# Valley Creek Feasibility Study, Bessemer and Birmingham, Alabama

## Final Integrated Feasibility Report and Environmental Assessment

## October 2021

US Army Corps of Engineers ®
Kansas City District

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# ACRONYMS AND ABBREVIATIONS

AAHU.....Average Annual Habitat Unit
APE.....Area of Potential Effect
CW-WBS.....Civil Works – Work Breakdown Structure
EPA.....U.S. Environmental Protection Agency
ES.....Executive Summary
ESA.....Endangered Species Act
ER.....Engineer Regulation
FR/EA.....Feasibility Report / Environmental Assessment
FWOP.....Future without Project
FWP.....Future with Project
H&H.....Hydrology and Hydraulics
HSI.....Habitat Suitability Index
HUC.....Hydrologic Unit Code
HWY.....Highway
LERRD.....Lands, easements, right of ways, relocations and disposals
NAAQS.....National Ambient Air Quality Standards
NED.....National Economic Development
NEPA.....National Environmental Policy Act
NHPA.....National Historic Preservation Act
NRCS.....U.S. Department of Agriculture – Natural Resources Conservation Service
OSE.....Other Social Effects
P&G.....U.S. Water Resources Council Principles and Guidelines
PA.....Programmatic Agreement
RED.....Regional Economic Development
RFFA.....Reasonably Foreseeable Future Actions
SHPO.....State Historic Preservation Office
TMDL.....Total Maximum Daily Load
USACE.....U.S. Army Corps of Engineers
USFWS.....U.S. Fish and Wildlife Service
USGS.....U.S. Geological Survey
WRDA.....Water Resources Development Act

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# EXECUTIVE SUMMARY

This integrated feasibility report and environmental assessment (FR/EA) presents the results of a U.S. Army Corps of Engineers (USACE) Flood Risk Management feasibility study undertaken to identify and evaluate alternatives to improve life safety and reduce damage to property in the Valley Creek watershed. This study is authorized by House Resolution Docket 2477 Village Creek, Jefferson County, Alabama, adopted March 7, 1996 by the Committee on Transportation and Infrastructure. USACE is undertaking the action in partnership with the City of Bessemer, the study's non-Federal sponsor. The report provides documentation on the plan formulation process to select a recommended flood risk management improvement plan, along with environmental, engineering, and cost details of the recommended plan, which will allow additional design and construction to proceed following the approval of this report.

The federally authorized Valley Creek watershed flood risk management project is located in the greater Birmingham, Alabama metropolitan area. The feasibility study area extends from Valley Creek's origins in Birmingham, Alabama, southwest to the city limits of Bessemer, Alabama, which was identified by USACE and City of Bessemer as the area of critical importance for flood risk management measures.

The purpose of the proposed Federal action is to improve life safety and reduce economic damages in the study area. Risks to life and property have been identified in the watershed. Repeated economic damages and threat to life safety result in economic inefficiencies that result in losses to the national economy.

The plan formulation process identified 48 initial measures for consideration, 35 structural and 13 non-structural including natural and nature-based features in accordance with implementation guidance for Section 1184 of the Water Resources Development Act of 2016. Structural measures identified were off-channel detention, levees, bridge modifications, channel modifications, and inline structures (dams). Types of physical non-structural measures considered include structure elevation, relocation, wet and dry floodproofing, and acquisitions. Nonphysical nonstructural measures included an emergency warning system. Off-channel detention basins were considered nature-based features because they mimic the natural floodwater storage capacity of floodplains. Measures carried forward for alternative development included off-channel detention, bridge modification, channel modification, and acquisitions. An initial array of 13 alternatives were evaluated using the four criteria established in the Principles Requirements for Federal Investments in Water Resources dated March 2013: effectiveness, completeness, efficiency, and acceptability. This evaluation resulted in a final array of four alternatives (Table ES-1).

**Table ES-1. Final Array of Alternatives.**

| Alternative | Description | Annual Mean Net Benefit |
|---|---|---|
| FWOP | Future without project – No action | N/A |
| Alternative 13 | Channel and Bridge Modification plus Residual Risk 2-year floodplain buyout (~79 structures) | 947 |
| Alternative 3 | Three Detention Basins | 933 |
| Alternative 4 | Two Detention Basins | 1053 |

Note: October 2019 (FY20) price level. Federal interest rate of 2.75%, 50 year period of analysis. Numbers are represented in $1,000s.

Alternative 4 is the National Economic Development (NED) plan. The non-Federal partners have expressed their desire to invest in Alternative 4. Alternative 4 provides the highest mean net annual benefits in flood risk management and provides those benefits throughout the corridor, resulting in a complete, effective, efficient, and acceptable plan that meets the planning objectives. Alternative 4 is the USACE recommended plan.

The recommended plan components include two overbank detention basins each with an inlet weir, containment berm, and outlet structure. Recreation features are included in the conceptual plan.

The estimated first cost of the Recommended Plan is $27.311 million, and this plan would provide $2.728 million in average annual benefits. The plan has a benefit-to-cost ratio (BCR) of 2.7 to 1 at Fiscal Year 2022 (FY22) price levels with 2.25% interest rate. If only flood risk management (FRM) costs and benefits are considered, the plan provides $2.324 million in average annual benefits and the BCR is 2.3 to 1.

Impacts to affected resources from the final array of alternatives including the Recommended Plan were evaluated in accordance with the National Environmental Policy Act. The Recommend Plan is anticipated to result in beneficial impacts to hydrology and hydraulics (H&H), public health and safety, floodplains, socioeconomics, transportation, and recreation within the study area by reducing flood risk. Construction of the Recommended Plan would result in adverse impacts to bottomland hardwood habitat requiring compensatory mitigation. A Clean Water Act Section 404(b)(1) evaluation was completed. No exceedances of water quality standards would be anticipated. A Section 401 water quality certification would be obtained from the Alabama Department of Environmental Management prior to construction of the project. The recommended plan would change aesthetics, land cover, and land use in the detention basin areas from open vegetated areas with interspersed tree cover and buildings to open vegetated areas with no tree cover and trails that would attract human use. These changes would be consistent with the predominant zoning of the areas for open space/passive recreation. USACE has executed and filed with the Advisory Council on Historic Preservation a Programmatic Agreement (PA) to fulfill its National Historic Preservation Act (NHPA) Section 106 compliance responsibilities. The PA identifies the procedures that will be followed in evaluation of historic properties that may be affected by the recommended plan.

# 1.0. INTRODUCTION

This Integrated Feasibility Report and Environmental Assessment (FR/EA) presents the results of the Valley Creek Feasibility Study. The FR/EA integrates plan formulation with documentation of environmental effects, potential alternatives for flood risk management within the Upper Valley Creek basin, outlines the process used for selecting the recommended plan, and concludes with recommendations for project implementation. It also documents compliance with the National Environmental Policy Act (NEPA) of 1969, and includes input from the non-federal study sponsors, natural resource agencies, and the public.

## 1.1. Study Authority

The feasibility study was authorized by House Resolution Docket 2477 Village Creek, Jefferson County, Alabama, adopted March 7, 1996 by the Committee on Transportation and Infrastructure. The authorization stated:

> *Resolved by the Committee on Transportation and Infrastructure of the United States House of Representatives, That, the Secretary of the Army review the reports of the Chief of Engineers on the Headwaters Reservoirs, Warrior River, Alabama, published as House Document Numbered 414, Eighty-fourth Congress, the report of the Chief of Engineers dated December 23, 1982 on Village Creek, Jefferson County, Alabama and other pertinent report with a view to determining whether modifications of the recommendations contained therein are advisable at this time, in the interest of environmental quality, water quality, flood damage reduction, and other purposes, including a comprehensive, coordinated watershed master plan for the watersheds in metropolitan Birmingham, Alabama, including Village Creek, Five Mile Creek and Valley Creek. Such studies should address water quality and flooding associated with storm water runoff, including identification and evaluation of environmental infrastructure and resource protection needs, and flood control needs.*

## 1.2. Study Area and Scope of Study

This study covers an approximate 20-mile length of Valley Creek, a tributary to the Black Warrior River (River Mile 170.23) located in Jefferson County, Alabama. Additionally, this study covers tributaries to Valley Creek, including approximately 1 mile of Opossum Creek, 2 miles of Halls Creek, and 1.5 miles of an unnamed tributary draining to Halls Creek. Jefferson County is in north-central Alabama and is bordered on the north by Blount and Walker Counties, on the east by Saint Clair and Shelby Counties, on the south by Bibb County, and on the west by Tuscaloosa County (Figure 1-1). Valley Creek has an overall length of about 55 miles, originating from headwater springs, but immediately passing through an underground storm drainage system before discharging to an open channel in central Birmingham near 5$^{th}$ Avenue and 7$^{th}$ Streets. From this location, Valley Creek flows southwesterly for approximately 22 miles through the cities of Birmingham, Fairfield, Midfield, Lipscomb, Brighton, Hueytown, and Bessemer. At this point, the stream turns to flow northwesterly for approximately 33 miles, before discharging into the Black Warrior River. The Valley Creek Basin drains approximately 255 square miles; the drainage area of the study-area is about 87 square miles. The basin divide crosses the channel at approximately 31 miles upstream from the mouth, bisecting the watershed into upper and lower portions. Per the study authorization, the study area focuses on the Birmingham metropolitan area and therefore ends just downstream of the Jefferson County Wastewater Treatment facility. The study area includes what is typically referred to as “upper” Valley Creek. The length of Valley Creek applicable to this study is located entirely within the upper basin. It is an urban watershed with land use ranging from 60 to 95 percent developed including residential, commercial, and industrial areas. The scope of the study focused on achieving National Economic Development (NED) benefits.

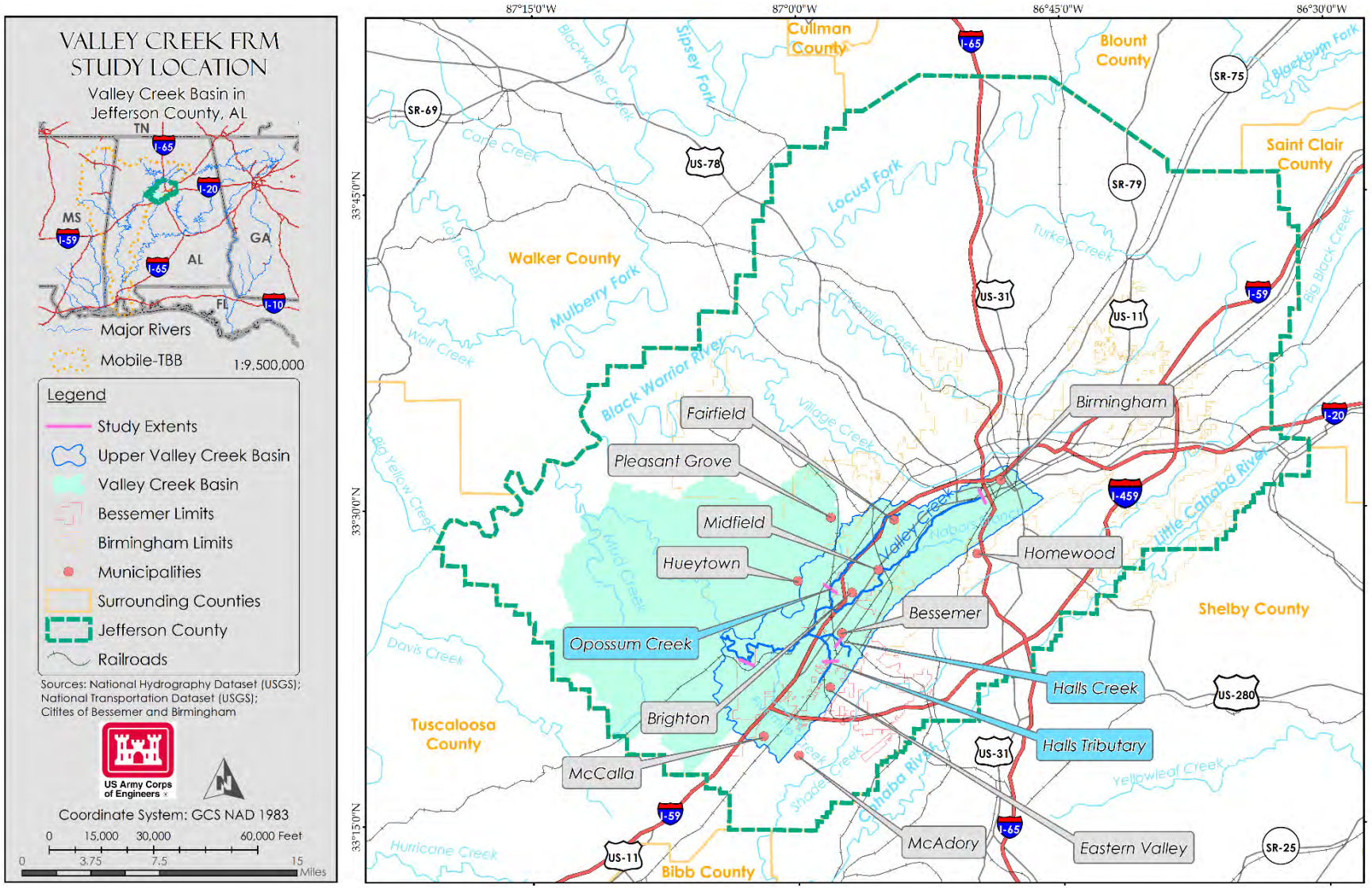


**Figure 1-1. Valley Creek Study Area Location**

## 1.3. Study Sponsors and Partners

The City of Bessemer, Alabama is the signatory to the Feasibility Cost Share Agreement (FCSA). Jefferson County, City of Birmingham, City of Hueytown, and City of Brighton, Alabama are contributing partners.

