papillion Creek system would be degraded as a result of construction activities.

Under Section 401 of the CWA, an applicant for a Federal license or permit (i.e. Section 404) must obtain a certification that the discharge and activity is consistent with State or Tribal effluent limitations (Section 301 of the CWA), water quality related effluent limitations (Section 302 of the CWA), water quality standards and implementation plans (Section 303 of the CWA), national standards of performance (Section 306 of the CWA), toxic and pretreatment effluent standards (Section 307 of the CWA) and "any other appropriate requirement of State or Tribal law set forth in such certification." An NDEE 401 Water Quality Certification would be obtained prior to any construction activities. Any mitigation contained within this permit would become part of the proposed action. The Recommended Plan would have minor, temporary construction-related adverse impacts to water quality resulting from site runoff and increased turbidity. These temporary impacts would be minimized to the greatest extent possible through the use of BMPs that would be required as a provision under the National Pollutant Discharge Elimination System (NPDES) permit and through permitting requirements from other local and state authorities.

BMPs would minimize any incidental fallback of material into the creek during construction and would minimize the introduction of fuel, petroleum products, or other deleterious material from entering into the waterway. Such practices and measures could include, but are not limited to the use of erosion control fences and storing equipment, solid waste and petroleum products above the ordinary high water mark and away from areas prone to runoff and requiring that all equipment is clean and free of leaks. To prevent fill from reaching water sources by wind or runoff, fill would be covered, stabilized, or mulched and silt fences used as required. With an

expectation that BMPs would be required as a part of the NPDES permit and implemented during construction activities, no significant impacts to water quality are anticipated.

The draft Section 404(b)(1) (Clean Water Act) evaluation (Appendix H) was conducted in consultation with the NDEE. A water quality certification pursuant to Section 401 of the Clean Water Act would be obtained from the Nebraska Department of Environment and Energy (NDEE) prior to construction. In a letter dated May 5, 2021, the NDEE stated they have reviewed the Papillion Creek and Tributaries Lakes General Reevaluation Report Section 404(b)(1) evaluation and have not identified any significant concerns with the project to this point. Water quality certification would be granted pending confirmation based on information to be developed during the pre-construction engineering and design phase. All conditions of the water quality certification will be implemented in order to minimize adverse impacts to water quality.

## 5.8 WETLANDS

There are no major wetland complexes within the project footprint due to the heavy urbanization, agrarian land uses and severe modification of the Papillion Creek basin. Some small wetland areas can be found on the landward side of some of the leveed sections of the creek. These wetlands are primarily sediment basins that allow storm water from interior drainage to settle prior to draining into the creek through a culvert that runs under the levee. Wetlands can also be found in some of the bays, along the fringes, and in the upstream delta areas of the reservoirs in the Papillion Creek tributaries basin. Small amounts of low-quality wetlands are also present along the fringes of the streams and tributaries in the Papillion Creek basin.

### 5.8.1 No Action

Under the No Action Alternative, there would be no impacts to wetlands, as no construction activities associated with a Federal project would occur. It is possible that non-Federal sponsors may continue to implement flood risk management measures such as channel improvement and dam construction with local funding. Non-Federal sponsors would have to comply with Section 404 of the CWA.

### 5.8.2 Recommended Plan

Construction of the proposed measures in the Recommended Plan may have minor impacts to existing wetlands. Existing ecological services were assessed with NeSCAP to ensure no net loss of habitat function. The tributaries within the Papillion Creek basin are primarily managed as flood risk management channels and have been channelized and fixed in place, disallowing the natural formation of floodplain wetlands. Additionally, the area has been constricted with heavy urbanization. The Recommended Plan would continue to restrict the channels, precluding the streams from interacting with the ecological floodplain and thus the ability to form wetlands.

#### 5.8.2.1 South Papillion Creek

Under the Recommended Plan, DS 19 would be constructed on the South Papillion Creek near 192nd and Giles Road in Sarpy County, Nebraska. Currently, over 90 percent of the land within

the proposed floodpool is farmed. The remainder of the land consists of the tree-lined creek channel and some woody draws. The only wetlands that are present are located in a narrow band of low-quality riverine wetlands dominated by reed canary grass that line the edge of the low flow channel. The creek channel is approximately 40 feet wide in the location where the dam would be constructed. Construction of the dam embankment would directly fill approximately 0.35 acres of palustrine emergent (PEM) wetlands within the creek channel. USACE requires a 4:1 mitigation ratio for changing the Nebraska Wetland Subclass of PEM wetlands from Riverine Channel to Lacustrine Fringe. The 0.35 acres of PEM wetlands lining the creek channel that would be lost at Dam Site 19 would be partially mitigated by the wetlands that develop along the shallow edges of the bays of the proposed reservoir. In addition, 1.4 acres of PEM wetlands would be created by excavating shallow areas or bays connected to the edge of the normal pool area and planting them with a native wetland seed mix. These areas would be located within the property acquisition limits of the project. The cost of constructing 1.4 acres of PEM mitigation wetlands would include the cost of excavating the depressions next to the normal pool of the reservoir and seeding the excavated areas. The native wetland seed mix is estimated to cost about $150/pound, and it would be applied at a rate of 12 pounds/acre for a total seed cost of $1,800/acre. The estimated cost to plant the seed is $867/acre. The total cost of purchasing the seed and planting it is $2,667/acre.

#### 5.8.2.2 Little Papillion Creek

Under the Recommended Plan, a dry dam at DS10 would be constructed on Thomas Creek near 126th Street and Highway 36 in Douglas County to provide flood risk management benefits along the Little Papillion Creek. Currently, over 90 percent of the land within the boundaries of the proposed flood pool is farmed. The remainder of the land consists of the tree-lined creek channel and some woody draws. The only wetlands that are present are PEM, forested/shrub, and riverine wetlands that line the banks, and the low flow channel within Thomas Creek. The creek channel is approximately 55 feet wide in the location where the dam embankment would be constructed. Construction of the dam embankment across the creek channel would directly fill approximately 0.25 acres of PEM wetlands. The 0.25 acres of PEM wetlands lost at Dam Site 10 would be mitigated by the wetlands that will develop adjacent to the creek bed along the 800-foot long backwater pool that would be created within the creek channel upstream of the dam face. Water in this 800-foot long segment of the creek will back up behind the dam and remain approximately 3 feet deeper than it currently is during normal flows. This deeper water would still be contained within the banks of the existing creek channel. The ground adjacent to the creek within the 800-foot long backwater area would remain wetter than it would have without the proposed project. Wetland vegetation is expected to develop in these areas with wetter soil. In addition, construction of the dam would cause the 2-year event to leave the banks of the creek and temporarily flood approximately 6 acres of land that is currently farmed. This more frequently flooded area is expected to no longer be farmable and much of the area will develop wetland characteristics over time.

New levees and/or floodwalls ranging in height from 2.6 to 9.8 feet in height would be constructed between Blondo Street and Saddle Creek. Examinations of aerial photography and on-site visits to the proposed levee/floodwall construction areas along the Little Papillion Creek

were conducted during May of 2019. These investigations revealed no wetlands within the proposed levee/floodwall alignments. The only wetlands identified in the area were the riverine wetlands lining the banks of the low-flow channel of Little Papillion Creek. Levee and floodwall construction would only occur along the high banks of the creek channel, so no disturbance to the wetlands lining the low-flow channel would occur. Because there are no wetlands within the proposed construction footprints of the levees/floodwalls along the Little Papillion Creek, the proposed levee/floodwall work would not adversely impact wetlands along the Little Papillion Creek.

#### 5.8.2.3 Nonstructural

Typical nonstructural measures that would be implemented under the Recommended Plan include elevating structures, dry floodproofing, and filling basements. These measures would occur in previously developed areas and often within the footprint of existing structures, therefore these activities would not adversely impact wetlands.

## 5.9 Air Quality

The Clean Air Act (CAA) (42 U.S.C. § 7401 et seq.), of 1970 tasked the EPA to establish National Ambient Air Quality Standards (NAAQS) to protect public health and welfare and to regulate emissions of hazardous pollutants. A designation of non-attainment indicates that an area does not meet these standards. Air quality in the area is influenced by a combination of factors, which include climate, meteorology, and density and geographic distribution of local and regional air pollution sources. The dispersion of pollutants is influenced by the properties of the pollutants as well as the way air masses interact with the regional topography. Sources of suspended particulate matter and air pollutants in the proposed project area include industrial and commercial businesses, agricultural activities, residential areas, and local and railway traffic.

Air quality in the Papillion Creek watershed and the State of Nebraska is monitored by the NDEQ. Additionally, the City of Omaha has a local agency named Omaha Air Quality Control as well as the Douglas County Health Department. These local agencies monitor air quality and plan, permit, and enforce standards within their jurisdictions. Douglas County has multiple air quality monitoring stations that monitor particulate matter 2.5 (PM) and PM10, carbon monoxide, ozone, sulfur dioxide, and a NCore site that monitors 9 pollutant parameters while Washington and Sarpy Counties each have a station that monitors PM2.5 (NDEQ, 20182).

AIRNow is an EPA-generated real time database that provides air quality index (AQI) information. As of February 2019, AQI within the general area of the Papillion Creek basin was considered “moderate” as a result of elevated PM2.5 levels, while ozone, carbon monoxide and PM10 were considered “good” (EPA, 2019). It should be noted that AQI’s fluctuate daily.

According to the EPA Green Book, as of February 2021, Douglas, Sarpy, and Washington Counties in Nebraska are all in attainment status for all priority pollutants (EPA, 2021).

### 5.9.1 No Action

Under the No Action Alternative, no construction activities utilizing federal funding would occur; however, non-federal sponsors may continue to implement flood risk reduction measures

should they receive local fiscal assistance. Non-federal sponsors would have to comply with the CAA. Non-federal sponsors may be required to obtain air quality construction permits dependent upon the type and duration of construction and the potential pollutants emitted associated with construction activities. No adverse impacts are anticipated under the No Action Alternative.

### 5.9.2 Recommended Plan

The proposed construction activities associated with the Recommended Plan would be temporary, occurring on an intermittent basis during the construction season over a period of 5 to 10 years. Construction activities that would generate emissions include earthwork (i.e., land clearing, ground excavation, and cut-and-fill operations), aggregate/material handling, and construction of project structures. Construction activities would result in short-term emissions including fugitive dust from soil disruption and combustion emissions from the construction equipment and on-road vehicles. Emissions associated with construction equipment and on-road vehicles include criteria pollutants (PM2.5, PM10, carbon monoxide, ozone, and sulfur dioxide), greenhouse gases, and small amounts of air toxics. These emissions are expected to be within acceptable air quality standards. In addition, the general actions below would help to avoid or minimize impacts to air quality during construction:

- Minimize clearing vegetation within all the construction work areas to minimize soil disturbance and keep dust down.
- Conduct construction activities in a manner to minimize the creation of dust. This may include measures such as limitations on equipment, speed, and/or travel routes.
- Implement measures to minimize the transfer of mud onto public roads.
- Maintain construction equipment in good working order.
- Implement a fugitive particulate emission control plan that specifies steps to minimize fugitive dust generation.
- Plan construction scheduling to minimize vehicle trips.

## 5.10 NOISE

Under the Noise Control Act of 1972 and its amendments (Quiet Communities Act of 1978; U.S.C. Title 42, Parts 4901-4918), states have the authority to regulate environmental noise by which governmental agencies must comply with in addition to community noise policies and regulations.

Ambient noise levels within the Papillion Creek watershed vary. Primary sources of noise include vehicle traffic from the City of Omaha as well as air traffic generated from Eppley Airfield and Offutt Air Force Base. Additionally, the Union Pacific Railroad intersects with various locations within the watershed, contributing to the ambient noise level. In Washington County, primary sources of noise include agricultural activities, noise created from residential areas, and recreational activities such as boating and seasonal hunting.