## 1.4. Federal Interest

The Federal objective of water and related land resources project planning is to contribute to NED consistent with protecting the Nation's environment, pursuant to national environmental statutes, applicable executive orders, and other Federal planning requirements. Plan formulation aimed to alleviate problems and take advantage of opportunities in ways that contribute to the Federal objective. Contributions to NED are increases in the net value of the national output of goods and services, expressed as monetary units. Contributions to NED are the direct net benefits that accrue in the planning area and the rest of the Nation. For flood risk studies, NED benefits are measured by the reduction in actual or potential flood damages (i.e. physical damages or losses, income losses, and emergency costs).

## 1.5. Purpose and Need

The purpose of the proposed Federal action is to achieve reduction to the potential risk of loss of life as well as reduce economic damages due to flooding. Multiple areas within the larger study area see frequent flood damages that are a repetitive economic cost to the nation. Although loss of life has not been recorded to date, emergency rescues have been necessary.

Flooding within the study area has been observed continuously by gaging efforts since 1975. Notable flood events on record within the watershed include April 12-13, 1979, December 2-3, 1983, and September 5-6, 2011. Rainfall during April 12-13, 1979 totaled 8.60 inches (at Oxmoor Road gage) during the event, which lasted from the morning of the 12th through the afternoon of the 13th. The peak discharge was 11,300 cubic feet per second (cfs), which is the third largest discharge on record for the gage. This discharge is estimated as having an annual exceedance probability (AEP) of between 0.1 and 0.05. A 0.01 AEP means a flood with a 1 in 100 chance of occurring in any given year; sometimes referred to as a "100-year flood".

Rainfall that occurred from December 2-3, 1983 produced record flooding on Valley Creek and resulted in a Presidential Disaster Declaration (USACE 1986). The Birmingham NWS Forecast Office recorded 9.22 inches of precipitation from 2200 December 2 to 2200 December 3, which is presently the record high 24-hour rainfall total for the area. The peak discharge recorded was 17,940 cfs (0.01 AEP), the highest on record for the gage station. Damage to commercial, public, and private property was estimated at 14 million dollars (USACE 1986).

More recently, in September 2011, the remnants of Tropical Storm Lee moved north out of the Gulf of Mexico and precipitated total rainfall depths that ranged from 8-to-15 inches over Jefferson County during the four-day period of September 3-7. Jefferson County as well as several other counties in north-central Alabama experienced flash-flooding as a result of the event. The peak flow was 13,000 cfs (0.05 AEP), which is the second largest flow on record.

## 1.6. Problems and Opportunities

The problems for the study include the following:

1. Risk for loss of life due to conditions of frequent river flooding with low warning times with associated depths ranging from 1-6 feet and velocities ranging from 1-7 feet per second in the Upper Valley Creek watershed overbanks.

2. Frequent flash flooding in the Upper Valley Creek watershed results in frequent and repeated economic damages.

Addressing the identified problems creates additional opportunities to improve:

1. Access to no-cost recreational features within the Valley Creek corridor that would provide connectivity to area residents and complement existing Jefferson County, and other local, recreation plans.
2. Communication of both immediate and long-term risks to local area residents.
3. Community resilience to future flooding through assessing and communicating potential climate change impacts to the watershed.

# 2.0. EXISTING CONDITIONS AND AFFECTED ENVIRONMENT

This chapter provides the existing conditions and regulatory setting for each of the resources that could be affected by implementing any of the identified alternatives. Existing conditions are the physical, chemical, biological, and sociological characteristics of the study area. The assessment of environmental effects is based on a comparison of conditions with and without implementation of the proposed plan and reasonable range of alternatives. The descriptions in this chapter focus on the study area. More focused discussions of the resources within the footprints of each plan alternative are included in Chapter 6.

## 2.1. Hydrology and Hydraulics

Valley Creek displays the distinctive characteristics of a highly developed, urban watershed. Land-cover within the basin varies but is dominated by urban use-types including industrial, commercial, and low- and high-intensity residential. High-density development produces hydrographs which are flashy in nature, whereby lag times between rainfall and runoff are short. Rising hydrograph limbs are steep, and typically, for characteristic events, falling limbs are as well. It is probable that the peak flood magnitudes observed on Valley Creek are intensified by the amount of impervious cover, floodplain grading, and artificial drainage present within the basin (Center for Watershed Protection 2004). Some water storage can be expected during flood events from unintended damming surfaces (bridges and culverts), low-lying overbank areas, and tributary floodplains and channels. This water storage is ultimately ineffective at protecting the most vulnerable development (defined as that which is affected by a flood event of a given frequency) along Valley Creek.

Flooding in the Valley Creek watershed is the result of slow-moving frontal systems and, sometimes tropical systems that move inland from the Gulf of Mexico. These tropical systems have been known to stall over areas once moving inland often producing days of intense rainfall resulting in the most severe floods. Flooding in the basin can occur within 2 hours of the beginning of intense rainfall or the river may gradually rise over a day or more from a slow moving, multi-day event with a moderate rainfall intensity. The reaction time to from rainfall to flooding is variable throughout the basin with the “flashiest” area being the extreme north end of the watershed. Out-of-bank flows begin to occur in the north part of the basin for the 0.5 AEP event with only minor effects to structures. Floodplain depths can range from inches up to 7 feet for major floods in excess of the 0.01 AEP event in the watershed. Most historic floods have been of the frontal variety in the basin. Most of the major floods recorded in the available period of record occurred in the 1970’s and 1980’s. Since the mid 1980’s the basin has seen a decrease in peak annual streamflow likely driven by a shift in flood seasonality, and therefore, a reduction in the frequency and magnitude of damaging floods (see Section 6.0 of Engineering Appendix [Appendix A] for additional details).

The stream channel of Valley Creek varies in its conveyance capability between reaches characterized by sedimentation and channel vegetation growth and engineered portions that are relatively clean. Rock outcroppings (limestone) are visible throughout most of the study reach, and some debris has been observed at bridge crossings. Stream bank side-slopes average 1-foot horizontal to 1-foot vertical and vary in cover from dense vegetation (including small-to-mature trees) to rip-rap. Overbank land use/land cover types range from low-to-high density urban types, to forest and pasture. Several significant tributaries draining to Valley Creek are located within the study area. These include Nabors Branch, Opossum Creek, Halls Creek, and Fivemile Creek.

The stream channel of Valley Creek was widened as part of a local effort in 1985 (USACE 1986) in a location extending from the 19th St. N. Bridge at river station (RS; distance above Black Warrior River confluence) 2188+59, to a location just below the Murphys Lane Bridge (RS 2410+07). The stream bottom width in this location is approximately 120 feet; bottom widths within the total study area range from about 60 feet to 120 feet. The stream narrows drastically downstream of this location but widens back out to approximately 100 feet just downstream of a service bridge linking structures with the Valley

Creek Water Reclamation Facility (wastewater treatment plant [WWTP]). This portion of the channel is concrete-lined. Training of the channel predates 1959 and was motivated by operations in the adjacent Delonah Quarry (USACE 1986), though more specific information regarding this effort has not been obtained.

Conveyance within Opossum Creek was improved in an environmental remediation project to remove tar-like material, completed in April 2018 (F. Freeman, personal communication, 6 November 2018). Large-scale excavation of tar-like material and surrounding sediments resulted in channel widening, vegetation removal, and slope protection from the Valley Creek confluence to a location approximately 1.6 miles upstream. This project also included material removal and erosion control measures (rip-rap placement) on Valley Creek; material was placed intermittently from the Opossum Creek confluence (upstream) to the 15th St. N. Bridge. Material removal resulted in widening of the Valley Creek stream channel to an approximate bottom width of 100 feet between the Opossum Creek confluence (RS 2236+94) to the 19th St. N. Bridge (RS 2188+95).

One levee exists within the study area. It is located on the right overbank of Valley Creek, beginning at RS 2227+16, and terminating approximately 4,100 feet downstream at the 19th Street Bridge (RS 2188+95). This project was constructed in 2000 based on design documentation and provides the capability to protect the residential community it borders up to the highest modeled flood event, AEP 0.002. Some rip-rap protection is intermittently located along the toe of the structure. Unconfirmed structural modifications along the stream corridor may also include several constructed berms. These features were most likely put in place without design as a method for disposal of excavated material produced from floodplain development. Figure 2-1 identifies the extent of the 0.01 AEP event within the study area. The 0.01 AEP is the AEP that the public tends to be most familiar. More detailed information on the H&H of the study area can be found in Appendix A.

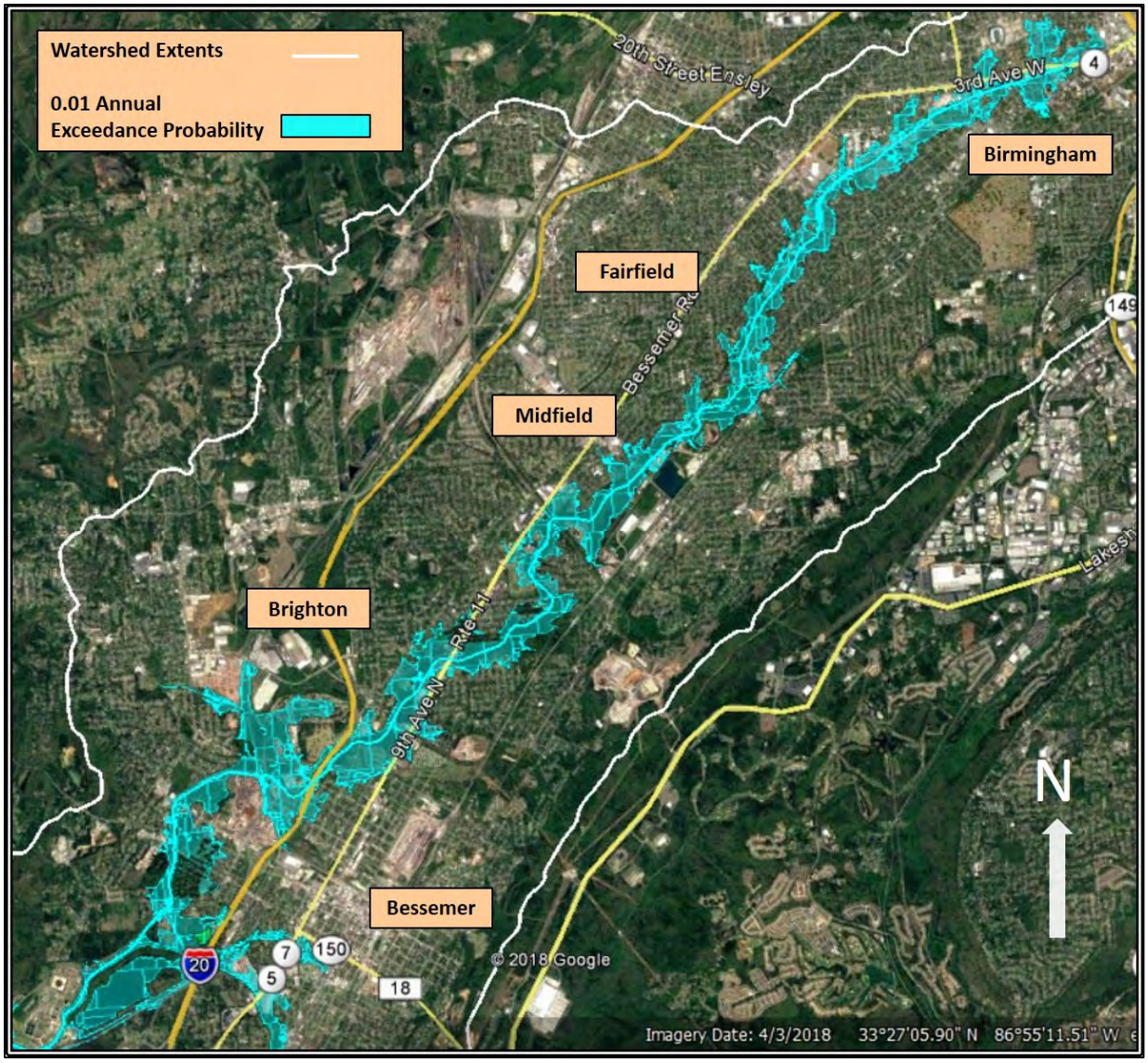


**Figure 2-1. Extent of the 0.01 Annual Exceedance Probability Event for Valley Creek.**

## 2.2. Climate

The following climate discussion is taken from U.S. Geological Survey (USGS) (2002). The study area has a temperate climate. Summers are characterized by warm, humid weather with frequent thunderstorms. Monthly mean temperatures range from 41.5 degrees Fahrenheit (°F) in January to 79.8 °F in July. Annual rainfall averages about 55 inches per year (in/yr) and is well distributed throughout the year. Most of the rainfall during the summer is from scattered afternoon and early evening thunderstorms, but rainfall during the winter and spring tends to be of longer duration and is usually associated with frontal systems. October generally is the driest month of the year with less than half the mean precipitation typically observed in March.

Based on a literature review of relevant climate data, there is a clear consensus that temperatures in the southeast will rise over the next century (USACE, 2015). There is some consensus that there will be mild increases in the severity and frequency of storms in the region. However, there is no consensus on future changes in hydrology. Observed data from near the study area shows temperatures have been gradually

rising since the 1970s after a cooling period in the earlier part of the century. Annual precipitation seems to be variable since the 1930s with a sudden drop in peak annual stream flow after 1984.

In accordance with ECB 2018-14 (USACE, 2018), a stationarity analysis was performed to determine if there are long-term changes in peak streamflow statistics within the Valley Creek basin and its vicinity. The USACE NonStationarity Tool was used to assess possible trends and change points in peak streamflow in the region. The analysis for the detection of nonstationarities was performed using the USACE NonStationarity Tool and in accordance with ETL 1100-2-3 (USACE, 2017b) which provides guidance for the detection of nonsationarities in annual maximum streamflow. This assessment, presented in appendix A, section 6, show that there is no general trend in increasing streamflow for the observed period of record. There is a sudden decrease in peak flow after 1984 resulting in a decrease in mean annual peak streamflow. The USACE Climate Hydrology Assessment Tool (CHAT) also indicates that there is no statistically significant trend in the period of record dataset between 1954 and 2014 based on streamflow at the USGS gage #2462000, Valley Creek near Oak Grove. These analyses provide almost no indication that there will be significant increases in peak annual streamflow in the future as a result of climate change. However, caution should be used in making any definitive statements on potential future hydrology as there is substantial uncertainty in both the climate and hydrologic models that drive these analyses. More detail of these analyses is available in the full climate change assessment in Appendix A, section 6.

In accordance with ECB 2018-14 (USACE, 2018), the USACE Watershed Climate Vulnerability Assessment tool was used to identify vulnerabilities to climate change on a HUC-4 watershed scale relative to other HUC-4 basins across the nation. This assessment presented in appendix A, section 6, indicates that the Valley Creek basin is does not have significant vulnerabilities to the Flood Risk Reduction business line with respect to other watersheds in the United States or the region.

Overall, there is some consensus of a small increase in the projected frequency and intensity of extreme precipitation events, however this does not necessarily translate into an increase in peak streamflow. Droughts and increased temperatures can offset the transformation of increase in rainfall volume into runoff. Additionally, increased uncertainty in the hydrology model used in long term forecasts make it more difficult to make any definitive statement on future hydrology. The effects of climate change can only be considered within the standard uncertainty bounds associated with the hydrologic/hydraulic analysis being conducted as part of this study.

## 2.3. Geology and Soils

The Valley Creek study area is located within the Birmingham-Big Canoe Valley District of the Alabama Valley and Ridge Physiographic Province. The province runs northeast to southwest, similar in orientation to the study area. Two predominant bedrock formations are noted for the area: the Conasauga and Ketona Formations. The Conasauga Formation consists of a medium bluish-gray, fine-grained, thin-bedded limestone and a dark gray, interbedded shale. The Ketona Formation is characterized as a thick bedded, coarsely crystalline dolomite that is light to medium gray in color. Prior studies in the area found the Conasauga Formation to be the predominant bedrock type (USACE 1992). The upper bedrock is made of limestone and dolomite pinnacles. These pinnacles were found at ground surface where the rock outcrops, down to greater than 20.0 feet below ground surface. The current study area is in the same general location as the prior studies; however, the footprint extends beyond the banks in some cases.

Geotechnical investigations were conducted in 1985 and 1989 as part of a previous effort. Eighty borings were sampled by auger, and four additional borings were sampled to obtain rock cores. There are no coordinates for the boring locations, but each of them has a corresponding channel stationing, suggesting they were sampled adjacent to the channel. Historical borings from the investigation show that the overburden soils consist of brown sandy clays, with varying degrees of sand. Refusal was encountered in many of the borings at bedrock, however it was noted that refusal could have been due to boulders within

the overburden. In general, the elevation of refusal decreased from the upstream end of the study area to the downstream end. Rock cores were obtained in the dolomite and limestone of the Conasauga and Ketona Formations. No test data was available for these samples, but it was reported that unconfined compression tests were run, yielding strengths ranging from 285 to 725 tons/square foot ($ft^2$). As such, drilling and blasting would be necessary to excavate into bedrock.

Twenty-four additional hand-augured borings were performed in August and September of 2019. Borings were taken at the potential off-channel detention locations, primarily to delineate the elevation of bedrock. All soil samples were visually classified, and no lab samples were conducted as part of this investigation. The overburden soils were also sampled, and the results are commensurate with the subsurface soil conditions detailed in the previous study report (USACE 1992). The overburden consists primarily of brown, sandy lean clay to clayey sand with some gravel. Fat clays were also encountered above top-of-rock in a few locations. Groundwater was present at multiple elevations, and it was typically found within 2.0 feet above bedrock. Full details of the geotechnical boring results conducted for the study can be found in Appendix A, Engineering.

## 2.4. Water Quality/Aquatic Habitat

Upper Valley Creek drains a major metropolitan area and has typical urban stream characteristics such as poor habitat, degraded water quality, and stressed biological communities (Alabama Department of Environmental Management [ADEM] 2001). Section 305(b) of the Clean Water Act requires each state to develop a water quality monitoring program and periodically report the status of its water quality. Water quality status is described in terms of the suitability of the water for its "designated uses" (e.g. drinking water, fishing, swimming, aquatic life). Section 303(d) of the CWA requires identification of "impaired waters" (i.e. those that do not meet applicable water quality standards) and Total Maximum Daily Loads (TMDLs) be determined for these waters. TMDLs establish the maximum amount of a contaminant that a water body can assimilate and still meet the water quality standards.

A Use Attainability Analysis to support upgrading Valley Creek's use classification from "Agricultural and Industrial Water Supply" to "Limited Warmwater Fishery" (LWF) was completed in 2001. Valley Creek is currently classified as LWF throughout the study area. For LWF classified waters, the best uses of water from May through November are agricultural irrigation, livestock watering, industrial cooling and process water supplies, and any other usage, except fishing, bathing, recreational activities, including water-contact sports, or as a source of water supply for drinking or food-processing purposes (ADEM Administrative Code r. 335-6-x-.xx).

ADEM (2001) attributed the degraded condition of upper Valley Creek to the extensive industrial and commercial land use within its watershed. The urbanized landscape creates dynamic flow events, reduced riparian zones, increased siltation, and other conditions that destroy habitat and impair water quality, thus making it difficult to sustain a healthy aquatic community (ADEM 2001). Upper Valley Creek was characterized by poor dissolved oxygen levels, high pathogen levels, and elevated biochemical oxygen demand (BOD) and nutrient concentrations (ADEM 2001). A USGS (2002) investigation of water quality and aquatic community structure in Valley Creek arrived at a similar conclusion stating:

> *The water quality and aquatic-community structure in Village and Valley Creeks are degraded in comparison to streams flowing through less-urbanized areas. Low community richness and increased density of certain species within the fish and benthic invertebrate communities indicate that degradation has occurred during an extended period of time. Decreased diversity in the aquatic communities and elevated concentrations of trace elements and organic contaminants in the water column, bed sediment, and fish tissues at Village and Valley Creeks are indicative of the effects of urbanization. The degree of degradation may be related to point and nonpoint sources of contamination originating within the basins. Industrial land use, in particular, was*

> *significantly correlated to elevated contaminant levels in the water column, in bed sediment, in fish tissue, and to the declining health of the benthic-invertebrate communities.*

A 0.9-mile segment of Valley Creek was placed on the CWA §303(d) list of impaired waters in 2004 for only partially meeting its LWF use classification due to mercury levels from atmospheric deposition (subsequently removed from the list in 2014). An ADEM habitat assessment for upper Valley Creek rated it as in sub-optimal condition (ADEM 2007). Water quality results indicated elevated levels of arsenic, mercury, total dissolved solids, specific conductance, hardness, and alkalinity, which are potential causes of the very poor macroinvertebrate community condition (ADEM 2007). In-stream aquatic habitat consisted primarily of run habitat (58-85%) with pool habitat comprising less than 10 percent (USGS 2002, ADEM 2007). In 2018, remediation work removed 34,000 cubic yards of tar-like material from Valley Creek between Opossum Creek confluence and 13th Street as part of corrective implementation measures for past contamination. Tar-like substances were identified as a key factor limiting aquatic life in Valley Creek for decades (ADEM 2001).

## 2.5. Wetlands and Waters of the United States

Waters of the United States, as defined under the CWA, are found in Valley Creek and tributaries within the study area. The discharge of dredged or fill materials into waters of the United States is regulated pursuant to Section 404 of the CWA. Waters of the United States also include wetlands and other special aquatic sites. As part of this study, a planning-level review was conducted to identify the ordinary high-water mark and extent of waters of the United States including wetlands.

For planning purposes, wetland data was reviewed using the U.S. Fish and Wildlife Service (USFWS) National Wetland Inventory (NWI) maps. No wetland delineation has been completed to date to identify jurisdictional wetlands. Although NWI maps are not definitive about the presence or absence of wetlands, they are useful as an initial planning tool. NWI mapping shows the presence of PFO1A, freshwater forested/shrub, wetlands within the study area. Wetlands within the study are consist primarily of broad-leaved deciduous forest with the higher quality areas containing water oak (*Quercus nigra*), red maple (*Acer rubrum*), shagbark hickory (*Carya ovata*), sweetgum (*Liquidambar straciflua*), hackberry (*Celtis occidentalis*), black willow (*Salix nigra*), and sycamore (*Platanus occidentalis*) (USFWS 1985). Streambank vegetation consists primarily of willow and sycamore. The occurrence of wetlands within the footprint of alternative features is further discussed in Section 6.4. Valley Creek is considered a water of the U.S. and the alternatives have potential to affect Valley Creek.