### 5.10.1 No Action

Should the No Action Alternative be implemented, there would be no federally funded construction activities. Non-federal sponsors may continue to implement flood risk reduction

measures such as channel improvement and dam construction measures. Local entities would be required to comply with the Noise Control Act; therefore, no adverse impacts are anticipated to occur to ambient noise conditions under the No Action Alternative.

### 5.10.2 Recommended Plan

Increases in noise from construction activities are expected at each of the project sites during construction. The expected increases in noise would be minor, temporary, and similar to those already occurring in the area. The two dam site construction areas (DS10 and DS19) are located primarily in agricultural areas where construction noise would not be unlike the noise created by farm machinery at certain times of the year in these locations. The areas where levee and floodwall construction would occur are located in more urban areas where construction noise would not be as noticeable compared to ambient noise levels. Therefore, the expected increases in noise levels from project construction would be minor and short-term.

## 5.11 VEGETATION

Vegetation in eastern Nebraska was historically a tallgrass prairie with a limited extent of woody vegetation found adjacent to rivers and streams. Prior to 1855 a distinct prairie-forest ecotone restricted to floodplains, terraces and other uplands bordering riparian areas existed. It is thought that lack of fire intensity and frequency allowed woody vegetation to colonize the region. Presently, cottonwood (*Populus deltoides*), bur oak (*Quercus macrocarpa*), American basswood (*Tilia americana*), and rough-leaved dogwood (*Cornus drummondii*) are more common than they were prior to settlement of the region (Rothenberger, 1989). Within the immediate study area, habitat types were historically upland deciduous forests along the floodplain of the streams and tributaries of Papillion Creek basin and upland tallgrass prairie beyond the riparian corridors. Today, vegetation and habitat types have been severely altered from natural, historical conditions due to land use conversion. Most of the remaining riparian forest is confined to the banks within the stream channels of a few of the reaches. Most of the stream channels have been channelized, straightened, or modified in some other way. These reaches are dominated by smooth brome grass above the bankfull bench and reed canary grass on the bankfull bench and below. Other vegetation that can be found mixed in with the smooth brome grass includes bluegrass, fescue, smartweed, common milkweed, crown vetch, yellow sweet clover, white clover, and curly dock.

### 5.11.1 No Action

Should the No Action Alternative be implemented, no federally-funded construction activities would occur; however, non-federal sponsors may continue to implement flood risk reduction measures such as channel improvement and dam construction. Should the non-federal sponsor implement any measures that require woody vegetation removal, they would be required to comply with the City of Omaha Forestry Department's Tree Mitigation Policy for tree removal that occurs on public property. This generally would require a replacement ratio of 2:1. Additionally, non-federal sponsors would be required to utilize native, weed-free seed mixes; with the exception of seeding levees which require smooth brome, a non-native, rhizomatous cool season grass that provides levee stabilization. Under the No Action Alternative, no adverse

impacts are anticipated to occur to vegetation as non-Federal sponsors would be required to replace the vegetation that would have been removed.

### 5.11.2 Recommended Plan

All of the proposed construction actions that are part of the Recommended Plan would include disturbance of existing vegetation. As discussed in Appendix H1, NeSCAP was utilized to determine the impacts of the Recommended Plan on stream habitat function, and to ensure that no net loss of habitat function would result. The NeSCAP model assessment procedure utilizes thematic variables for the major physical, ecological, and anthropogenic factors that can strongly influence streams and the adjacent riparian systems. Riparian vegetation composition, riparian continuity and width, and riparian land use are all variables used in the NeSCAP model related to riparian vegetation. However, the NeSCAP model does not adequately address the loss of certain vegetation communities such as riparian forest that may be considered significant resources by the Corps or the partnering resource agencies. While the model may show a lower condition index rating for a particular variable if a resource such as native trees are replaced with a different type of non-native vegetation, the loss of the trees themselves may not hold enough weight in the model to result in mitigation of the trees.

Construction of the Recommended Plan would result in the loss of 19.5 acres of riparian forest at DS19, 2 acres at DS10, and 2 acres from scattered locations along the Little Papillion Creek for a total loss of 23.5 acres of riparian forest. The trees are part of the existing riparian ecosystem in the basin, and they are considered by the PDT, the USFWS, and the Nebraska Natural Heritage Program to be a significant resource that is steadily declining in the basin as development continues. For these reasons, replacement of the 34.8 acres of riparian forest would occur to mitigate for losses. Mitigation requirements were determined using the Brown Thrasher Habitat Evaluation Procedure (HEP); see Section 5.11.2.1 and reference Appendix H1. Mitigation of the riparian forest habitat would support a recommendation made by the USFWS in an email dated May 28, 2019, in response to a request for FWCA comments on the proposed project. The USFWS recommended incorporating riparian buffers along any proposed channel improvements or reservoirs to improve water quality. They also recommended the use of seed mixes that would produce pollinator habitat (see Appendix B for correspondence).

#### 5.11.2.1 Habitat Evaluation Procedure (HEP)

The HEP was used to determine the appropriate quality and quantity of riparian forest habitat to be replaced under the Recommended Plan. The HEP was developed by the USFWS in the 1970s. HEP is a well-known land management tool used to quantify (assign a value to) the suitability of habitat for selected species at baseline conditions and at different points in time. HEP can be used to compare the wildlife impacts of different project alternatives or mitigation techniques.

A HEP is comprised of one or more Habitat Suitability Index/Indices (HSI), which are models for calculating the habitat suitability for specific species based on habitat variables that are critical to their survival or successful reproduction. HSI models using existing USFWS-developed indicator species were certified by the USACE. A set of variables that represent the life requisites for the species (e.g. percent cover, water depth, tree height) are described for each

species. The variables are measured using desktop methods and subsequently verified in the field and their value is assigned a corresponding index value. These values are then inserted into the HSI mathematical model to produce a score that describes existing habitat suitability. This score is a score between 0 (no value) and 1 (optimum value). Computation of the HSI model will result in an overall "suitability index" for each existing or planned habitat being evaluated. This HSI score is then multiplied by the number of acres affected by the project to produce a number referred to as a "Habitat Unit" or HU.

The Brown Thrasher Habitat Suitability Index (HSI) model was selected to measure the quality of the existing riparian forest habitat that would be impacted by the proposed project, and to predict the quality of the habitat that would be restored through mitigation. The model was developed to evaluate brown thrasher habitat in its entire breeding range during the breeding season (April – August). The variables that are assessed in the brown thrasher HSI model include the density of woody stems > 1.0 meter tall (in thousands of stems), the percent canopy cover of trees > 5.0 meters (16.5 feet) tall, and the percent of ground covered by leaf litter > 1 cm (0.4 inches) deep. To calculate the HSI score for each site, the suitability index score of each variable is multiplied by the suitability index scores of the other two variables. The following equation is used to calculate the HSI for each site: SIV1 x SIV2 x SIV3. See Section 3 in Appendix H1 for a more thorough explanation of the brown thrasher HSI model, and how it was used to determine the appropriate quantity and quality of riparian forest mitigation for each of the proposed alternatives in the Recommended Plan.

#### 5.11.2.1.1 Existing Conditions

Existing conditions HSI scores were developed for the three forested locations (DS10, DS19, and Little Papillion Creek) that would be adversely impacted (removed) under the Recommended Plan. See the EA for the lists the HSI scores for the existing conditions at the three impacted locations.

Existing conditions HSI scores were also developed for the three locations where the proposed mitigation plantings would be planted. The proposed mitigation locations for DS19 are located in selected areas within the fee acquisition boundary in the band between the normal operating pool and the top of the flood pool. The selected locations are all currently being farmed for corn or soybeans, there are no woody stems, and less than 20 percent of the ground is covered by leaf litter. The proposed mitigation location for DS10 is located along Thomas Creek within the flood pool of the dry dam. Similar to the mitigation site at DS19, the ground is currently being farmed for corn or soybeans, there are no woody stems, and less than 20 percent of the ground is covered by leaf litter. The proposed mitigation location for the forested areas along Little Papillion Creek will be located on ground owned by the non-federal sponsor within the Papillion Creek and tributaries basin. The ground at this location is planted in smooth brome grass, and there are no woody stems. The percent of the ground covered by leaf litter is at least 80 percent. See the EA for the existing conditions HSI scores and associated habitat units for the three proposed mitigation areas.

#### 5.11.2.1.2 Future With-Project Conditions

A mitigation planting plan was developed to replace the quality and quantity of riparian forest habitat that would be lost at the three areas where trees would be cleared for construction or killed due to flooding. The proposed mitigation areas would be planted at a rate of 135 stems per acre. Within each acre, 10 percent of the stems would consist of native tree species with a minimum diameter breast height of 2 inches, and 90 percent of the stems planted would consist of native shrub species. With 14/trees per acre being planted for a cost of $2,800/acre, and shrubs are estimated to cost $60 per potted plant installed with 121 shrubs/acre being planted for a $7260/acre; total cost for planting 135 woody stems/acre is estimated to be $10,060.

#### 5.11.2.1.3 Results of the HEP

The minimum target HSI scores at the proposed mitigation sites to replace the lost riparian forest habitat with habitat of equivalent quality are 0.196 for DS19, 0.198 for DS10, and 0.138 for the Little Papillion Creek. Based on the future with-project scoring results the target HSI scores at all three mitigation sites would be exceeded by year 10 with predicted scores of 0.2. The minimum target number of habitat units required to mitigate the lost habitat at each of the three mitigation sites is 3.83 for DS19, 0.39 for DS10, and 0.28 for the Little Papillion Creek. Based on the future with-project predicted habitat unit scores, the target habitat unit scores would be exceeded at all three sites by year 10. At year 10 the habitat unit scores are predicted to be 3.9 for DS19, 0.4 for DS10, and 0.4 for the Little Papillion Creek mitigation site. HSI scores and habitat unit scores are expected to slowly increase out to year 50 as the stem count continues to increase over time.

##### 5.11.2.1.3.1 South Papillion Creek

Under the Recommended Plan, DS19 would be constructed along the South Papillion Creek. This would involve the construction of a 1,450-foot earthen dam across the South Papillion Creek to create a 74-acre lake within the existing creek valley. Currently, most of the land that would be inundated by the normal pool of the proposed reservoir is under cultivation to grow corn and soybeans. However, the creek channel and some attached drainage ditches are lined with trees consisting mostly of silver maple, green ash, box elder, mulberry, and cottonwood. In most areas, a narrow strip of smooth brome grass separates the edge of the creek channel from the planted crop fields. It is estimated that approximately 19.5 acres of the riparian forest lining the creek channel would be inundated by the filling of the normal pool of the proposed reservoir. Utilizing the Brown Thrasher HSI Model, it was determined that appropriate mitigation of the lost riparian forest habitat would be achieved by planting 29.5 acres of trees and shrubs as described in Section 5.11.2.1.2 above. The trees and shrubs would be planted within the 135 acres of land surrounding the reservoir between the normal pool elevation and the maximum flood pool elevation. Some access roads and recreational features would also be constructed within this 135-acre band, but the remainder of this land that is currently in crop production would be converted to native grasses and shrubs for wildlife habitat.

#### 5.11.2.1.3.2 Little Papillion Creek

Under the Recommended Plan, a dry dam would be constructed at DS10 along Thomas Creek, which is a tributary to the Little Papillion Creek to reduce flood damages on the Little Papillion Creek. A 1,450-foot long dam would be constructed across the creek to form a dry dam within the creek valley Currently, most of the land within the proposed flood pool is under cultivation to grow corn and soybeans. However, the creek channel and some attached drainage ditches are lined with riparian forest trees consisting mostly of silver maple, green ash, box elder, mulberry, and cottonwood. In most areas, a narrow strip of smooth brome grass separates the edge of the creek channel from the planted crop fields. It is estimated that approximately 2 acres of the riparian forest lining the creek channel would have to be cleared within the proposed dam footprint to construct the dam The loss of this riparian forest habitat would be mitigated by planting 2.3 acres of riparian forest habitat along Thomas Creek within the footprint of the proposed flood pool as described in Section 5.11.2.1.2 above. Because DS10 is proposed to be a dry dam, most of the land within the footprint of the proposed flood pool would continue to be farmed. However, a portion of the ground closer to the creek channel would be subject to more frequent flooding, would likely become too wet to farm over time, and would eventually turn into wetlands.

Under the Recommended Plan, new levees and/or floodwalls ranging in height from 2.6 to 9.8 feet would be constructed along the Little Papillion Creek between Blondo Street and Saddle Creek. Construction of the levees and/or floodwalls in this reach would occur along the high bank directly adjacent to the creek channel. Approximately 2 acres of riparian forest habitat spread out in a few different areas would have to be cleared to construct the levees and/or floodwalls. Most of the vegetation along the high banks where the construction would occur consists primarily of smooth brome grass with some areas of blue grass mixed with or adjacent to the brome. A strip of vegetation up to 70 feet wide and running the entire length of the proposed levee/floodwall alignment on both sides of the creek where construction is proposed, would be removed, or otherwise disturbed to construct the levees/floodwalls. Once construction is complete, the new levees and all areas disturbed by construction activities would be re-seeded with smooth brome grass. The two acres of riparian forest that would have to be cleared would be mitigated by planting 3 acres of replacement habitat as described in Section 5.11.2.1.2 above along the banks of a creek within the Papillion Creek Basin on land owned by the non-Federal sponsor. It should also be noted that there are a few areas along the Little Papillion Creek where the new levee footprint could extend into areas that are currently concrete parking lots or sidewalks. Levee construction in these areas would result in more vegetated grassy areas than currently exist.

#### 5.11.2.1.3.3 Nonstructural

Nonstructural measures of elevating structures, dry floodproofing, and filling basements would occur in previously developed areas and often within the footprint of existing structures, therefore these activities would not adversely impact vegetation.

## 5.12 FISH

A graduate thesis entitled Fishes of the Papillion Creek Tributaries Basin, Nebraska was completed in 2006. This document provided an inventory of the fish species in the Papillion Creek Basin, and an assessment of stream habitat quality within the basin by conducting an Index of Biotic Integrity (IBI). Results of the IBI determined that the fish population was dominated by generalist minnow species that are tolerant of lower quality habitat. As a result, the overall habitat quality of the streams within the basin was determined to be poor due to the high level of development along the creeks and the multiple modifications that have occurred within the streams for flood risk reduction and bank stabilization. Twenty-three species of fish were collected in the streams of the Papillion Creek Basin during the 2006 study. Over 95 percent of the fish collected were species from the minnow family (*cyprinidae*). Minnow species collected included the bigmouth shiner (*Notropis dorsalis*), sand shiner (*Notropis stramineus*), emerald shiner (*Notropis atherinoides*), river shiner (*Notropis blennius*), red shiner (*Cyprinella lutrensis*), fathead minnow (*Pimephales promelas*), brassy minnow (*Hybognathus hankinsoni*), creek chub (*Semotilus atromaculatus*), and common carp (*Cyprinus carpio*). Other species collected include the channel catfish (*Ictalurus punctatus*), black bullhead (*Ameiurus melas*), yellow bullhead (*Ameiurus natalis*), stonecat (*Noturus flavus*), bluegill (*Lepomis macrochirus*), green sunfish (*Lepomis cyanellus*), largemouth bass (*Micropterus salmoides*), shortnose gar (*Lepisosteus platostomas*), brook silverside (*Labidesthes sicculus*), brook stickleback (*Culaea inconstans*), gizzard shad (*Dorosoma cepedianum*), quillback (*Carpiodes cyprinus*), river carpsucker (*Carpiodes carpio*), and shorthead redhorse (*Moxostoma macrolepidotum*).

### 5.12.1 No Action

Under the No Action Alternative, no construction of flood risk reduction measures would occur, so there would be no impacts to the fish within the Papillion Creek Tributaries Basin. The quality of the fish habitat in the basin would remain poor, and the fish community would continue to be dominated by tolerant, generalist species reflective of the poor habitat conditions.

### 5.12.2 Recommended Plan

Construction of the various features of the Recommended Plan may cause minor impacts to the already impaired fish community in the Papillion Creek Tributaries Basin. The project area has been highly disturbed with industrial and commercial activities. The Recommended Plan would result in minor, temporary, construction-related adverse impacts to fish. The potential impacts to fish are described below by stream.

#### 5.12.2.1 South Papillion Creek

Under this alternative, DS19 would be constructed along the South Papillion Creek. This would involve the construction of a 1,450-foot earthen dam across the South Papillion Creek to create a 74-acre lake within the existing creek valley. The proposed dam site would be constructed in the upstream portion of the creek's watershed where the channel is relatively small, and the amount of available fish habitat is small and of poor quality. Construction of the dam would convert over 4,800 feet of poor-quality stream fish habitat into a lake. The lake would be stocked with game

species that prefer lake habitat such as largemouth bass, crappie, bluegill, and channel catfish. The reservoir that is created by DS19 would support a diverse sport fish population that would differ from the riverine species composition historically found within the Papillion Creek basin prior to urbanization, channelization, dam construction and levee construction.

Additionally, the trees that become inundated during dam construction would remain in place and provide physical structure that would be used by fish as feeding, shelter, and breeding habitat. The additional surface area provided by the inundated woody vegetation would provide substrate for macro invertebrate colonization, which in turn would serve as a food source for fish and other aquatic organisms.

The construction of DS19 would also create a barrier to upstream movement by fish that would result in long-term, minor impacts to the fish community in the upper reaches of South Papillion Creek. The impacts would be considered minor due to the poor quality of the existing fish habitat, and low diversity and abundance of the existing fish population in the South Papillion Creek within the proposed project area.

#### 5.12.2.2 Little Papillion Creek

To reduce flood risk along the Little Papillion Creek, Dam Site 10 would be constructed along Thomas Creek, which is a tributary to the Little Papillion Creek. A 1,450-foot long dam would be constructed across the creek to create a dry dam with a 358-acre flood pool. Because DS10 would be a dry dam, most of the time the creek would remain within its banks and continue to flow as usual. The creek would only come out of its banks and begin to fill the flood pool during higher than normal runoff events. Construction of the dam would cause a small backwater to form within the creek channel for a distance of approximately 800 feet upstream from the face of the dam. This backwater would be contained within the banks of the creek, but it would create a pool that is approximately three feet deeper than the water in the creek would be without the proposed project. The structure within the dam that creates the backwater pool would likely serve as an impediment to upstream fish migration. DS10 would be constructed in the upstream portion of the Thomas Creek watershed where the channel is relatively small and the amount of available fish habitat is small, and of poor quality. The creek is surrounded by farm ground on both sides of the channel. The backwater pool that is formed by construction of the dam would provide some habitat diversity and potential refugia for fish in the reach upstream of the dam. However, the structure that creates the backwater pool would create an impediment to upstream migration by fish. In addition, approximately 1,500 feet of Thomas Creek would be lined on each side with a 100-foot buffer of native riparian forest and prairie plantings to mitigate impacts to riparian forest and stream function. These buffered areas would provide some benefits to fish by intercepting ag runoff and improving water quality. These buffered areas would also improve instream fish habitat diversity as leaf litter and branches fall or wash into the creek. The impacts of construction of DS10 to fish would be long term and minor. The impacts would be considered minor due to the location of the dam high up in the watershed, and the poor quality of the existing fish habitat and associated fish community.

Under the Recommended Plan, new levees and/or floodwalls ranging in height from 2.9 to 7.4 feet would be constructed along the Little Papillion Creek between Blondo Street and Saddle

Creek. Construction of the levees and/or floodwalls in this reach would occur along the high bank and would not affect fish habitat within the channel. The channel in this reach is 150 to 180 feet wide and there are very few trees along the channel. Where there are trees, they are along the high bank and too far from the low flow channel to provide shade and organic matter input to the stream. A Section 402 permit would be obtained prior to construction and best management practices would be utilized to prevent sediment from flowing into the channel during construction. For these reasons, the construction of new levees and/or floodwalls along the Little Papillion Creek is not likely to adversely impact fish in the creek.

#### 5.12.2.3 Nonstructural

Typical nonstructural measures that would be implemented under the Recommended Plan include elevating structures, dry floodproofing, and filling basements. These measures would occur in previously developed areas, and often, within the footprint of existing structures, therefore these activities would have no effect on fish or fish habitat.

## 5.13 MAMMALS

Mammals that may typically be found in the vicinity of waterways in eastern Nebraska, like that of the Papillion Creek basin, include whitetail deer (*Odocoilius virginianus*), Virginia opossum (*Didelphis virginiana*), masked shrew (*Sorex cinereus*), least shrew (*Cryptotis parva*), eastern red bat (*Lasiurus borealis*), woodchuck (*Marmota monax*), white-footed mouse (*Peromysus leucopus*), northern grasshopper mouse (*Onychomys leucogaster*), southern bog lemming (*Synaptomys cooperi*), meadow vole (*Microtus pennsylvanicus*), and least weasel (*Mustela nivalis*) (Benedict et al., 2000). It is anticipated that generalist species prone to urbanized areas such as raccoon (*Procyon lotor*), Virginia opossum, skunk (*Mephitis mephitis*), fox squirrel (*Sciurus niger*), white-footed mouse and red fox (*Vulpes vulpes*) would likely be present throughout the study area.

### 5.13.1 No Action

Under the No Action Alternative, no federally funded construction activities would take place within the Papillion Creek Basin; however, non-federal sponsors may continue to implement flood risk reduction measures should local funding become available. It is anticipated that under the No Action Alternative, no adverse impacts to mammals would occur.

### 5.13.2 Recommended Plan

None of the proposed construction areas under the Recommended Plan currently provide high quality habitat for mammals or other wildlife. The project area is highly urbanized or in agricultural production. Most of the areas where construction activities would take place are composed of smooth brome and reed canary grasses, neither of which provide habitat value to wildlife. In these grassed areas, common small mammal species such as cottontail rabbits, skunks, woodchucks, and various mouse species may be temporarily displaced to similar nearby habitat during construction activities. It is anticipated that small mammals would recolonize the project area after construction is complete and the areas have been replanted.

Approximately 2 acres of tree clearing would be required along the Little Papillion Creek for levee and floodwall construction, and 2 acres of trees would be cleared along Thomas Creek to construct DS10. At DS19, approximately 19.5 acres of trees would either be cleared or inundated and killed by construction of the dam and filling of the reservoir pool. The loss of these trees would displace common mammal species typically found in forested areas or timber strips near water such as raccoons, fox squirrels, opossums, mink, and white tail deer  All trees lost to flooding or removal would be replaced as described in Section 5.10. The mitigation plantings for Little Papillion Creek would occur along the top of the banks of creek channels within the Papillion Creek basin that are currently owned by the NRD. The mitigation plantings for DS10 would occur along the banks of Thomas Creek within the footprint of the proposed flood pool. Mitigation plantings for DS19 would occur within the band of land surrounding the reservoir between the top of the normal pool elevation and the flood pool elevation. As the tree plantings mature over time, mammal species displaced by construction would begin to utilize the new habitat areas.  The tree plantings around DS19 would provide higher quality habitat than currently exists because the land surrounding the South Papillion Creek in the proposed project area is currently in agricultural production, providing lower quality habitat to most resident mammal species within the area. Once DS19 is constructed, the project lands surrounding the normal pool would be managed for recreation and wildlife habitat. This area would be planted with native grasses, shrubs, and trees, replacing the cropland.