## 2.6. Terrestrial Habitat

Most of the study area consists of urban development. However, the study area includes terrestrial forested areas. Much of the length of Valley Creek in the study area is characterized by a relatively narrow band of riparian forest; however, larger forested tracts are found in several locations. Most of the larger forested tracts are held by the Freshwater Land Trust, a local nonprofit organization that works to protect land for conservation purposes through donation, purchase, or conservation easement. Canopy tree species found in the riparian forests include water oak (*Quercus nigra)*, green ash (*Fraxinus pennsylvanica)*, winged elm (*Ulmus alata)*, sugarberry (*Celtis laevigata)*, boxelder maple (*Acer negundo)*, American elm (*Ulmus Americana)*, American hophornbeam (*Ostrya virginiana)*, Southern red oak (*Quercus falcate)*, shingle oak (*Quercus imbricaria)*, loblolly pine (*Pinus taeda)*, and Virginia pine (*Pinus virginiana)*.

Invasive plants of particular concern in the area are privet (*Ligustrum* spp.) and kudzu (*Pueraria* spp.). Other invasive plants in the area include heavenly bamboo (*Nandina domestica*), English ivy (*Hedera helix*), Oregon grape (*Mahonia aquifolium*), Japanese honeysuckle (*Lonicera japonica*), mimosa spp.,

Amur honeysuckle (*Lonicera maackii*), Bradford pear (*Pyrus calleryana*), and leatherleaf mahonia (*Mahonia bealei*).

## 2.7. Fish and Wildlife

Fish sampling by USFWS (1985) and USGS (2002) documented few fish species in Valley Creek: western mosquitofish (*Gambusia affinis*), largescale stoneroller (*Campostoma oligolepis*), longear sunfish (*Lepomis megalotis*), green sunfish (*Lepomis cyanellus*), bluegill (*Lepomis macrochirus*), blackbanded darter (*Percina nigrofasciata*), blacktail shiner (*Cyprinella venusta*), and creek chub (*Semotilus atromaculatus*). Species were primarily pollution tolerant fishes. Mosquitofish and minnows had the highest relative abundance (USGS 2002). Reptiles and amphibians inhabit the stream. Crayfish have also been observed (USFWS 1985).

The riparian area along Valley Creek is largely characterized by urban development. There are some limited remaining large tracts of forested areas. As a result, wildlife in the study area primarily include urban wildlife species that are adapted to living in habitats modified by people. Wildlife found throughout the Valley Creek riparian corridor may include gray squirrel (*Sciurus carolinensis*), raccoon (*Procyon lotor*), opossum (*Didelphis virginiana*), rabbit (*Sylvilagus floridanus*), raptors, small mammals, songbirds, doves, wading birds, reptiles, and amphibians. The Migratory Bird Treaty Act (16 USC § 703(a)), originally implemented in 1918, prohibits the take, possession, or sale of migratory birds. Migratory bird species have potential to use the study area.

## 2.8. Threatened and Endangered Species

Section 7 of the Endangered Species Act (ESA) (16 USC 1531 *et seq*.) requires federal agencies to ensure that any actions authorized, funded, or carried out by the agency do not jeopardize the continued existence of a federally listed threatened or endangered species, or result in the destruction or adverse modification of designated critical habitat of a federally listed species. An official species list was obtained from the USFWS Information, Planning, and Conservation (IPaC) system for the study area (Appendix E). Following coordination with the USFWS regarding the initial IPaC list, four Federally listed species were identified with potential to occur in the study area: gray bat (*Myotis grisescens*), Indiana bat (*Myotis sodalis*), Northern long-eared bat (*Myotis septentrionalis*), and watercress darter (*Etheostoma nuchale*). These species are discussed in the following sections. No critical habitat is found in the study area.

### 2.8.1. Gray Bat

The gray bat was federally listed as endangered in 1979 due to declining populations. The range of the gray bat is geographically limited to the limestone karst areas of the southeastern United States. This species primarily occurs in Alabama, northern Arkansas, Kentucky, Missouri, and Tennessee although few gray bats also occur in northwestern Florida, western Georgia, southeastern Kansas, southern Indiana, southwestern Illinois, northeastern Oklahoma, northeastern Mississippi, western Virginia, and western North Carolina. The gray bat is identifiable by its uniform grayish-brown fur which is dark gray following their molt and then lightens to a rusty brown in the summer. This species is most easily identified and distinguished from other closely related bat species by its wings that attach to the ankle and not the base of the toes. The gray bat also has a distinct notch on the inside curve of each claw (Missouri Department of Conservation 2019).

Gray bats occupy caves in limestone karst regions within its range during both the summer and the winter. In the winter, these bats hibernate in deep, vertical cold caves or mines that trap large volumes of cold air (USFWS 2019a). Hibernacula for this species often have multiple entrances and maintain temperatures between 5 and 9°C (41 and 48.2°F) with a range of 1 to 4°C (33.8 to 39.2°F) being preferable. During the summer, females roost in warmer caves ranging in temperature from 14 to 25°C (57.2 to 77°F) with close proximity to water where they can forage (USFWS 2006). Gray bats mate in the fall when males and

females arrive at the hibernacula. Female gray bats begin hibernating in early fall following copulation, store the sperm through the winter and become pregnant in spring after emerging from hibernation. Male gray bats remain active after the females enter hibernation until early November, when they also begin to hibernate. Females give birth to one pup in late May or early June after a 64-day gestation period and form large maternity colonies in caves with domed ceilings. Gray bats are dependent on aquatic insects, specifically, mayflies, caddisflies, and stoneflies; and use water features and forested riparian corridors for foraging and travel. Due to this foraging need, maternity colonies are usually within proximity to prime feeding areas near large reservoirs or rivers (USFWS 2006).

Human disturbance, habitat loss and degradation, cave commercialization, and improper gating continue to threaten the gray bat. The continued spread of white-nose syndrome also poses a threat to this species, as is the case with many bats. The gray bat is vulnerable to disturbance due to their narrow habitat requirements and high density of cave occupancy. Disturbance during hibernation reduces energy stores and disturbance during the roosting period startles mothers which could cause potential harm to the pups. Caves within the gray bat range have been flooded from reservoir creation which forces the bats out in search of another suitable cave which may be difficult. Commercialization of caves also forces bats out and alters the conditions that make it suitable habitat for gray bats (USFWS 2019a).

### 2.8.2. Northern Long-Eared Bat

The northern long-eared bat was listed as a threatened species under ESA in 2015 (80 FR 17974). This small bat species occurs across much of the eastern and north central United States, encompassing 37 states and all Canadian provinces from the Atlantic coast west to the southern Northwest Territories and eastern British Columbia. During the summer months, the northern long-eared bat roosts underneath bark or in cavities of a variety of tree species, both live and dead, and may roost individually or in colonies. Summer roosting sites may also include caves, mines, or human-made structures, such as barns, other buildings, utility poles, window shutters, and bat houses (80 FR 17974). During the winter, the northern long-eared bat inhabits large caves or mines known as hibernacula (Caceres and Pybus 1997). Foraging habitat consists of forested areas or forested edges along rivers and lakes. Northern long-eared bats feed at dusk preying on moths, leafhoppers, caddisflies, and beetles while in flight or by gleaning insects from vegetation (USFWS 2019b).

The northern long-eared bat was placed on the Endangered Species List due to severe impacts of white-nose syndrome, a fungal disease that has caused massive population declines in some portions of the species range (81 FR 1901). Other threats include habitat fragmentation, destruction, and modification from logging, oil/gas/mineral development, and wind energy development. Disturbances of hibernacula caused by recreational caving activities have also been documented as a potential threat to the northern long-eared bat (78 FR 61046). In January 2016 the USFWS published a Final 4(d) Rule which provides an exemption from incidental take restrictions for northern long-eared bats occurring in areas not yet affected by white-nose syndrome (81 FR 1901).

The study area falls within the range of the northern long-eared bat. Jefferson County is within the white-nose syndrome zone per the Final 4(d) Rule. Thus, individuals in the area are subject to full protection under ESA.

### 2.8.3. Indiana Bat

The Indiana bat (*Myotis sodalis*) is listed as an endangered species under the ESA. This species was listed as in danger of extinction in 1967 and was grandfathered in under the ESA in 1973 (USFWS 2007). The range of the Indiana bat spans most of the eastern half of the United States, but the population is largely concentrated in southern Indiana. The Indiana bat is similar in size to the northern-long eared bat and has many of the same habitat requirements. However, the Indiana bat requires hibernacula with cooler temperatures than those used by the northern long-eared bat. The Indiana bat is more selective with

roosting sites, showing preference for trees that are dying or dead, and has been found to select trees by size, species, and surrounding canopy cover (USFWS 2007). Like the northern long-eared bat, foraging habitat for the Indiana bat consists of forested areas or forested edges along rivers and lakes. Indiana bats feed while in flight on a variety of flying insects along rivers, lakes, and uplands. This species consumes up to half of its body weight in insects daily (USFWS 2019c). Threats to this species include loss or alteration of cave and forest habitats and human disturbance of hibernating individuals (USFWS 2007).

### 2.8.4. Watercress Darter

The watercress darter is a small, robust species growing to a maximum size of just over 2 inches in total length (USFWS 1993). Breeding males have red-orange and blue fins, and red-orange on the lower part of the body. Watercress darter habitat includes deeper, slow-moving backwaters of springs that are choked with aquatic vegetation such as watercress (USFWS 1993). The watercress darter is found within an unnamed tributary to Halls Creek, which is included in the study area. Available information states that naturally occurring populations of the species are known from four locations. Three of these locations (Glenn, Thomas, and Seven Springs) are located on tributaries to Valley Creek (USFWS 2018). The mainstem of Valley Creek does not include suitable habitat.

## 2.9. Air Quality

Emissions from construction activities under the proposed action would affect air quality in the immediate study area. Air quality is defined by ambient air concentrations of specific pollutants that the U.S. Environmental Protection Agency (EPA) has determined to be of concern for the health and welfare of the general public and the environment. The primary pollutants of concern, called criteria pollutants, include carbon monoxide, sulfur dioxide, nitrogen dioxide, ozone, suspended particulate matter less than or equal to 10 microns in diameter, fine particulate matter less than or equal to 2.5 microns in diameter, and lead. Under the CAA, the EPA has established National Ambient Air Quality Standards (NAAQS) (40 CFR §50) for these pollutants. Areas that are and historically have been in compliance with the NAAQS are designated as attainment areas. Areas that violate a federal air quality standard are designated as nonattainment areas. Areas that have transitioned from nonattainment to attainment are designated as maintenance areas and are required to adhere to maintenance plans to ensure continued attainment. The NAAQS represent the maximum levels of background pollution that are considered safe, including an adequate margin of safety, to protect public health and welfare. Short-term standards (1-, 3-, 8-, and 24-hour periods) are established for pollutants contributing to chronic health effects.

The study area is currently in attainment for all NAAQS (Jefferson County Health Department 2019). Emissions associated with the alternatives would be short-term, occurring during construction activities. No alternative includes a management measure that would create a permanent new source of air pollutant emissions including greenhouse gasses that would contribute to climate change. Air quality was dismissed from detailed evaluation because the study area is currently in attainment and it is not anticipated that any alternatives would result in exceedance of the NAAQS.