## 5.14 Migratory Birds

As of 2017, Nebraska had an official state bird list that includes 461 species. Approximately 350 occur annually and 200 breed within the state. Many species of birds native to Nebraska have become extirpated due to human activities while several specialized species have considerably decreased due to wetland loss and loss and fragmentation of natural habitat and vegetation. Generalists, such as ravens (*Corvus corax*) and cowbirds (*Molothrus ater*) and nonnative species, such as European starlings (*Sturnus vulgaris*) have benefitted from these land changes and shift in composition of bird populations. Based on breeding bird surveys, breeding species that are increasing in Nebraska include the wild turkey (*Meleagris gallopavo*), Canada goose (*Branta canadensis*) and merlin (*Falco columbarius*), while many species of grassland-adapted birds such, as Henslow's sparrow (*Ammodramus henslowii*) and greater prairie chicken (*Tympanuchus cupido*), are precipitously declining. In fact, 75-percent of grassland species are undergoing population declines and according to USFWS, have nationally declined greater than any other ecological category (Johnsgard, 2013).

All Federal agencies are subject to the provisions of the Migratory Bird Treaty Act (MBTA) (16 U.S.C. § 703-712, though §709 is omitted) which regulates the take of any migratory bird species.  If a Corps project is expected to impact any migratory bird species, coordination with the USFWS is typically initiated in order to minimize impacts to these species.  The Papillion Creek basin falls within the Central Flyway which merges easterly towards the Mississippi Flyway as it follows along the Missouri River. This route has been recognized as a collective north-south migratory pathway that houses 114 U.S and 21 Canadian localities of special importance to birds migrating. An estimated 400 species from 50 avian families utilize the Central Flyway to and from breeding and wintering grounds (Johnsgard, 2012).

Utilizing the USFWS IPaC online tool, 21 migratory birds of Conservation Concern were identified as having the potential to occur, or breed within the study area.

### 5.14.1 No Action

Under the No Action Alternative, there would be no construction of a federal project within the Papillion Creek Basin; however, non-federal sponsors may continue to implement flood risk reduction measures such as channel improvement and damming. Local entities must comply with the MBTA so there would be no anticipated impacts to migratory birds under the No Action Alternative.

### 5.14.2 Recommended Plan

Construction of the various features of the Recommended Plan would result in the removal or flooding and eventual mortality of over 23.5 acres of trees. Tree removal activities would be restricted to the time period between April 1st and October 31st to avoid impacts to nesting migratory birds. In addition, all trees removed or inundated would be replaced as described in Section 5.10. For these reasons, migratory birds are not likely to be adversely impacted by implementation of the Recommended Plan.

## 5.15 BALD EAGLE

The bald eagle (*Haliaeetus leucocephalus*) was federally listed as a threatened species under the ESA (7 U.S.C. § 136, 16 U.S.C § 1531) in 1973 though they were officially declared as endangered prior to the ESA in 1967. On August 9, 2007, the bald eagle was removed from the federal list of threatened and endangered species but continues to be protected under the Bald and Golden Eagle Protection Act (BGEPA) (16 U.S.C. § 668-668d), MBTA and the Lacey Act (16 U.S.C. § 701). Bald eagles are known to inhabit forested areas along waterways and near waterbodies. These birds tend to construct their nests in mature trees near aquatic habitats, especially in cottonwood trees. Bald eagle nests are typically easy to identify due to their large size and their height (they can be eight feet or more in diameter and 12 feet or more in height). They feed primarily on fish and crippled waterfowl but may also feed on upland game birds and other birds, carrion, and small rodents. Over the past few years, a pair of bald eagles have nested in a cottonwood tree near the soccer fields at Wehrspann Lake, which is one of the existing dam sites along the South Papillion Creek. However, no bald eagle nests have been identified near any of the proposed project construction locations.

### 5.15.1 No Action

Under the No Action Alternative, there would be no construction of a federal project within the Papillion Creek Tributaries Basin, so there would be no impacts to bald eagles. Should non-federal sponsors continue to implement flood risk reduction measures such as channel improvement, levee construction, or dam construction, they would be required to comply with the BGEPA and MBTA. No adverse impacts are anticipated to occur to bald eagles under the No Action Alternative.

### 5.15.2 Recommended Plan

Bald eagles are known to pass through the proposed project area and likely occasionally roost on trees along the creek channels; however, the quality of the habitat for bald eagles in the proposed project area is relatively poor. No bald eagle nests or communal roost sites have been identified within the proposed project area, and bald eagle nest surveys would be conducted prior to commencement of construction activities. For these reasons, tree removal and other construction activities are not likely to adversely affect bald eagles. The construction of DS19 would provide new habitat that could be beneficial to bald eagles. The reservoir would be stocked with fish and the open water would attract waterfowl. Fish and waterfowl are both primary prey items for bald eagles, so the new reservoir at DS19 could provide productive foraging areas for bald eagles.

## 5.16 Reptiles and Amphibians

Presently, 13 species of amphibians and 47 species of reptiles are known to exist in the entire State of Nebraska. In Eastern Nebraska, the tiger salamander (*Ambystoma trigrinum*), cricket frog (*Acris crepitans*), woodhouse toad (*Bufo woodhousii*), western gray tree frog (*Hyla chrysoscelis*), plains leopard frog (*Rana blairi*), northern leopard frog (*Rana pipiens*) and western striped chorus frog (*Pseudacris triseriata*), are all amphibians that have a high probability of being found in and around the project area.

Reptiles expected to be found within the Papillion Creek basin include the blue racer (*Coluber constrictor*), prairie kingsnake (*Lampropeltis calligaster*), milk snake (*Lampropeltis triangulum*), common watersnake (*Nerodia sipedon*), bull snake (*Pituophis catenifer*), varying species of gartersnakes (*Thamnophis spp*.), the prairie skink (*Eumeces septentrionalis*), snapping turtle (*Chelydra serpentina*), and painted turtle (*Chrysemys picta*) (Lynch, 1985). During a site visit in May of 2019, a large spiny softshell turtle (*Apalone spinifera*) was observed basking on the bank of the low flow channel in Little Papillion Creek between Dodge Street and 72nd Street.

The quality of the habitat for reptiles and amphibians in most of the proposed construction areas is relatively poor because the creeks are flashy, so the water levels rise and fall rapidly. The vegetation is dominated by smooth brome grass and reed canary grass with a few areas of trees along the steep channel banks. Most of the frogs and turtles spend the majority of their time in the low flow channel, along the water's edge, or in the vegetation immediately next to the channel. Some snakes, toads and leopard frogs can be found using the grasses on the channel bench and along the channel side slopes above the bench.

### 5.16.1 No Action

Under the No Action Alternative, there would be no construction of a federal project within the Papillion Creek Tributaries Basin, so there would be no impacts to reptiles or amphibians.

### 5.16.2 Recommended Plan

Under the Recommended Plan, construction activities associated with the proposed construction of new levees and/or floodwalls along Little Papillion Creek would result in a significant amount of ground disturbance that could temporarily displace some reptiles and amphibians.

Construction activities associated with the levee and floodwall work would be limited to areas along the top of the high bank where the habitat quality is relatively poor for reptiles and especially amphibians. Best management practices, such as the construction of silt fences would be used to prevent sediment from washing into the creek channel during construction. Once construction is complete, all disturbed areas would be replanted with grasses. Snakes, toads, and frogs would likely recolonize the levee construction areas. Construction of the proposed floodwalls would create a barrier for reptiles and amphibians as they attempt to move between the creek channel and the floodplain on the high bank. The impacts of levee construction to reptiles and amphibians would be considered temporary and minor. The impacts would only occur during construction, and the primarily brome grass and bluegrass habitat that would be disturbed, would be replaced after construction is complete. Construction of the floodwalls would have long-term minor impacts to reptiles and amphibians. The floodwalls would be permanent structures that could inhibit movement of reptiles and amphibians between the banks of the low flow channel and the high banks. These impacts would be considered minor because the existing habitat on the high banks is of poor habitat value to reptiles and amphibians, and most of them utilize the habitat within the banks of the creek channel. Within the banks of the creek channel, most of the reptiles and amphibians utilize the banks of the low flow channel and the associated channel bench.

Construction of DS19 on South Papillion Creek would result in the conversion of stream channel into reservoir habitat. The current habitat along the South Papillion Creek channel is of relatively poor quality for reptiles and amphibians. The habitat consists of a narrow strip of trees growing out of the steep side slopes of the creek channel. On the high banks, there is a narrow, 25- to 50-foot wide buffer strip of smooth brome grass directly adjacent to either side of the creek channel. The areas beyond the buffer consist entirely as crop ground that has little value to most wildlife. Construction of DS19 would significantly improve habitat for reptiles and amphibians. The reservoir would provide much more usable shoreline for frogs, toads, and snakes, and the open water of the lake would provide significantly more habitat for turtles. In addition, the land between the normal pool elevation and the maximum flood pool elevation would be planted with native vegetation, providing significantly more usable habitat for reptiles and amphibians than is currently provided by the existing crop fields.

Construction of the proposed dry dam at DS10 on Thomas Creek would result in some benefits for reptiles and amphibians. Currently, the habitat within the portion of Thomas Creek located within the proposed project area consists of a narrow strip of trees growing out of the steep side slopes of the creek channel. On the high banks, there is a narrow, 25- to 50-foot wide buffer strip of smooth brome grass directly adjacent to either side of the creek channel. The areas beyond the buffer consist entirely as crop ground that has little value to most wildlife. Construction of the dam would result in the creation of an 800-foot long backwater pool within the creek channel upstream of the dam face. Water in this 800-foot long segment of the creek would back up behind the dam and remain approximately 3 feet deeper than it currently is during normal flows. This deeper water would still be contained within the banks of the existing creek channel. The ground adjacent to the creek within the 800-foot long backwater area would remain wetter than it would have without the proposed project, and wetland vegetation is expected to develop in these areas with wetter soil. In addition, construction of the dam would cause the 2-year event to leave

the banks of the creek and temporarily flood approximately 6 acres of land that is currently farmed. This more frequently flooded area is expected to no longer be farmable and much of the area would develop wetland characteristics over time. The backwater pool that is created within the creek channel, and the wetlands that develop adjacent to the channel, and in a portion of the ground that is currently being farmed, would all provide improved habitat conditions for reptiles and amphibians when compared to the existing conditions.

## 5.17 AQUATIC MACROINVERTEBRATES

Macroinvertebrates are organisms that lack a spine and are large enough to be seen with the naked eye. Examples of aquatic macroinvertebrates that inhabit the Papillion Creek basin include aquatic insects, mussels, crustaceans, worms, and other arthropods that are commonly found attached to rocks, vegetation or woody debris, or burrowed into the streambed. They directly reflect water quality and stream habitat quality as they are extremely sensitive to pollutants. The Stream Biological Monitoring Program (SBMP) provides statewide assessments of the biological conditions of Nebraska's streams. This SBMP began in 1983 where over 900 stream sites throughout the state were sampled for fish and macroinvertebrates. In 1997, NDEQ added additional randomly selected sites. Within the entire state, since 1997, NDEQ has collected over 600 species of macroinvertebrates (NDEQ, 2019).

Big Papillion Creek and Papillion Creek are both sampled as part of the SBMP and habitat scores were rated as "poor" for macroinvertebrates using an Invertebrate Community Index (Bazata, 2005). Another field assessment conducted in 2002 for streams in Douglas County assessed the West Papillion, Big Papillion, and Little Papillion creeks. Of the segments assessed on these three streams, on average, approximately 30 percent were classified as "poor" habitat and approximately 70 percent were considered "marginal" using the EPA rapid bioassessment protocol (CH2MHILL, 2008).

### 5.17.1 No Action

Under the No Action Alternative, no federally funded construction would occur; however, non-federal sponsors may continue to implement flood risk reduction measures should local funding be sourced for such activities. The quality of habitat for aquatic macroinvertebrates in the basin would remain poor or marginal at best should the No Action Alternative be implemented; the invertebrate community would continue to be dominated by tolerant, generalist species reflective of the poor habitat conditions.

### 5.17.2 Recommended Plan

Construction of the various features of the Recommended Plan may cause minor impacts to the already impaired aquatic invertebrate community in the Papillion Creek Tributaries Basin. The potential impacts to invertebrates are described below by stream.

#### 5.17.2.1 South Papillion Creek

Under this alternative, DS19 would be constructed along the South Papillion Creek. This would involve the construction of a 1,450-foot earthen dam across the South Papillion Creek to create a

74-acre lake within the existing creek valley. A sediment retention structure would also be constructed just upstream of the normal lake pool. The proposed dam site would be constructed in the upstream portion of the creek's watershed where the channel is relatively small and the amount of available macroinvertebrate habitat is small, and of poor to moderate quality. Construction of the dam would convert over 4,800 feet (4.4 acres) of poor to moderate quality stream habitat into a 74-acre lake. The lake would provide significantly more potential habitat for aquatic macroinvertebrates; inundated trees would remain in place providing increased habitat. It is expected the invertebrate community would likely shift to species that prefer the stiller waters of a lake rather than the flowing water conditions that currently exist in the creek. The reservoir that is created by DS19 would support a larger and slightly different aquatic macroinvertebrate community than the creek currently supports. For these reasons, the construction of DS19 is not likely to adversely affect aquatic macroinvertebrates in the South Papillion Creek. In fact, construction of DS19 may result in some beneficial impacts by providing significantly more potential habitat.

#### 5.17.2.2 Little Papillion Creek

To reduce flood risk along the Little Papillion Creek, a dry dam at DS10 is proposed for construction along Thomas Creek, which is a tributary to the Little Papillion Creek. A 1,450-foot long dam would be constructed across the creek to create a dry dam. The proposed dam site would be constructed high up in the Thomas Creek watershed where the channel is relatively small, and the amount of available aquatic habitat is small and of poor quality. Because DS10 is proposed to be a dry dam, the creek would continue to flow and function as a stream most of the time except during precipitation events large enough to cause the water to back up behind the dam and spill out into the flood pool. Because the creek will continue to function as a creek most of the time, construction of the dry dam at DS10 is expected to result in long-term minor impacts to the already poor to marginal macroinvertebrate community in the creek. These minor impacts would be the result of the more frequent flooding of the adjacent farmland that would occur once the dam is in place. This more frequent flooding could potentially introduce more agricultural chemicals, or sediment into the creek depending on the time of year and type of ground cover present when the flooding occurs. This potential increased frequency of exposure to agriculture chemicals and sediment could result in minor impacts to the macroinvertebrate community in the creek that consists primarily of generalist species that are more tolerant of changes to water quality.

Under the Recommended Plan, new levees and/or floodwalls ranging in height from 2.6 to 9.8 feet would be constructed along the Little Papillion Creek between Blondo Street and Saddle Creek. Construction of the levees and/or floodwalls in this reach would occur along the high bank and would not affect aquatic macroinvertebrate habitat within the channel. The channel in this reach is 150 to 180 feet wide and there are very few trees along the channel. Where there are trees, they are along the high bank and too far from the low flow channel to provide any shade to the stream. A Section 402 permit would be obtained prior to construction and BMPs would be utilized to prevent sediment from flowing into the channel during construction. For these reasons, the construction of new levees and/or floodwalls along the Little Papillion Creek is not likely to adversely impact aquatic macroinvertebrates in the creek.

#### 5.17.2.3 Nonstructural

Elevation, dry floodproofing, and filling basements would occur in previously developed areas and often within the footprint of existing structures, therefore these activities would have no effect on aquatic macroinvertebrates or their habitat.

## 5.18 Threatened and Endangered Species

In accordance with Section 7 of the Endangered Species Act (7 U.S.C. § 136, 16 U.S.C. § 1531), the USFWS was consulted to obtain information on federally listed threatened and endangered species that have the potential to occur within the proposed project area. A letter dated November 20, 2018 was submitted to the USFWS Region 6 Ecological Services Field Office requesting information on anticipated impacts that may be associated with proposed alternatives and a list of federally-listed threatened and endangered species that may be found in the study area. The USFWS responded with a letter dated April 16, 2019 that provided a list of Federally listed species that may occur within the proposed project area or be affected by the proposed project. Three Federally listed threatened or endangered species were identified as having the potential to occur within the study area. They include the threatened northern long-eared bat (*Myotis septentrionalis*), western prairie fringed orchid (*Platanthera praeclara*) and the endangered pallid sturgeon (*Scaphirhynchus albus*).

The analysis presented within Section 5.18 and its sub-sections are intended to serve as the Biological Assessment for the USFWS to assess potential impacts to listed species that may occur within the project area. Effect determinations are pending concurrence with USFWS.

### 5.18.1 Northern Long-eared Bat

The northern long-eared bat was listed as federally threatened on May 2, 2015 and may be found within the project area. The northern long-eared bat is distributed along the eastern half of the United States, with a range that extends into and throughout the majority of the state of Nebraska, including Douglas, Sarpy, and Washington Counties. It is thought that habitat fragmentation, human disturbance and the emergence of white-nose syndrome (*Pseudogymnoascus destructans*) has decimated populations. As of October 2018, white nose syndrome has been confirmed in four counties of Nebraska, including Sarpy County.

During summer, northern long-eared bats roost singly or in colonies underneath bark, in cavities, or in crevices of both live and dead trees. Males and non-reproductive females may also roost in cooler places, like caves and mines. These bats are opportunistic and select roost tree species based on the tree's suitability to retain bark or provide cavities or crevices. It has also been found, rarely, roosting in structures like barns and sheds. Northern long-eared bats spend the winter hibernating in caves and mines, referred to as hibernacula. They typically use large caves or mines with large passages and entrances; constant temperatures; and high humidity with no air currents. Specific areas where they hibernate have very high humidity (USFWS, 2015).

Northern long-eared bats emerge at dusk to fly through the understory of forested hillsides and ridges feeding on moths, flies, leafhoppers, caddisflies, and beetles, which they catch while in

flight using echolocation. Northern long-eared bats also feed by gleaning motionless insects from vegetation and water surfaces.

In Nebraska, breeding begins in late summer or early fall when males begin swarming near hibernacula. Fall swarming is the final stage before hibernation. Swarming starts in mid-August and lasts through the end of October. After copulation, northern long-eared bats hibernate in caves in southeastern Nebraska from October 15 to March 15 before beginning migration to summer-use areas. After hibernation, pregnant females migrate to summer areas where they roost in small colonies and give birth to a single pup in June or early July (USFWS, 2015). Maternity colonies disperse toward hibernacula shortly after the young are able to fly. Northern long-eared bats can live up to 19 years (USFWS, 2015).

#### 5.18.1.1 No Action

No Federally funded construction activities would occur within the Papillion Creek Basin under the No Action Alternative. There is potential that non-federal sponsors may choose to continue to implement flood risk reduction measures such as channel improvement and/or dam construction should local funding be provided. Should any non-federal sponsors determine to implement these measures, they would have to comply with Section 10 of the ESA which would require them to provide a Habitat Conservation Plan to the USFWS. Because there would be no federally funded construction associated with this alternative, there would be no impacts to northern long-eared bats.

#### 5.18.1.2 Recommended Plan

During an agency scoping meeting for the proposed project on December 10, 2018, the Nebraska Game and Parks Commission stated that there are no known hibernacula for northern long-eared bats within the Papillion Creek Basin. A total of approximately 2 acres of trees would have to be removed from the banks of the Little Papillion Creek to construct the levees and floodwalls, and 2 acres would have to be removed from Thomas Creek to construct the dam at DS10. Tree clearing would be restricted to the period between November 1st and March 31st to avoid the taking of potential maternity roost trees during the pup season (June 1 to July 31) and to avoid taking potential roost trees during the active season (April 1 to October 31) for the bats. In addition, the filling of the reservoir behind DS19 would inundate and eventually kill approximately 19.5 acres of mature trees. It is estimated it could take up to five years for the reservoir to fill to its normal pool level. The trees within the reservoir would be expected to slowly die as the pool level rises, and portions of the crowns of the trees would likely remain above the normal pool elevation. Because the trees would slowly be flooded and slowly die, northern long-eared bats would be able to find other suitable trees to roost in outside the reservoir pool if and when the trees within the reservoir pool are completely inundated or otherwise become unsuitable habitat for the bats. For these reasons, the Recommended Plan may affect, but is not likely to adversely affect northern long-eared bats.

### 5.18.2 Western Prairie Fringed Orchids

The western prairie fringed orchid is an herbaceous perennial that was listed as federally threatened on September 28, 1989. This member of the orchid family is native to the Midwest

prairies, typically found in wet-mesic sedge meadows (Sharma et al., 2003). Loss of habitat through agrarian and urban encroachment have caused population declines.

The western prairie fringed orchid is reportedly long lived, provided adequate environmental factors exist. This plant is entirely propagated by seed and perpetuates through a perennating bud which forms on fusiform tubers. The initial shoot will emerge between April and May. A single bud is produced on the rhizome but will remain dormant over the winter after the plant senesces in September. In the following spring, the bud will develop into vegetative shoots. Inflorescence typically occurs in July. Pollination is required and is typically performed by various species of hawkmoths (USFWS, 1996). Mature seeds are released in the early fall and new progeny will form.

It is thought that a drought lasting longer than a year will severely increase mortality and reduce seed viability of remaining individuals. It is also sensitive to extensive periods of inundation. Habitat management practices such as grazing, mowing and burning may also affect survivorship.

The Papillion Creek basin does not provide adequate habitat to support western fringed prairie orchids due to the severe alteration of the watershed, urbanization, and agricultural impacts.

#### 5.18.2.1 No Action

No construction activities would occur in the Papillion Creek Basin under the No Action Alternative, so there would be no impacts to western prairie fringed orchids.

#### 5.18.2.2 Recommended Plan

No unbroken, native prairie habitat exists within the proposed project area, and none of the proposed work areas under the Recommended Plan have suitable habitat for western prairie fringed orchids. The two proposed dam sites would be constructed within heavily disturbed agricultural land that is currently in crop production. The proposed levee and floodwall construction along Little Papillion Creek are all located in areas dominated by non-native smooth brome grass and turf forming bluegrass and fescue. For these reasons, the Recommended Plan would have no effect on western prairie fringed orchids as the species is not present.

### 5.18.3 Pallid Sturgeon

The pallid sturgeon is a large, long-lived bottom-dwelling fish that inhabits turbid, fast-flowing rivers within the Missouri and Mississippi River basin. Pallid sturgeon are often mistaken for their close relative, shovelnose sturgeon (*S. platorynchus*) and were not identified as a distinct species until 1905. Pallid sturgeon are not present within any of the streams of the Papillion Creek watershed; however, they are present immediately downstream in the Missouri River.

#### 5.18.3.1 No Action

No construction activities would occur in the Papillion Creek Tributaries Basin under the No Action Alternative, so there would be no impacts to pallid sturgeon.

#### 5.18.3.2 Recommended Plan

Pallid sturgeon are not present in any of the streams of the Papillion Creek Basin, so the proposed project would have no effect on pallid sturgeon.