## 2.10. Hazardous, Toxic, and Radiological Waste

Various Federal and State legislation regulates the proper use, disposal, and cleanup of hazardous materials and waste. The Resource Conservation and Recovery Act (RCRA) gives the EPA authority to regulate hazardous waste disposal. This is accomplished by tracking the hazardous waste from its generation to its disposal. In 1984, amendments were made to this act, called the Hazardous and Solid Waste Act (HSWA). The amendments were enacted to include underground storage tank regulation, all releases of hazardous waste to the environment, and mandates for corrective action at hazardous waste facilities. The Toxic Substance Control Act (TSCA) deals with all chemicals produced or imported into the United States. It requires that the chemical be adequately tested for toxicity prior to its commercial release to the public. The TSCA was amended to include the prohibition of the manufacture and

distribution of polychlorinated biphenyls (PCBs). PCBs are required to be labeled and disposed of properly. The Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), nicknamed Superfund, started a trust fund for the payment of remediation at abandoned hazardous waste sites. The EPA manages the National Priority List, which lists certain CERCLA sites of the highest priority. Superfund Amendments and Reauthorization Act (SARA) amended CERCLA in 1984. The amendments included more state and community involvement in the remediation process, increased focus on human health problems posed by contaminated sites, selection of remedies that permanently cleaned the site, and consideration of standards and other requirements in State and other Federal laws and regulations. The Federal Facility Compliance Act (FFCA) requires the Department of Energy to develop and submit Site Treatment Plans for the development of capacity and technologies for treating mixed waste. All facilities that the DOE stores or generates these wastes must have such a plan. It also requires schedules for bringing new treatment facilities into operation. Alabama is an "authorized" state, meaning that it is authorized by the EPA to administer state environmental law in lieu of most federal environmental laws. This is consistent with Alabama statutes that created ADEM, and which express legislative intent to have federal environmental laws administered at the state level.

A records search was conducted of past and present environmental activities and enforcement actions near each of the identified management measures to determine if there were potential contamination issues that could result in increased costs to the sponsor or the government (Appendix F). Information sources reviewed as part of the records search included:

- USEPA Cleanups in My Community (CIMC) Map/Database – This database includes information on Brownfields Properties, Brownfields Grants Jurisdictions, RCRA Corrective Action, Superfund, Federal Facilities and Federal Agency Hazardous Waste Compliance Docket, Removals/Responses, and Recovery Act Funded Cleanups.
- ADEM Brownfield Map – The ADEM Brownfield Map is similar to the USEPA CIMC Map/Database but is limited to sites in Alabama. The title Brownfields sites is somewhat of a misnomer in that the map/database identifies all contaminated or previously contaminated sites regardless of whether they are in the Brownfields program.
- UST Facility Map/Database – This map/database provides information on the location and status of registered underground storage tanks.
- UST Incident Map/Database – This map/database provides information on sites where underground storage tanks have leaked or have been removed and any additional actions that were taken to clean up the site as well as any ongoing actions.

The following potential areas of concern associated with measures included in one or more final array alternatives were identified:

- Twin City Clarage Inc., 245 Center Street, Birmingham, AL – This site is identified on the ADEM Brownfield Map. The site contains several scrap vehicles and other debris. However, no documents were available on the ADEM site to describe what type of contamination or other environmental issues were found at the site.
- Center Street Food and Gas, 62nd Ave North, Birmingham, AL – Four USTs were removed and replaced at this site. No contamination was during removal of the tanks and there is frequent leak detection performed on the new tanks.
- Jefferson County Family Court, 120 2nd Ct N Birmingham, AL – There was a suspected leak in a 1,000-gallon diesel tank that provided fuel for a generator. An investigation was performed, and no extensive contamination was found.
- Triple T's Food Store, 1001 Lomb Ave SW Birmingham, AL – There was a leaking incident at the Triple T's Food Store reported in July 1998. A June 2001 groundwater monitoring report did not find any remaining contamination in the groundwater as a result of the leak. Three new

regulated tanks were installed at this location and it now goes by the name Triple Food Store Citgo.

- Three existing USTs are associated with the Jefferson County sewage treatment plant. There are no reported leaks or spills associated with these tanks.

## 2.11. Public Health and Safety

The primary public health and safety issue relevant to this study is the potential for loss of life associated with flooding. Within the study area, Valley Creek flows through numerous municipalities, all within Jefferson County, including the cities of Birmingham, Fairfield, Midfield, Lipscomb, Brighton, Hueytown, and Bessemer. Each municipality has its own police and fire departments that serve as first responders; however, the Lipscomb and Brighton fire departments are voluntary. Past flooding events in the study area have necessitated water rescues; however, no loss of life has been documented.

Jefferson County has a hazard mitigation plan which has been adopted by the municipalities. While somewhat different than a floodplain management plan, the two contain common elements. This plan would be updated to include the change of conditions due to any recommended plan for Valley Creek so as to address any residual risk that may be present in conjunction with a U.S. Army Corps of Engineers (USACE) flood risk management project.

## 2.12. Floodplain

EO 11988 directs federal agencies to avoid to the extent possible the long and short-term adverse impacts associated with the occupancy and modification of floodplains and to avoid direct or indirect support of floodplain development wherever there is a practicable alternative. ER 1165-2-26 documents USACE policy for compliance with EO 11988. ER 1165-2-26 states it is the policy of USACE to formulate projects which, to the extent possible, avoid or minimize adverse impacts associated with use of the base floodplain and avoid inducing development in the base floodplain unless there is no applicable alternative. The base floodplain is defined as the one percent chance floodplain (i.e. the 0.01 AEP event). Most of the study area is located within the base floodplain.

The Cities of Bessemer and Birmingham participate in the National Flood Insurance Program (NFIP). The City of Bessemer joined NFIP in 1981. Development within Bessemer's 100-year floodplain is controlled through a Flood Plain Ordinance and is reviewed and permitted by the City Engineer's office and the Building and Inspection Services Department. The ordinance requires residential buildings be located above the 100-year base flood elevation and nonresidential buildings must be elevated or flood-proofed. The City of Bessemer is currently going thru the process to join the Community Rating System (CRS). The City of Birmingham joined NFIP in 1981 and the Community Rating System, a voluntary program to establish floodplain management programs to exceed NFIP requirements, in 1993. Development within Birmingham's 100-year floodplains is controlled through a Flood Plain Ordinance and is reviewed and permitted by floodplain management staff housed within the Planning, Engineering and Permits Department. The ordinance requires residential buildings be located above the 100-year base flood elevation and nonresidential buildings must be elevated or flood-proofed. Through its floodplain management efforts, the city is rated Class 6, which provides a 20% reduction in flood insurance premiums for property owners (City of Birmingham 2014).

## 2.13. Land Cover and Land Use

2016 National Land Cover Dataset indicates that land cover within the Valley Creek study area is primarily developed (approximately 90%) with relatively high intensity in the upper portion and medium to lower intensity in the middle and lower reaches (Figure 2-2).

Based on review of the City of Birmingham and Jefferson County online mapping, land use within the study area is predominantly residential, commercial, and industrial uses including duplex, single family housing, multi-family housing, light industry, warehouse/storage, and heavy industrial. There are areas of open space/passive recreation, parks, and a cemetery along the Valley Creek corridor as well.

## 2.14. Socioeconomics

The study area encompasses the cities of Birmingham, Bessemer, Brighton, Hueytown, Lipscomb, and Midfield. This section describes the population, employment, and income for this area. Additional demographic information on race, ethnicity, and poverty is provided under Environmental Justice. Further information can be found in the Appendix B.

### 2.14.1. Population

The City of Birmingham is the most populous municipality in the study area and is the largest city in Alabama. Birmingham contains roughly one third of the population of Jefferson County. Since 2000, Birmingham has experienced a decline in population, although more recently (2010 to 2017), population changes have been stable. Jefferson County has followed the same trend. The communities of Lipscomb, Midfield, and Bessemer have experienced decreases in population in the past two decades. Only the city of Hueytown has seen an increase in residents since 2000. Table 2-1 shows the population of the cities within the study area as well as Jefferson County and the State of Alabama.

**Table 2-1. Study Area Population.**

| Area | 2000 | 2010 | 2017 | % Change 2000-2010 | % Change 2000-2017 | % Change 2010-2017 |
|---|---|---|---|---|---|---|
| Alabama | 4,447,100 | 4,779,736 | 4,850,771 | 7.0% | 8.3% | 1.5% |
| Jefferson County | 662,047 | 658,466 | 659,460 | -0.5% | -0.4% | 0.2% |
| Bessemer | 29,672 | 27,456 | 26,697 | -8.1% | -11.1% | -2.8% |
| Birmingham | 242,820 | 212,237 | 212,265 | -14.4% | -14.4% | 0.0% |
| Brighton | 3,640 | 2,645 | 2,848 | -37.6% | -27.8% | 7.1% |
| Hueytown | 15,364 | 16,105 | 15,698 | 4.6% | 2.1% | -2.6% |
| Lipscomb | 2,458 | 2,210 | 2,040 | -11.2% | -20.5% | -8.3% |
| Midfield | 5,626 | 5,364 | 5,174 | -4.9% | -8.7% | -3.7% |

Source: U.S. Census Bureau, American Community Survey, 2013-2017.

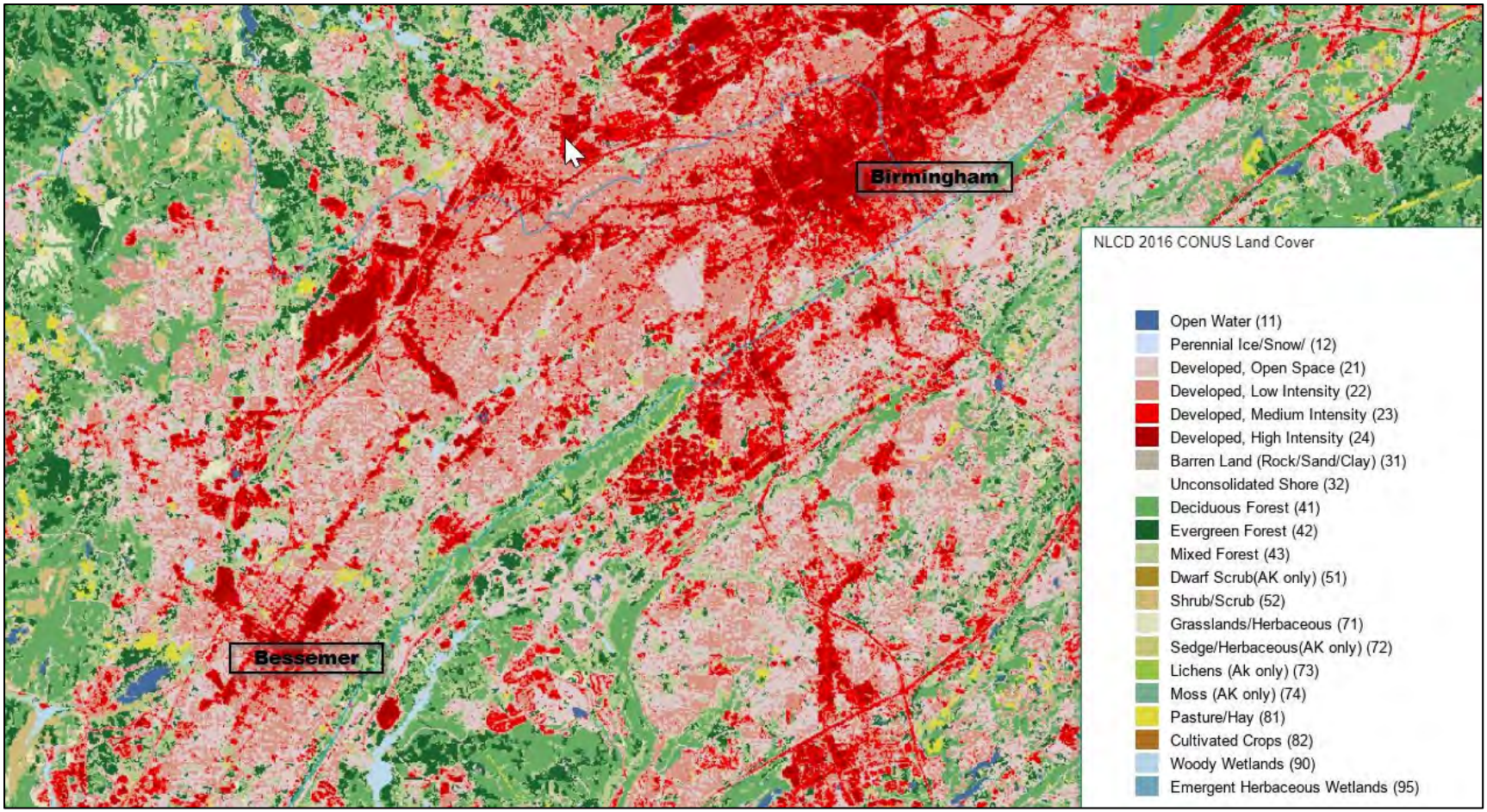


**Figure 2-2. Land Use in the Study Area**

### 2.14.2. Employment and Income

Median household income for municipalities in the study area is considerably lower than both the state and county averages. Lipscomb and Brighton have the lowest median household incomes, while Hueytown has the highest.

The unemployment rate varies across the study area. Brighton has the highest unemployment rate, at nearly 8 percent, while Hueytown, Midfield, and Lipscomb have unemployment rates similar to the state and county averages. Table 2-2 displays the employment data as well as the median household income of the study area.

Trends in employment by industry within the study area are consistent with national trends. The educational, healthcare, and social services sectors employ most residents in all cities, except for Brighton. Retail and manufacturing employ the second largest percentage of study area residents. Table 2-3 displays the employment by industry in the study area.

**Table 2-2. Study Area Employment and Income.**

| Area | Employed Labor Force (%) | Unemployment Rate (%) | Median Household Income ($) |
|---|---|---|---|
| Alabama | 53.3 | 3.8 | $48,486 |
| Jefferson | 57.6 | 4.5 | $51,979 |
| Bessemer | 46.0 | 7.9 | $31,610 |
| Birmingham | 53.9 | 6.1 | $35,346 |
| Brighton | 47.3 | 8.0 | $26,700 |
| Hueytown | 53.8 | 4.4 | $49,705 |
| Lipscomb | 54.8 | 3.7 | $28,472 |
| Midfield | 56.9 | 4.7 | $36,837 |

**Source:** U.S. Census Bureau American Community Survey, 2014-2018.

## 2.15. Transportation

Transportation in the Birmingham metropolitan area is predominately of privately owned and commercial vehicles, public bus transportation, commercial plane, and train (Amtrak). The metropolitan area is traversed with interstate, principal arterials, minor arterials, major collectors, minor collectors and local roads specifically I-20, I-59, Highway 5, Highway 7, Highway 150, and others. Interstate traffic ranges from 50,000 to 100,000 average annual daily traffic.

Public transportation via bus (MAX) provides fixed route and demand response service (Paratransit) to various municipalities. The current service area is more than 200 square miles with a demand population base of nearly 400,000. The municipalities within the service area are Birmingham, Bessemer, Homewood, Mountain Brook, Midfield, Center Point, Hoover, Vestavia Hills, and Tarrant. Passenger trips and service miles are approximately three million (3,000,000) each annually.

In 2019, approximately three million passengers passed through the Birmingham-Shuttlesworth International Airport (BHM). BHM is a civil-military airport serving Birmingham and its metropolitan area.

**Table 2-3. Study Area Employment by Industry.**

| Industry | Alabama | Jefferson County | Bessemer | Birmingham | Brighton | Hueytown | Lipscomb | Midfield |
|---|---|---|---|---|---|---|---|---|
| Agriculture, forestry, fishing and hunting, and mining | 2% | 1% | 1% | 0% | 0% | 2% | 1% | 0% |
| Construction | 6% | 5% | 7% | 4% | 7% | 5% | 17% | 4% |
| Manufacturing | 14% | 9% | 14% | 8% | 16% | 9% | 11% | 9% |
| Wholesale trade | 3% | 3% | 2% | 2% | 0% | 1% | 5% | 1% |
| Retail trade | 12% | 11% | 14% | 12% | 14% | 13% | 7% | 8% |
| Transportation and warehousing, and utilities | 5% | 5% | 6% | 5% | 2% | 8% | 3% | 5% |
| Information | 2% | 2% | 1% | 2% | 0% | 0% | 1% | 1% |
| Finance and insurance, and real estate and rental and leasing | 6% | 9% | 7% | 7% | 7% | 7% | 3% | 4% |
| Professional, scientific, and management, and administrative and waste management services | 9% | 10% | 7% | 10% | 11% | 9% | 11% | 13% |
| Educational services, and health care and social assistance | 23% | 26% | 20% | 27% | 11% | 25% | 14% | 31% |
| Arts, entertainment, and recreation, and accommodation and food services | 8% | 9% | 13% | 12% | 22% | 8% | 15% | 12% |
| Other services | 5% | 6% | 5% | 5% | 8% | 8% | 11% | 6% |
| Public administration | 6% | 4% | 4% | 4% | 2% | 5% | 1% | 5% |

Source: U.S. Census Bureau, American Community Survey, 2013-2017.

## 2.16. Environmental Justice

Executive Order 12898, issued in 1994, directs federal agencies to incorporate environmental justice (EJ) as part of their mission by identifying and addressing the effects of programs, policies, and activities on minority and low-income populations. The fundamental principles of Executive Order 12898 are as follows:

- Ensure full and fair participation by potentially affected communities in the decision-making process.
- Prevent the denial of, reduction in, or significant delay in the receipt of benefits by minority or low-income populations.
- Avoid, minimize, or mitigate disproportionately high and adverse human health and environmental effects, including social and economic effects, on minority populations and low-income populations.
- Encourage meaningful community representation in the NEPA process using effective public participation strategies and special efforts to reach out to minority and low-income populations.
- Identify mitigation measures that address the needs of the affected low-income and minority populations.

An EJ assessment requires an analysis of whether minority and low-income populations (i.e. "populations of concern") would be disproportionately adversely affected by a proposed federal action. Of primary concern is whether adverse impacts fall disproportionately on minority and/or low-income members of the community compared to the larger community and, if so, whether they meet the threshold of "disproportionately high and adverse." If disproportionately high and adverse effects are evident, then EPA guidance advises that it should initiate consideration of alternatives and mitigation actions in coordination with extensive community outreach efforts (EPA 1998).

Areas can be determined to have a high proportion of minority residents if either (1) 50 percent or more of the population identifies themselves as a minority; or (2) there is a significantly greater minority population than the reference area (EPA 1998). Individuals are of a minority if they are identified as a race other than Non-Hispanic White Alone. Low-income populations are defined as those individuals living below the poverty line, as defined by the U.S. Census Bureau. According to the U.S. Census Bureau, a poverty area consists of 20 percent of the population living below the poverty level, while an extreme poverty area includes 40% of the population living below the poverty level (U.S. Census Bureau, 2016). Thus, block groups with more than 20 percent of their families living below the poverty level were identified as a potential EJ poverty area.

Table 2-4 summarizes the percentage of the population that identify as minority as well as the percent of the population living below the poverty level. All the cities within the study area except for Hueytown have populations of concern because of substantially higher proportions of minority and impoverished residents than Jefferson County as a whole.

**Table 2-4. Minority Population and Poverty Data for Study Area.**

| City/County | Population | Population Identifying as Minority (%) | Population Living Below Poverty Line (%) |
|---|---|---|---|
| Jefferson County | 659,460 | 48 | 18 |
| Bessemer | 26,697 | 76 | 30 |
| Birmingham | 212,265 | 75 | 28 |
| Brighton | 2,848 | 97 | 32 |
| Hueytown | 15,698 | 36 | 15 |
| Lipscomb | 2,040 | 74 | 27 |
| Midfield | 5,174 | 90 | 25 |

## 2.17. Prime and Unique Farmlands

Prime farmland is defined as land that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, oilseed crops, and other agricultural crops with minimum inputs of fuel, fertilizer, pesticides, and labor, and without intolerable soil erosion [7 U.S.C. 4201 (c)(1)(A)]. Prime farmlands are not excessively erodible or saturated with water for a long period of time, and they either do not flood frequently or are protected from flooding. The Farmland Protection Policy Act (PL 97-98; 7 U.S.C. 4201 et seq.) was passed by Congress with the stated purpose of minimizing the unnecessary and irreversible conversion of farmland to nonagricultural uses by Federal programs.

A review of the U.S. Department of Agriculture – Natural Resources Conservation Service (NRCS) web soil survey indicated that the only prime farmland present is approximately 322 acres of Decatur silt loam, 2 to 8 percent slopes, found near the southern portion of the study area in proximity to Delonah Quarry. This prime farmland does not overlap with the study area or any measures included in the alternatives, and no prime farmland impacts are anticipated. Prime and unique farmlands were dismissed from detailed evaluation because no direct or indirect conversion is anticipated to result from the plan.

## 2.18. Cultural Resources

Section 106 of the National Historic Preservation Act of 1966, as amended and implementing regulations 36 Code of Federal Regulation (CFR) Part 800 requires the USACE to consider the effects of its undertakings upon historic properties, defined as any cultural resource eligible for inclusion on the National Register of Historic Places (NRHP). USACE is also required to consult with other agencies such as the Alabama State Historic Preservation Officer (SHPO) and federally recognized Tribes (Tribes) to avoid, minimize, or mitigate adverse effects upon those properties.

A records search and literature review were conducted using the Alabama Historical Commission's Alabama Cultural Resources Online Database on November 12, 2019 and July 1, 2020 to identify known historic properties within the area of potential effect (APE). The APE encompassed all considered project alternatives. However, it was later narrowed to the present recommended plan that consists of two proposed detention areas (VD1 and VD2). The review found that little of the initial overall potential APE has been inventoried for cultural resources. Three prehistoric sites, including one historic property, have been recorded within 0.5 miles of Valley Creek within the original APE, including Bessemer Mounds, an excavated Moundville culture, Mississippian period mound site. The APE for the recommended plan includes the two detention areas, consists of approximately 23.1 combined acres, and all areas where associated ground disturbance may occur such as access roads, easements, and disposal areas. Neither proposed detention area has been professionally surveyed for cultural resources and no historic properties or other cultural resource sites have been recorded within the APE, which is the physical boundary of each detention area. The Bessemer Mounds Site is mapped approximately 10 miles southwest of the southernmost detention area.

A review of the two detention areas was conducted to determine the likelihood of unrecorded sites in these areas. Sources used included aerial images from Google Earth Pro and mapped soil data from the NRCS Web Soil Survey (on-line). This review found there is low potential for intact precontact archeological sites in both detention areas. Both locations appear to have been heavily disturbed by previous urban development as evidenced by housing developments present in both locations on aerial photographs dating to 1997. All structures except for one in VD1 were removed by 2019. Soils mapped in both locations are urban soils with low to moderate potential for buried archeological deposits. In sum, the APE has little potential for intact precontact archeological sites. Further consultation with SHPO would be needed to determine if the foundations of the former structures would be required to be recorded as archeological sites and evaluated for the NRHP eligibility. However, it is unlikely that the remains of these structures would be determined to be historic properties.

A Programmatic Agreement (PA) with SHPO and appropriate tribes to guide the Section 106 process and mitigate any adverse effects to potential historic properties has been executed and filed with the Advisory Council on Historic Preservation (Appendix I).

## 2.19. Recreation

Available recreation opportunities in and adjacent to the study area include community recreation centers, neighborhood parks, trails, and a water park. The five recreation centers and one YMCA in the study area offer amenities such as weight rooms, walking tracks, sports fields, pools, fitness classes, and youth programs. An equal number of neighborhood parks exist in the study area, mostly concentrated in the northeastern part of the study area. These parks have play structures for children, picnic shelters, and outdoor sports fields.

The study area contains one hiking trail and two others are adjacent to the study area. The High Ore Line trail is about 3 miles long and bisects the study area in the Midfield area. The trail is a paved rails-to-trails project. The Vulcan Trail, located in Birmingham, but outside of the immediate study area, is a 1.7 mile paved and gravel trail within a wooded area. Red Mountain Park, located approximately 3-5 miles southeast of the study area, is operated by a 501(c)3 entity. The park contains 15 miles of hiking trails and offers activities, including a zip line and obstacle courses.