## 5.19 State Listed Species of Concern

According to the Nebraska Natural Heritage Program, four species of State concern have the potential to occur in Douglas, Sarpy and Washington counties: lake sturgeon (*Acipenser fulvescens*), sturgeon chub (*Macrhybopsis gelida*), river otter (*Lontra canadensis*), and American ginseng (*Panax quinquefolium*). Currently the Papillion Creek Basin does not provide adequate habitat to support any of these species.

### 5.19.1 No Action

No construction activities would occur in the Papillion Creek Tributaries Basin under the No Action Alternative, so there would be no impacts to the lake sturgeon, sturgeon chub, river otter, or American ginseng.

### 5.19.2 Recommended Plan

No suitable habitat for the lake sturgeon, sturgeon chub, river otter, or American ginseng exists within the proposed project area, therefore implementation of the Recommended Plan would have no effect on these state-listed species.

## 5.20 Invasive Species

Several Federal and state agency authorities, statutes, policies, and procedures regulate floral and faunal invasive species. The National Invasive Species Act of 1996 (NISA; 16 U.S.C. § 4701 [PL 104-332]), which arose from the Non-indigenous Aquatic Nuisance Species Prevention and Control Act of 1990 (16 U.S.C. § 4701, as amended through Public Law (PL) 106-580 December 2000) is intended to prevent invasive species from entering inland waters. Executive Order (EO) 13112 seeks to prevent the introduction of invasive species and authorizes control of said species to minimize economic, ecological, and human health impacts. This EO directs all federal agencies to address invasive species concerns and refrain from actions likely to increase invasive species problems. EO 13751 further amends 13112 to direct continuation of coordination for federal prevention and control efforts. This order also maintains and expands the National Invasive Species Council and further incorporates considerations of human and environmental health, climate change, technological innovation, and other emerging priorities into federal efforts to address invasive species in a cost-efficient manner. EO 11987 directs agencies to restrict the introduction of exotic species into the natural ecosystems on lands and waters which they own, lease or hold for purpose of administration and encourage state and local governments as well as private citizens to prevent the introduction of exotic species in natural ecosystems of the United States.

Additionally, the USACE has established a nationwide policy for the prevention, control and assessment of invasive species on all USACE managed and/or administered lands and waters

proposed for Civil Works projects, and USACE land utilized for outgrants and permits as identified in the USACE Invasive Species Policy Memorandum, dated June 2, 2009.

The State of Nebraska has identified Category 1 and 2 species, which are not known or prevalent species but would pose significant risk if introduced and are a top priority for eradication for new or existing populations, respectively. Category 3 species are established species; within the study area, established species include callery pear (*Pyrus calleryna*), reed canary grass (*Phalaris arundinacea*), Chinese elm (*Ulmus parvifolia*), and crown vetch (*Securigera varia*).

In addition to invasive flora, faunal species known to be present within the Papillion Creek basin include zebra mussels (*Dreissena polymorpha*) and common carp (*Cyprinus carpio*). Both Lake Zorinsky and Glen Cunningham were infested with zebra mussels. In an effort to eliminate the mussels, both lakes were drained to expose the zebra mussels to cold temperatures over the winter causing them to freeze and desiccate. While the lakes were drained, they were also treated with Rotenone to target common carp.

### 5.20.1 No Action

Under the No Action Alternative, no federally funded construction activities would occur within the Papillion Creek Basin; however, the non-federal sponsors may continue to implement flood risk reduction measures such as channel improvement and dam construction. Non-federal sponsors would be required to comply with NRD and County Weed Management Plans. No adverse impacts are anticipated under the No Action Alternative.

### 5.20.2 Recommended Plan

Reed canary grass, an invasive species, dominates the banks of the low flow channels and on the riverward side of the channel benches within all of the creeks of the Papillion Creek Basin. Once construction is complete, the disturbed areas will be replanted with smooth brome or other sod forming grasses. While reed canary grass would not be planted in the disturbed areas following construction, it is so prevalent in the basin that it is likely to recolonize the lower elevation, and wetter areas within the replanted areas and eventually become the dominant species in the years after construction is complete. Management of invasive species would be addressed following construction during adaptive management and monitoring as well as identified in the Operations and Maintenance Manual.

As previously mentioned above, both Lake Zorinsky and Glen Cunningham Lake have been previously infested with zebra mussels. In an effort to eliminate the mussels, both lakes were drained to expose the zebra mussels to cold temperatures over the winter causing them to freeze and desiccate. Currently, these measures seem to have killed off the zebra mussels. The proposed reservoir at DS19 would be at risk of infestation by zebra mussels that could be brought in by boats or bait that have previously been in zebra mussel infested waters. Efforts would be made to educate the public about how to prevent the introduction of zebra mussels into the proposed reservoir at DS19. Signage about the prevention of the spread of aquatic nuisance species would be prominently posted near boat ramps and other public use areas.

## 5.21 SOCIOECONOMICS AND ENVIRONMENTAL JUSTICE

Socioeconomic and demographic information gathered for the Papillion Creek study relies heavily upon data obtained from the U.S. Census Bureau. The boundaries of the 0.2 percent AEP floodplain extent are used as the basis for gathering socioeconomic and demographic conditions for Papillion Creek. The most recent Census data available is from the 2013-2017 American Community Survey (U.S. Census Bureau, 2019). The American Community Survey includes data at the block group level. Block group level data provides a reasonable approximation of population and housing unit counts for the Papillion Creek study area (from the 2010 Census). There are 172 census block groups intersecting the Papillion Creek 0.2 percent AEP study area.

### 5.21.1 No Action

Under the No Action Alternative, no Federal project would be constructed, so the current level existing flood risk in the Papillion Creek Basin would not be reduced. As a result, the potential flood-related economic damages to individuals and businesses would remain high.

The No Action Alternative would not provide additional flood risk reduction beyond existing conditions to the residents living within the study area. There would be no direct impact on minority and/or low-income population groups under this alternative. However, since the No Action alternative fails to provide additional flood risk reduction, the actual and perceived risks to minority and/or low-income population groups under this alternative would be higher than under the recommended plan.

### 5.21.2 Recommended Plan

The Recommended Plan would result in a long-term benefit to the socioeconomic condition of the study area. The Recommended Plan would reduce equivalent annual damages from $14,434,470 under future without-project conditions to $7,026,580 with project. The difference between the future without project and with project condition represents total annual benefits of $7,407,890 resulting from the proposed structural and nonstructural flood risk management measures. When compared to total annual costs of $5,156,420 the resulting benefit-cost ratio is 1.44. The combined flood risk management plan measures, which are individually justified, generate a benefit-to-cost ratio above unity, and produce $2,251,470 in annual net benefits to the Nation.

The USACE is obligated under E.O. 12898 of 1994 and the Department of Defense's Strategy on Environmental Justice (EJ) of 1995, which direct Federal agencies to identify and address any disproportionately high adverse human health or environmental effects of Federal actions to minority and/or low-income populations.

There is a potential adverse direct impact to EJ communities from implementation of the Recommended Plan. Direct impacts occur within the footprint of the structural alternative, which for this project includes two dam sites and a new levee/floodwall. The Recommended Plan will directly impact 131 private residences. The adverse impact of relocation is potentially disproportionate to low-income homeowners if they comprise a majority of homes being acquired.

Indirect impacts are those felt by the community that occur outside of the footprint of the actual structural alternative construction. Positive, indirect impacts related to construction of the structural alignments include reducing the likelihood of flooding and/or damages to housing in EJ and non-EJ communities that would normally flood under a 1 percent AEP flood event. Additionally, the amount of flooding from the 1 percent AEP flood event on the community would be reduced under the with-project condition. Adverse, indirect impacts from construction of the recommended plan include noise, dust, transportation impacts, and possibly induced flooding.

A few reaches in the study area are identified as potentially having flooding induced from construction of the levee/floodwall. Modeling indicates the induced stages would primarily occur on structures in these reaches at events less frequent than the 1 percent AEP event. One structure downstream of the levee/floodwall would experience induced stages at the 1 percent AEP event; however, the stage increase is only 0.14 feet and inundation would remain below the first floor of the structure. The damages from potential induced flooding are minimal and are not considered high adverse impacts.

The Recommended Plan will not cause any significant impacts, nor will it cause either disproportionately high and adverse human health or environmental effects. The recommended plan is expected to provide long-term benefits to the EJ communities by reducing flood risk. Individuals included in any relocation would be provided the necessary relocation assistance and equitable housing provided to displaced persons per the Uniform Relocation Assistance Act (URA). Therefore, disproportionate impacts to EJ communities would not be expected.

## 5.22 Cultural Resources

Under the authority of the National Historic Preservation Act of 1966, as amended; the Archeological Resources Protection Act of 1979, as amended; the Antiquities Act of 1906; the Native American Graves Protection and Repatriation Act of 1990, as amended; the National Environmental Policy Act of 1969; and ER 1130-2-1; the USACE is authorized to preserve eligible cultural resources that may be affected by the operation and management of its projects. Many cultural resource sites are located within the Papillion Creek watershed. Cultural resources can be defined as physical evidence or place of past human activity: site, object, landscape, structure; or a site, structure, landscape, object, or natural feature of significance to a group of people traditionally associated with it.

Consultation with the Nebraska SHPO, Tribes, and other interested parties was initiated in November 2018. The Tribes included in this effort are the Ponca Tribe of Nebraska, the Omaha Tribe, the Otoe-Missouria Tribe, the Ponca Tribe of Indians of Oklahoma, the Pawnee Nation of Oklahoma, the Winnebago Tribe and the Iowa Tribe of Nebraska and Kansas.

A file search with History Nebraska was completed on June 4, 2019. The file search identified numerous surveys located within the Papillion Creek watershed. There are 26 sites within the one-mile radius of the considered alternatives, but only one site has been recorded within the Areas of Potential Effect (APE) of DS19.

Based upon the results of the file search, and the fact that a majority of potential construction areas have been previously impacted, there is a low likelihood of adverse effects on historic properties. As the process of plan formulation took time and the study area is so large, survey contract(s) were not suggested until the design phase. A Programmatic Agreement (PA) is being finalized, in consultation with the Nebraska SHPO, the Advisory Council on Historic Preservation, and interested parties, to address potential impacts to unrecorded historic properties that may be discovered prior to, or during, the construction of levees, floodwalls, and reservoirs on undeveloped land. This includes both structural and nonstructural alternatives. The Draft PA was sent to the SHPO, ACHP, Sponsor, Ponca Tribe of Nebraska, the Omaha Tribe, Otoe-Missouria Tribe, Ponca Tribe of Indians of Oklahoma, Pawnee Nation of Oklahoma, Winnebago Tribe and Iowa Tribe of Nebraska and Kansas for comment prior to finalization on December 18. 2020.

### 5.22.1 No Action

Under the No Action Alternative, no federally funded construction activities would occur within the Papillion Creek Basin; however, the non-federal sponsors may continue to implement flood risk reduction measures such as channel improvement and dam construction. Federal permits would be required to complete this work, so the non-federal sponsors would be required to comply with all applicable state and federal laws for the protection of cultural resources. For this reason, the No Action alternative is not likely to adversely impact cultural resources.

### 5.22.2 Recommended Plan

#### 5.22.2.1 South Papillion Creek

The proposed construction of DS19 on the South Papillion Creek is not likely to have an effect on historic properties, as the footprint of the inundation area has been completely surveyed. One site, 25SY417, was recorded. If eligible historic properties are discovered during construction, construction activities would cease and appropriate mitigation would be determined through a PA being developed in consultation with the Nebraska SHPO, the Advisory Council on Historic Preservation, and interested parties.

#### 5.22.2.2 Little Papillion Creek

The construction of the dry dam at DS10 currently has the potential to effect historic properties, as only one small survey within the APE for DS10 has been conducted. Additional surveys would be required before construction could commence. Construction of the proposed levees and floodwalls along the Little Papillion Creek also currently have the potential to effect historic properties, as only one survey of the proposed levee and floodwall alignments has been conducted. Additional surveys would be required before construction of the levees and floodwalls would be allowed to commence. If eligible historic properties are discovered during construction, construction activities would cease and appropriate mitigation would be determined through a PA being developed in consultation with the Nebraska SHPO, the Advisory Council on Historic Preservation, and interested parties.

#### 5.22.2.3 Nonstructural

Nonstructural measures may be recommended as a result of this study. The owners of thousands of structures may be eligible to apply for such protections for their property, which would be on a voluntary basis. It is also unknown how many of said structures may be eligible for listing on the National Register of Historic Places (NRHP). In advance of implementing such a program, the Corps will continue to pursue the development of a Programmatic Agreement (Appendix C) with the Nebraska SHPO, the Advisory Council on Historic Preservation, and other interested parties, regarding mitigation of any effects to such properties.

## 5.23 RECREATION

The Papillion Creek basin provides over 730 acres of recreational benefits to the citizens of Omaha. Ample recreational opportunities are present throughout the study area, primarily at the dam sites where Papio-NRD manages the reservoirs for fishing, swimming, boating, and kayaking/canoeing. Surrounding the reservoirs is a network of pedestrian and biking trails in addition to the trails associated with the levee system. Passive recreational opportunities such as bird watching, and wildlife viewing are also available at the existing dam sites.

### 5.23.1 No Action

Under the No Action Alternative, there would be no construction of a federal project within the Papillion Creek Tributaries Basin, so there would be no impacts to recreation.

### 5.23.2 Recommended Plan

Construction of the new levees and/or floodwalls along the Little Papillion Creek would cause temporary disruptions to recreational activities along the bike trails that parallel these streams. During construction, the bike trails in the proposed construction areas would have to be closed to the public and demolished to facilitate the levee or floodwall construction. Once levee and/or floodwall construction is complete, the bike trails would be rebuilt on top of the new or raised levees or on the landward side of the proposed floodwalls. The recreation impacts associated with bike trail closures would be considered temporary and minor.

Construction of the dry dam at DS10 would not provide any new recreational opportunities for the public because flowage easements would be acquired for the required lands within the footprint of the proposed flood pool instead of acquiring the land in fee. All of the acquired easement land would remain in private ownership and would not be accessible to the public. In addition, the land within the footprint of the dam and the proposed flood pool is currently privately owned and there are no public recreational opportunities that would be adversely impacted by the proposed project.

Construction of DS19 would provide a significant amount of new recreational opportunities in Sarpy County. Construction of DS19 would result in the creation of a 74-acre lake at normal pool with an additional 135 acres of land between the normal pool elevation and the elevation of the maximum flood pool. The new lake would provide opportunities for fishing, boating, and kayaking/canoeing. The project lands surrounding the lakes would be used for hiking, biking, picnicking, and wildlife viewing.

## 5.24 Cumulative Impacts and Mitigation

The combined incremental effects of human activity are referred to as cumulative impacts (40CFR 1508.7). While these incremental effects may be insignificant on their own, accumulated over time and from various sources, they can result in serious degradation to the environment. The cumulative impact analysis must consider past, present, and reasonably foreseeable actions in the study area. The analysis also must include consideration of actions outside of the USACE, to include other state and federal agencies. As required by NEPA, the USACE has prepared the following assessment of cumulative impacts related to the alternatives being considered in this EA. The Recommended Plan is not anticipated to cumulatively degrade the habitat or current resources within the basin due to its present, altered condition. Adverse effects associated with the Recommended Plan are short-term and minor, primarily limited to construction activities.

Based on the analysis of potential impacts to the environment of the Papillion Creek basin utilizing NeSCAP, and HEP, it was determined that the impacts of the proposed construction included in the Recommended Plan to stream condition and function, riparian forest habitat, and wetlands would require mitigation. Total mitigation acreages and costs by location are shown in Table 53 below.

**Table 53. Total Mitigation Acreages and Costs for the Recommended Plan**

| Impact Location | Habitat Type Impacted | Acres | Cost/Acre | Total RE Cost | Excavation Cost @ $9.09/CY | Seeding/Planting Cost/Acre | Total Implementation Cost | Grand Total Mitigation Cost |
|---|---|---|---|---|---|---|---|---|
| DS10 | Stream | 4.6 | $18,392 | $84,603 | - | $1,800 | $8,280 | $92,883 |
| DS10 | Riparian Forest | 3 | $18,392 | $55,176 | - | $10,060 | $30,180 | $85,356 |
| DS19 | Stream | 5.5 | $8,854 | $48,697 | - | $1,800 | $9,900 | $58,597 |
| DS19 | Riparian Forest | 29.5 | - | - | - | $10,060 | $296,770 | $296,770 |
| DS19 | PEM Wetland | 1.4 | - | - | $50,413 | $2,667 | $3,734 | $54,147 |
| Little Papillion | Riparian Forest | 2.3 | - | - | - | $10,060 | $23,138 | $23,138 |
| **Grand Total** | | **46.3** | | **$188,476** | | | **$372,002** | **$610,891** |

# 6 Plan Implementation

The Final Feasibility Report, Environmental Assessment, Finding of No Significant Impact, and accompanying Chiefs Report, once approved, will be offered to Congress for authorization of the Recommended Plan. Construction activities will not commence until such authorization is received, typically within a Water Resources Development Act.

## 6.1 Construction and LERRDs

Cost for detailed design of the project will be shared between the non-Federal sponsor and USACE. All detailed design and construction will be in accordance with USACE's regulations and standards. LERRDs would be the responsibility of the non-Federal sponsor.

## 6.2 Cost Sharing

A non-Federal sponsor must support all phases of the project. Feasibility Study costs are typically shared 50 percent Federal and 50 percent non-Federal. Design and implementation phases are cost-shared, with the non-Federal sponsor providing a minimum of 35 percent of the total. Additionally, the non-Federal sponsor must provide all the LERRDs. While the sponsor may receive credit toward this cost-share for work in-kind and LERRDs, a minimum cash contribution of 5 percent is required for structural components of the project. Once a project has been implemented, OMRR&R of the project is a 100 percent non-Federal responsibility, however, will require coordination with USACE for water management purposes. Cost share estimates are shown in Table 54.

**Table 54. Recommended Plan Cost Share Costs**

| Flood Risk Management | Federal | Non-Federal | Total |
|---|---|---|---|
| Structural Construction Cost | | | $37,859,428 |
| Nonstructural Construction Cost | | | $27,099,412 |
| Environmental Mitigation Construction Cost | | | $286,384 |
| Sub-Total Construction Cost | | | $65,245,224 |
| | | | |
| Planning, Engineering, and Design | | | $6,524,522 |
| Supervision and Administration | | | $5,219,618 |
| Contingency | | | $23,866,703 |
| **Total Construction Cost** | | | **$100,856,067** |
| | | | |
| Lands & Damages | | | $26,955,517 |
| Relocations | | | $2,382,330 |
| **Total LERRD** | | | **$29,337,848** |
| | | | |
| **Total FRM First Costs** | | | **$130,193,915** |
| | | | |
| **Cost-Sharing Breakdown (FRM)** | | | |
| Non-Federal LERRD | | $29,337,848 | |
| Non-Federal minimum 5% cash (FRM) | | $6,509,696 | |
| Non-Federal additional cash (FRM) | | $9,720,327 | |
| | | | |
| **Total Cost-Share Amount FRM** | **$84,626,045** | **$45,567,870** | **$130,193,915** |
| **Cost Share Percentage** | **65%** | **35%** | **100%** |
| | | | |
| **Recreation** | **Federal** | **Non-Federal** | **Total** |

| | | | |
|---|---|---|---|
| Construction Cost | | | $2,544,148 |
| Planning, Engineering, and Design | | | $254,415 |
| Supervision and Administration | | | $203,532 |
| Contingency | | | $930,649 |
| **Total Construction Cost** | | | **$3,932,744** |
| | | | |
| **LERRD** | | | **$0** |
| | | | |
| **Total Recreation First Costs** | | | **$3,932,744** |
| | | | |
| **Cost-Sharing Breakdown (Recreation)** | | | |
| Non-Federal LERRD | | $0 | |
| Non-Federal additional cash (Recreation) | | $1,966,372 | |
| | | | |
| **Total Cost Share Amount Recreation** | **$1,966,372** | **$1,966,372** | **$3,932,744** |
| **Cost Share Percentage** | **50%** | **50%** | **100%** |
| | | | |
| **Recommended Plan Total Cost Share Amount** | **Federal** | **Non-Federal** | **Total** |
| | | | |
| **FRM NON-FEDERAL LERRD** | | **$29,337,848** | |
| **FRM NON-FEDERAL CASH** | | **$16,230,023** | |
| **FRM COST SHARE** | **$84,626,045** | **$45,567,870** | |
| | | | |
| **RECREATION NON-FEDERAL LERRD** | | **$0** | |
| **RECREATION NON-FEDERAL CASH** | | **$1,966,372** | |
| **RECREATION COST SHARE** | **$1,966,372** | **$1,966,372** | |
| | | | |
| **TOTAL COST SHARE** | **$86,592,417** | **$47,534,242** | **$134,126,659** |
| **TOTAL COST SHARE PERCENTAGE** | **64.6%** | **35.4%** | **100.00%** |

Following Final Feasibility Report approval, USACE will negotiate and execute a Design Agreement with the sponsor to cost share the design of the first phase of the construction of the Recommended Plan. This PED phase serves to efficiently proceed with design of priority projects while USACE and the sponsor are awaiting authorization from Congress for the actual construction. Development of the plans and specifications will begin as soon as funding is made available. During the PED phase, USACE will prepare a Design Documentation Report and plans and specifications for the initial construction contract. The overall project schedule is based upon the assumption that a positive Chief of Engineers' Report will be forwarded to the Assistant Secretary of the Army for Civil Works. Funding is assumed available at the earliest practical opportunity for new PED starts. Lack of initial PED funding will shift the schedule out accordingly until such time as the PED funding is made available. Additional refinements to the project schedule will be made as authorization and program guidance is received.

The project schedule provides for an almost immediate start of the Recommended Plan design work (PED) beginning in FY22, followed by award of construction contracts, pending authorization, in FY25 through FY29. Several assumptions have been used to project the schedule. Among these are:

- Real estate actions are completed on schedule.
- Federal and non-Federal construction funding is available in the years required.
- All construction activities will be completed by USACE.
- Construction contracts are arranged to accomplish logical sequences of work for increased efficiency.
- More than one contract can be awarded in a given year.

Following construction authorization and near the completion of the PED phase (and prior to the acquisition of any required project lands) the USACE and the respective sponsor will execute a Project Partnership Agreement (PPA). The Design Documentation Report prepared during PED will guide development of the PPA. Work under the signed PPA can begin in reaches requiring no additional lands. For project areas that require lands, the sponsor will acquire easements, rights-of-way and any necessary disposal areas prior to advertisement and award of the first construction contract. Construction contracts are then awarded in sequence following real estate acquisition and the appropriate Engineering During Construction efforts. A preliminary schedule for the design and implementation of this project is shown in Table 55.

**Table 55. Preliminary Design and Implementation Schedule**

| Milestone | Schedule |
|---|---|
| Final Feasibility Report | July 2021 |
| Signed Chiefs Report | September 2021 |
| Earliest Congressional Authorization | 2022 |
| Begin Construction | 2024 |
| Construction Complete | 2029 |
| Adaptive Management & Monitoring Period Complete | 2034 |
| Complete Project and Close Out | 2034 |

The technical scope and magnitude of the project, combined with reasonable assumptions of future funding availability, indicate a likely four construction contract package arrangement for construction of the Recommended Plan. The construction contracts could be implemented simultaneously, depending on availability of funds, but are geographically separated so they will likely be contracted separately. In addition to the structural contracts, nonstructural alternatives would be implemented on individual structures throughout the five-year construction window on a voluntary basis. Further construction details will be developed during PED, which follows completion of the feasibility study. Contract work items would likely be grouped as shown below.