## 2.20. Aesthetics

The aesthetics of Valley Creek in the study area is that of an urban watershed. Vegetated riparian areas are limited. The predominant visual is that of development, varying between residential, commercial, and industrial depending on the location in the study area. Due to the highly developed nature of the study area, heavy rainfall washes trash and litter into the water body, which can become caught up in vegetation within the stream channel. Figure 2-5 is a representative photo of Valley Creek in the study area.

**Figure 2-3. Valley Creek at 19th St. North Looking Downstream.**

# 3.0. FUTURE WITHOUT PROJECT CONDITION

This section provides a description of the future without project (FWOP) conditions within the study area and described how the FWOP is used in the comparison and evaluation of alternative plans.

## 3.1. "With and Without" Comparisons

The Principles, Requirements and Guidelines for Water and Land Related Resources Implementation Studies (PR&G) govern how Federal agencies evaluate and propose water resource development projects. One requirement is to evaluate the effects of alternative plans based on a comparison of the most likely future conditions with and without those plans in place. To make this type of comparison, descriptions (often called forecasts) must be developed for two different future conditions: the FWOP condition and the future with project (FWP) condition. Note that the project referred to in FWP context is any one of the alternative plans that have been considered in the study. The FWOP condition describes what is assumed to be in place if none of the study's alternative plans are implemented. The FWOP condition is the same as the alternative of "no action" that is required to be considered by the Federal regulations implementing NEPA. The FWP condition describes what is expected to occur as a result of implementing each alternative plan being considered. The differences between the FWOP and the FWP condition are the effects (benefits or detriments) of the project.

## 3.2. Planning Horizon

The planning horizon encompasses the planning study period, construction period, economic analysis period, and the effective life of the project. The timeframe used when forecasting future with and without project conditions while considering impacts of alternative plans is called the period of economic and environmental analysis. It may also be referred to as simply the period of analysis. It is the period of time over which extending the analysis of the plan impacts is important. A 50-year period of analysis was used to assess effects of the project. The years 2023-2073 were selected to represent the future without project condition in HEC-FDA; however, the project will require a five-year implementation period and will not be operational until 2028. It is at that point in which the 50-year period of analysis begins and will run until 2078. HEC-FDA will not be adjusted to reflect a new base year since a 50-year stream of benefits were calculated

## 3.3. Hydrology

The FWOP Condition hydrology considers three important factors: land use changes, changes in stormwater management and climate change. The EPA's Integrated Climate and Land-Use Scenarios percent impervious surface projections dataset (Version 1.3.2) was used to estimate the future land use conditions of the basin. This dataset uses population projections through the end of the century, reflecting different assumptions about fertility, mortality, and immigration to determine the demand for new homes, and estimates the amount of impervious surface that can be expected. The results of the analysis show almost no change in land use for this basin, which aligns with information provided by the non-federal sponsor.

Stormwater Management Plans (SWMPs) were provided for Bessemer, Birmingham, Brighton, Hueytown, Midfield, and Jefferson County. The total area of these municipalities covers most of the study area. The core regulation within the SWMPs is shared by the communities – post-construction hydrology shall mimic (i.e. be less than or equal to) pre-construction hydrology for annual exceedance probabilities of 0.5, 0.2, 0.10, and 0.04 rainfall events as determined from Atlas 14, Vol. 9, Version 2 (NOAA 2013). A small portion of the drainage area within the study basin is covered by district boundaries of the McCalla, McAdory, and Eastern Valley areas. For these locations, the core regulation from the SWMPs was carried forward, due in part to their location downstream (mostly) of infrastructure analysis locations, and their very small area of coverage in comparison to the sub basins by which they are encompassed.

The effects of climate change for the FWOP condition were addressed using a literature review as well as the Non-Stationarity Assessment Tool and the Climate Hydrology Assessment Tool (CHAT). The literature review present low consensus of an increase in the frequency and intensity of extreme precipitation events in the future. Furthermore, the Non-Stationarity Assessment Tool showed a decrease in mean annual peak streamflow record in Valley Creek after 1984. An assessment of temperatures in the area show temperatures have been gradually rising in the basin since the 1970s. A shift in seasonality of the most extreme, short duration precipitation events to the dry season has been observed however, this is based on a very small sample size and should be considered as only an indicator of a possible source of the drop in mean annual peak streamflow with more analysis needed on the precipitation dataset. This shift could offset the effects minor increase in average annual precipitation, though no clear consensus on this trend has been established and, additional analysis would be needed to infer this contributes to the over decrease in annual peak streamflow in the basin. The CHAT facilitates an assessment of annual maximum monthly streamflow projections as generated by an ensemble of 93 different combinations of Global Circulation Model (GCM) derived meteorological traces applied to force the U.S Bureau of Reclamation's Variable Infiltration Capacity (VIC) hydrology model. Based on this assessment there is not a statistically significant trend in the modeled future streamflow for years 2000-2099. The full climate change evaluation can be found in Appendix A.

There are few changes in hydrology from existing conditions to the FWOP condition. Changes are driven by SWMPs for the more frequent events, which would lessen the effect that land use has on increasing flows. As stated above, the changes to land use are minimal. In summary, flows for existing conditions were determined to be very similar to the FWOP condition due to little change in forecasted land use and climatology as well as the implementation of SWMPs.

## 3.4. Economics

Based on U.S. Census data from 2010 to 2017 Bessemer, Alabama experienced a population decrease of 3% while Birmingham's population has remained fairly stable during this period. The Bessemer and Birmingham 2010 population, per the USACE National Structure Inventory (NSI), within the 500-year floodplain and floodway is an estimated 15,325 individuals. Please note that the USACE NSI reflects 2017 population levels and 2018 price levels. Although uncertain, future population growth is likely to be consistent with recent trends, with stable to slightly decreasing population over the period of analysis in the study area. Jefferson County, Alabama 2018 Assessor's data was retrieved for parcels within the 500-year FWOP floodplain, resulting in approximately 2,378 structures in the study area. Of these structures 2,074 are residential, 293 commercial, and 11 public. The total investment is an estimated $600 million (FY20), including the value of structures, contents, vehicles, and streets in the 0.002 AEP FWOP flood extents. Residential buildings, excluding automobiles, make up $184,000,000 of the total investment. Public structures, excluding streets, make up the smallest number of structures in the study area, and represent the smallest portion of the total investment at $333,000.

Mirroring the FWOP population trend, and referencing the U.S. Census County Business Patterns, the total number of businesses in Jefferson County, Alabama decreased by 0.78% from 2010 to 2016. Therefore, it's reasonable to assume during the FWOP condition there will be no significant increase in the study area's potential flood risk damages as there will be no new economic development. Absent any new information, it can be assumed the FWOP structure inventory will parallel the present existing structure inventory.

## 3.5. Life Safety

Per USACE guidelines, risk should be considered throughout the planning and design processes (USACE, 2019b) in order to ensure population and infrastructure risk is not increased with any proposed plan, life safety is prioritized, and facilitation of risk-informed decision making. In this study, a comprehensive hazard analysis was completed to assess the residual and incremental risks to life and infrastructure

potentially associated with the proposed plan. This analysis was considered applicable by referenced guidance (USACE 2019) as features of the proposed measures are designated as levees by EM 1110-2-1913 (USACE 2000). In designs, robust features were considered to increase measure resiliency, decreasing hazard risk (i.e. life or infrastructure), and decrease cost risk. The hazard analysis completed for this assessment shows that a low hazard designation likely applies to the measures of the proposed plan.

In accordance with the USACE risk framework, the tolerable risk guidelines (TRGs) were evaluated with respect to recommended plan performance. The first step in addressing TRGs is to gain an understanding of the risk associated with a recommended plan. Specifically, life safety, societal, and environmental risks should be evaluated. Evaluation of life safety risk with respect to TRG 1 is guided by a risk matrix (Figure 5-15) and includes components of societal life risk and individual life risk. To address TRG 1, a comprehensive hazard analysis was completed. The hazard analysis is not equivalent to a semi-quantitative risk assessment (SQRA); however, the analysis leveraged quantitative assessment methods to inform risk understanding. Through this phase of the project development process, TRG 2 has been addressed through communication of plan performance, risk, and best available information with the Non-Federal Sponsor. TRG 3 is expected to be met through O&M and monitoring activities as well as emergency action plan development. Finally, TRG 4 has been satisfied by plan design and quantitative assessment of life and infrastructure safety; however, there may be precedent for further analysis of life safety to reduce uncertainty in results.

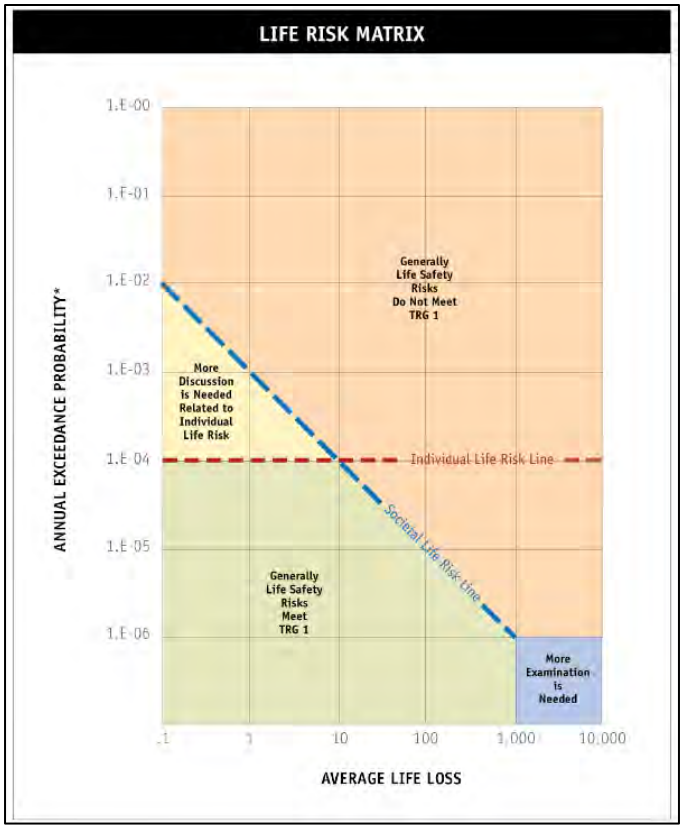


**Figure 3-1: Life Safety Risk Matrix (from USACE, 2019)**

The H&H analyses supporting this study were supplemented with a hazard analysis that included life and infrastructure safety assessments. Both with-project and breach conditions were assessed against FWOP conditions to gain a comprehensive understanding of residual and incremental risk-potential associated

with the recommended plan. A life loss and direct damage estimation model (HEC-LifeSim) was constructed to assess life risk in the study area, while a hydrodynamic assessment was used to assess potential impacts to critical infrastructure and the environment. Breach simulations included individual pond sites as well as combined scenarios. Section 5.2.4 of the Engineering Appendix provides additional detail and results of the analysis.

LifeSim takes into consideration the magnitude and frequency of a flood, the population at risk (including age) with number and type (number of stories) of structures inundated, the infrastructure available for the public to get out of harm's way, and any advanced warning that may be given. The term population at risk (PAR) is the number of people that get flooded during the simulation. Not everyone in the study area is considered part of the PAR. For example, consider two next door neighbors in House A and House B, there is a flood, and House A is inundated but House B is not inundated. House A is considered in the PAR and House B is not in the PAR.

PAR depends on the magnitude of the flood, varies between day and night, and depends on the area under evaluation. In residential areas, people are most likely at work during the day and home at night. If a flood were to occur at night in a residential area, then more population may be at risk than compared to a flood that may occur during the day.

In commercial and industrial areas, the number of people at risk is just the opposite of residential. If a flood were to occur at night in a commercial or industrial area, then less population may be at risk than compared to a flood that may occur during the day.

The infrastructure available for the public to get out of harm's way is predominately the street and highway system. Of course, a large flood event (less frequent) would have a larger PAR than a small (less frequent) event. The simulation takes into consideration the effectiveness of the street and highway system as a means for the public to get out of harm's way and is based on the PAR.