- Contract #1: DS10 Dry Dam
- Contract #2: Little Papillion Creek Levee/Floodwall

- Contract #3: DS19 Wet Dam
- Contract #4: Nonstructural Measures: Elevation, Basement Fill, and Dry Floodproofing

# 7 SUMMARY OF COORDINATION, PUBLIC VIEWS, AND COMMENTS

Public involvement provides for general public and agency input and review within the overall National Environmental Policy Act (NEPA) process. USACE actively solicits input and coordinates with numerous Federal, state and local agencies, businesses, and organizations. More detail on public and tribal coordination can be found in Appendix K.

Public scoping meetings for the feasibility study and environmental assessment were held on December 3 and 5, 2018. The information presented during these initial meetings focused on informing the public about the study and the USACE process, answering questions pertaining to the study area, and receiving initial feedback on the study. Total attendance at the initial meetings was over 50 residents, who provided over 25 comments which are provided in Appendix K. An additional public meeting requested during the scoping meetings to discuss potential alternatives under evaluation was held July 23, 2019. About 50 residents attended this meeting, while no formal comments were taken at this meeting a question and answer session was conducted during the open house.

Feedback from these meetings showed that the public and officials in the local area recognized the need for effective flood risk management in the Omaha area. Issues and concerns raised during the scoping meeting identified:

- Implementation of DS10 and the need to acquire private land
- Long-term sedimentation of dams
- Inadequate enforcement of floodplain regulations

The draft report was available for public comments November 21, 2019 through January 3, 2020 and the draft report public meeting was held on December 3, 2019. Approximately 60 people attended the public meeting including a representative from U.S Senator Deb Fischer's (R-NE) office. Transcripts from the meeting are included in Appendix K. Approximately 31 formal, verbal comments were received during the public meeting and 15 written comments were received either via mail or email. Comment themes included floodplain development, Dam Site 19, Public Involvement, Dam Site 10, operations and maintenance costs, stormwater management, ecosystem services, channel improvements, and modeling.

Due to the on-going COVID-19 pandemic, and in accordance with U.S. Army Corps of Engineers Guidance on conducting public participation for the Civil Works Program during the COVID-19 pandemic, the Papillion Creek GRR Study Team, in cooperation with the PMRNRD held a virtual public meeting on Wednesday, February 10, 2021 for the draft final feasibility report. The meeting was structured to include a formal Power Point presentation followed by an opportunity for the public to ask questions via the WebEx chat function. Questions from the chat box were read and members of the team worked to answer as many as possible in the time allotted.

Invitations and announcements for the scoping and additional public meetings were made in public websites, local City announcements, and through contacts in routine communication channels. The NRD created a webpage on their website to hold all of the study's information, public meeting materials, and provide public comment forms: https://www.papionrd.org/flood-control/papillion-creek-watershed/papillion-creek-and-tributaries-lakes-nebraska-general-reevaluation-study/. Information was also made available on the USACE project web page at (https://www.nwo.usace.army.mil/Missions/Civil-Works/Planning/Planning-Projects/Papillion-GRR/). All meetings were conducted in an open house setting with a brief formal presentation followed by questions from the audience.

# 8 RECOMMENDATIONS

Numerous alternatives for Papillion Creek and its tributaries including West Papillion Creek, South Papillion Creek, Little Papillion Creek, Big Papillion Creek, Papillion Creek, Cole Creek, Saddle Creek, and Thomas Creek, were examined in the study area. These alternatives were evaluated for engineering feasibility, environmental impact, economic viability, and public acceptability. Furthermore, these plans were validated against national and study planning objectives to ensure the best investment for the nation.

The Recommended Plan (RP) includes South Papillion Creek Dam Site 19 (dam with 74 acre conservation pool and sediment detention structure) near Gretna, NE, Thomas Creek Dam Site 10 (dry dam) in rural Douglas County, NE and Little Papillion Creek new levee/floodwall (3.67 miles on right bank and 2.98 miles on left bank with 8 road and bridge closure structures) in Omaha, NE and nonstructural features including 71 basement fills, 59 elevation of residential structures and 256 dry floodproofing of commercial/industrial/municipal structures along Big Papillion Creek, Cole Creek, Papillion Creek, Saddle Creek, South Papillion Creek, and West Papillion Creek. The Dam Site 19 reservoir also includes associated recreational features consisting of a 2.5-mile trail, parking lots, restrooms, picnic shelter, boat access, and related features. Required mitigation of stream, wetland, and riparian forest impacts is also included. The Recommend Plan has substantial economic benefits and reduces study area expected annual flood damages by 51 percent overall, and by 69-78 percent across the South Papillion, Little Papillion, Thomas, and Saddle Creeks portions of the watershed. The Recommended Plan is in compliance with all laws and regulations, meets the intent of the authority, and is fully supported by the non-Federal sponsor, local and regional governments, agencies, and tribes.

In addition to NED the recommended plan provides further benefits and minimizes impacts in terms of Regional Economic Development, Environmental Quality, and Other Social Effects. The implementation of the Recommended Plan would result in local economic activity which is accounted for within the RED account. The Recommended Plan is expected to result in approximately $107,170,094 in construction expenditures across the region. These construction expenditures are expected to support approximately 1,697 local jobs and approximately $114,061,171 in local value added within local impact area. A summary of potential impacts on natural and cultural resources for each stream was identified based on the Recommended Plan to ensure that the EQ Account was not adversely impacted and required mitigation costs are included and captured in the NED analysis. With mitigation, the Recommended Plan is not

anticipated to cumulatively degrade the habitat or current resources within the basin due to its present, altered condition. The recommended plan is not anticipated to adversely impact Cultural Resources, but a Programmatic Agreement (PA) is being finalized in consultation with the Nebraska SHPO, the Advisory Council on Historic Preservation, and Interested Parties to address potential impacts to unrecorded historic properties that may be discovered prior to, or during, the construction of levees, floodwalls, and reservoirs on undeveloped land as well as potential effects from nonstructural modifications to existing properties should the property owners choose to participate in the nonstructural part of the recommended plan. Adverse effects associated with the Recommended Plan are short-term and minor, and primarily limited to construction activities. Other Social Effects (OSE) were also considered including impacts to life safety. A risk assessment was conducted on the recommended Little Papillion Creek levee/floodwall, DS19, and DS10 to inform potential life safety risks associated with their construction. The DS19 and DS10 analysis show the structures fall well below societal tolerable risk guidelines. For the Little Papillion Creek, the recommended plan levee/floodwall alternative (1% AEP energy grade line plus three additional feet) will reduce potential life loss by 2 orders of magnitude over the existing condition.

The recommended plan is estimated to cost $134.1M, at FY21 price levels, which will be cost-shared $86.6M Federal, $47.5M non-Federal. The non-Federal cost includes projected LERRDs value of $29.3M with the balance of $16.2M to be provided in cash. Annual net benefits are $2.8M and the benefit-to-cost ratio (BCR) is 1.51. The Recommended Plan represents a significant investment to the nation and provides an excellent opportunity for the USACE to partner with a very proactive and committed non-Federal sponsor to reduce flood risks throughout the community.

Commander Recommendation:

I have given consideration to all significant aspects in the overall public interest, including environmental, social and economic effects, engineering feasibility, and any other elements bearing on the decision. The plan described above is being recommended with such modifications thereof as in the discretion of the Commander, HQUSACE, may be advisable.

Items of Local Cooperation:
Federal implementation of the project for structural flood risk management and recreation includes, but is not limited to, the following required items of local cooperation to be undertaken by the non-Federal sponsor in accordance with applicable Federal laws, regulations, and policies:

a. Provide a minimum of 35 percent, up to a maximum of 50 percent, of construction costs allocated to flood risk management, and 50 percent of construction costs allocated to recreation, as further specified below:

1. Provide, during design, 35 percent of design costs, in accordance with the terms of a design agreement entered into prior to commencement of design work for the project;

2. Pay, during construction, a contribution of funds equal to 5 percent of construction costs allocated to flood risk management;

3. Provide all real property interests, including placement area improvements, and perform all relocations determined by the Federal government to be required for the project;

4. Provide, during construction, any additional contribution necessary to make its total contribution equal to at least 35 percent of construction costs for flood risk management and 50 percent of construction costs for recreation;

b. Prevent obstructions or encroachments on the project (including prescribing and enforcing regulations to prevent such obstructions or encroachments) that might reduce the level of flood risk reduction the project affords, hinder operation and maintenance of the project, or interfere with the project's proper function;

c. Keep the recreation features, access roads, parking areas, and other associated public use facilities, open and available to all on equal terms;

d. Inform affected interests, at least yearly, of the extent of risk reduction afforded by the flood risk management features; participate in and comply with applicable Federal floodplain management and flood insurance programs; prepare a floodplain management plan for the project to be implemented not later than one year after completion of construction of the project; and publicize floodplain information in the area concerned and provide this information to zoning and other regulatory agencies for their use in adopting regulations, or taking other actions, to prevent unwise future development and to ensure compatibility with the project;

e. Operate, maintain, repair, rehabilitate, and replace the project or functional portion thereof at no cost to the Federal government, in a manner compatible with the project's authorized purposes and in accordance with applicable Federal laws and regulations and any specific directions prescribed by the Federal government;

f. Give the Federal government a right to enter, at reasonable times and in a reasonable manner, upon property that the non-Federal sponsor owns or controls for access to the project to inspect the project, and, if necessary, to undertake work necessary to the proper functioning of the project for its authorized purpose;

g. Hold and save the Federal government free from all damages arising from design, construction, operation, maintenance, repair, rehabilitation, and replacement of the project, except for damages due to the fault or negligence of the Federal government or its contractors;

h. Perform, or ensure performance of, any investigations for hazardous, toxic, and radioactive wastes (HTRW) that are determined necessary to identify the existence and extent of any HTRW regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 U.S.C. 9601-9675, and any other applicable law, that may exist in, on, or under real property interests that the Federal government determines to be necessary for construction, operation, and maintenance of the project;

i. Agree, as between the Federal government and the non-Federal sponsor, to be solely responsible for the performance and costs of cleanup and response of any HTRW regulated under applicable law that are located in, on, or under real property interests required for construction, operation, and maintenance of the project, including the costs of any studies and investigations necessary to determine an appropriate response to the contamination, without reimbursement or credit by the Federal government;

j. Agree, as between the Federal government and the non-Federal sponsor, that the non-Federal sponsor shall be considered the owner and operator of the project for the purpose of CERCLA liability or other applicable law, and to the maximum extent practicable shall carry out its responsibilities in a manner that will not cause HTRW liability to arise under applicable law; and

k. Comply with the applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, as amended, (42 U.S.C. 4630 and 4655) and the Uniform Regulations contained in 49 C.F.R Part 24, in acquiring real property interests necessary for construction, operation, and maintenance of the project including those necessary for relocations, and placement area improvements; and inform all affected persons of applicable benefits, policies, and procedures in connection with said act.

The recommendations contained herein reflect the information available at this time and current Departmental policies governing formulation of individual projects. They do not reflect program and budgeting priorities inherent in the formulation of a national Civil Works construction program nor the perspective of higher review levels within the Executive Branch. Consequently, the recommendations may be modified before they are transmitted to the Congress as proposals for authorization and implementation funding. However, prior to transmittal to the Congress, the sponsor, the States, interested Federal agencies, and other parties will be advised of any modifications and will be afforded an opportunity to comment further.

Mark R. Himes, P.E.
Colonel, U.S. Army Corps of Engineers
Omaha District Engineer

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