Advanced warning of imminent threat of a flood is also taken into consideration during the simulation and this is called the Public Warning Issuance. The Public Warning Issuance is when the Emergency Management Agency warns the population there is an imminent threat and to take precautions or evacuate. Additional information can be found in Section 5.0 Evaluation and Comparison of Alternative Plans.

# 4.0. FORMULATION OF ALTERNATIVES

## 4.1. Plan Formulation Process

The guidance for conducting civil works planning studies, Engineering Regulation (ER) 1105-2-100, Planning Guidance Notebook, requires the systematic formulation of alternative plans that contribute to the Federal objective. To ensure sound decisions are made with respect to development of alternatives and ultimately with respect to plan selection, the plan formulation process requires a systematic and repeatable approach. This chapter presents the results of the plan formulation process for the Valley Creek Feasibility Study. Alternatives were developed in consideration of study area problems and opportunities as well as study objectives and constraints. Measures and alternatives were evaluated against the four Principles, Requirements, and Guidelines evaluation criteria: completeness, effectiveness, efficiency, and acceptability.

## 4.2. Planning Objectives

The study team along with the non-federal project sponsor identified the following primary and secondary planning objectives to guide the plan formulation process.

Primary Objectives

- Reduce the economic damages from flooding along the upper Valley Creek watershed for a duration of 50 years beginning in 2028 and ending in the year 2078.
- Reduce the risk for loss of life from flooding in the upper Valley Creek watershed for a duration of 50 years beginning in 2028 and ending in the year 2078.

Secondary Objective

- To the extent practicable, seek ancillary recreational benefits along the upper Valley Creek watershed that complement existing local master recreation plans, consistent with the primary objectives to reduce flood risk.

## 4.3. Planning Constraints and Considerations

Constraints are significant barriers or restrictions that limit the extent of the planning process. Plans are formulated to meet the planning objectives and to avoid violating the constraints. Considerations are those issues or matters that should be considered during the planning process, but do not necessarily limit the extent of the process as do constraints. No true constraints were identified during the planning process; however, several considerations were recognized. Induced damages and construction of features in the regulatory floodway were avoided to the extent practicable, and carefully considered when evaluating measures. Railroad bridges near Valley Creek influenced the assessment of potential measures, as railroad property is costly and difficult to alter. Similarly, the presence of utilities near the creek and major transportation thoroughfares pose challenges to the implementation of a measure or alternative. Although these items are less difficult to manage than railroad property, utility relocation and thoroughfare modifications can have substantial cost implications. Alternatives were developed and evaluated in consideration of these items and sought to minimize the need to alter this existing infrastructure.

Operational and maintenance considerations are important. Due to the hydraulic conditions of the creek in which the stream rises very quickly response time to operate a flood risk management system should be taken into consideration. For example, closing gates or stoplog gaps on levees or sandbagging around structures would be challenging if not impossible. Engineered features should be as passive as possible, i.e. require little to no human intervention to operate, considering the response time. Maintenance

considerations are also important. Maintenance, repair, and/or replacement requirements should be manageable in terms of cost sustainable for the local stakeholders.

The potential presence of HTRW materials in the study area was also a consideration in the evaluation of potential measures. Several industrial operations have been and are currently located in the Valley Creek watershed. Several HTRW remediation actions have occurred in the study area. Careful consideration was taken when evaluating measures near current or former industrial sites.

Finally, the densely developed and urbanized corridor that runs parallel to Valley Creek prompted additional consideration during the planning process. The study team sought to minimize disruptions to the community cohesion that would be associated with any measure or alternative.

## 4.4. Formulation and Evaluation Tools

The primary tools used for evaluation of plan alternatives included hydrology and hydraulics (H&H) modeling and economics modeling.

### 4.4.1. Hydrology and Hydraulics Modeling

A planning level hydrologic model was developed within the Hydrologic Engineering Center Hydrologic Modeling System (HEC-HMS), version 4.3 for the 87 square mile study area. Construction of the hydrologic model began from an existing HEC-HMS model for Valley Creek. This model was initially produced for a joint effort between the Mobile District and the City of Birmingham originally in support of the Silver Jackets Flood Forecasting and Inundation Mapping program in 2017. The updated model was extended further downstream and the delineation was refined to match potential measures to be investigated as part of alternatives formulation. Additionally, methods for loss, transform, routing, and precipitation modeling were updated. NOAA Atlas 14 (NOAA 2013) was used to develop design storms for the following annual exceedance probabilities: 0.50, 0.20, 0.10, 0.04, 0.02, 0.01, 0.005, and 0.002.

An unsteady hydraulic model was developed in the HEC River Analysis System (HEC-RAS), version 5.0.7. The model consists of both 1D and 2D components. Valley Creek is modeled as a 1D reach from its headwaters near downtown Birmingham at RS 2859+15, to a location just downstream of the Murphys Lane Bridge in Bessemer (RS 2140+07). At this location, the 1D reach transitions into a 2D mesh. This modeling approach was pursued as a most accurate method of portraying the characteristics of floodplain hydraulics in and around the overbanks of Valley Creek and Halls Creek (an additional system included in modeling and analysis), the confluence of the two stream channels, and flow into and around a retired quarry in the vicinity of the confluence location. Further downstream, just upstream of Powder Plant Road, the model transitions back into a 1D reach, and continues as such to the downstream extent of the study extent (RS 1788+76). The total length of model along Valley Creek is approximately 20.3 miles. This length features 2 storage areas (Fivemile Creek and leveed area), and a total of 35 hydraulic structures including two lateral weirs (one levee and one railroad embankment), 28 bridges, and 5 culverts. One bridge is modeled as a culvert to comply with 2D modeling limitations (WWTP bridge at Valley Creek Water Reclamation).

Additional systems included in the hydraulic model are Opossum Creek, Halls Creek, and a tributary to Halls Creek. Detailed information on the modeling approach for these systems as well as a details of the H&H modeling calibration and validation can be found in Appendix A.

### 4.4.2. Economic Modeling

Economic modeling for the study used the Flood Damage Reduction Analysis (HEC-FDA) software developed by HEC, which provides the capability to perform an integrated hydrologic engineering and economic analysis during the formulation and evaluation of flood risk management plans. HEC-FDA is designed to assist U.S. Army Corps of Engineers (USACE) study members in using risk analysis

procedures for formulating and evaluating flood risk management measures (EM 1110-2-1619, ER 1105-2-101). Also, the software will assist USACE staff in analyzing the economics of flood risk management projects. The software, 1) stores hydrologic and economic data necessary for an analysis, 2) provides tools to visualize data and results, 3) computes expected annual damage (EAD) and equivalent annual damages, 4) computes AEP and conditional non-exceedance probability as required for levee certification, and, 5) implements the risk analysis procedures described in EM 1110-2-1619.

The software follows functional elements of a study involving coordinated study layout and configuration, hydrologic engineering analyses, economic analyses, and plan formulation and evaluation. HEC-FDA is used continuously throughout the planning process as the study evolves from the base year without-project condition analysis through the analyses of alternative plans over their project life. Hydrologic engineering and portions of the economics are performed separately, but in a coordinated manner after specifying the study configuration and layout and merged for the formulation and evaluation of the potential flood risk management plans.

## 4.5. Formulation and Screening of Measures

Measures are the building blocks of alternatives. Structural and non-structural measures were considered, consistent with USACE planning guidance. The PDT identified areas most vulnerable to frequent flooding to focus measures development. The plan formulation process initially identified 48 possible measures to implement in the study area, 35 structural and 13 non-structural resulting in an unmanageable number of alternatives to evaluate in a timely manner.

Structural flood risk management measures were developed based analysis of the study area, engineering judgment and limited field evaluations. Previously published FEMA floodplain mapping as well as previous work performed by USACE through other programs provided an indicator of which areas were vulnerable to flood risk. Engineering experts utilized measures that have proven to be effective in reducing flood risk. Experts identified site locations using open space and location with the study area relative to vulnerable areas. Open space is property with little known above ground infrastructure. This was done to minimally disrupt the people the project is trying to protect and because infrastructure relocations can be costly. Aerial photography was used to identify open space that could potentially accommodate measures such as off-channel detention and inline detention. Some measures do not require large open spaces but rather longer, narrower strips of property along the creek; but wide enough to accommodate measures such as levees, floodwalls, or channel modifications. Again, aerial photography was used to identify potential sites for levees, floodwalls, or channel modifications.

The approach to screening measures was first to screen measures based on effectiveness. In other words, the question was asked, “Does the measure solve the problem?” Measures were evaluated both qualitatively and quantitatively eliminating measures that clearly did not solve the problem. Remaining measures were retained and evaluated based on efficiency.

The remaining measures were evaluated to determine if the benefits from that measure outweighed the costs of implementing that same measure. The measures where the costs are higher than the benefits were eliminated from further consideration.

Several iterations of this process were completed. Each iteration increased detail to allow the team to make risk-informed decisions as to what is effective and efficient. The process of elimination ultimately allowed the PDT to focus on developing alternatives using only building blocks that were considered effective and efficient. Alternatives were formulated and reevaluated for effectiveness and efficiency. Alternatives were also evaluated for completeness and acceptability. This section describes the measures considered, results of initial screening of measures, and identifies the measures that were carried forward for alternative development.

### 4.5.1. Structural Measure Identification and Screening

The measures were located throughout the Valley Creek study length, in addition to Halls Creek and the Halls Tributary. The scope of investigation was expanded to explore opportunities in these tributaries based on repetitive loss areas (data provided by the City of Bessemer [F. Freeman, personal correspondence, 16 October 2018]). The extents of exploration are in accordance with planning guidance (ER1165-2-21). An initial array of 35 structural measures was compiled by the study team.

Structural measures identified included off-channel detention, levee, bridge modification, channel modification, and inline structures (dams). A naming convention was derived for organizational purposes and is shown with details of the measures in Table 4-1. This nomenclature was helpful in identifying and tracking the very large number of potential opportunities within the study area. The nomenclature definitions are: VD (Valley Detention), VL (Valley Levee), VB (Bridge over Valley Creek), HB (Bridge over Halls Creek), UB (Bridge over Halls Tributary), VC (Valley Channel Modification), VI (Inline Structure on Valley Creek), and VO (Inline structure on Opossum Creek). The subsequent number behind each is an identifier.

Off-channel detention areas were considered nature-based features in accordance with implementation guidance for Section 1184 of the Water Resources Development Act of 2016 because they are features that would be created by human design, engineering, and construction that work to mimic as closely as possible conditions which would occur in the area absent human changes (i.e. the natural storage of floodwaters within the floodplain). Other nature based features such as widespread channel widening and restoration were considered, but found not to be acceptable. Table 4-1 also provides the status of each measure. Retained means the measure was kept for future evaluation, while screened out means it was not considered any further in the study. Subsequent sections describe the rational for keeping or removing each measure.

**Table 4-1. Valley Creek Structural Measures.**

| Type | Name | Description | Screening Status |
|---|---|---|---|
| Off-Channel Detention | VD1 | 10.0 acres on left overbank downstream of Center St. One home on property and minor roadways. | Retained |
| Off-Channel Detention | VD2 | 13.6 acres on left overbank downstream of Princeton Pkwy. Two sizes initially considered with largest moving forward. Area includes 3 homes and minor roadways. | Retained |
| Off-Channel Detention | VD3 | 22.2 acres on left overbank at Fayette Ave. SW. Previous buyout area with minor roadways and slab foundations. | Screened Out |
| Off-Channel Detention | VD4 | 16.4 acres on left overbank at Lincoln Ave. | Retained |
| Off-Channel Detention | VD5 | 55.6 acres on left overbank downstream of Alemeda Ave. SW. | Screened Out |
| Off-Channel Detention | VD6 | 27.9 acres on left overbank at Hartman Industrial Blvd. Site uses existing quarry. | Screened Out |
| Off-Channel Detention | VD7 | 38.6 acres at By Williams Sr. Dr. Site uses existing, ponded quarry. | Screened Out |
| Off-Channel Detention | VD8 | 54.5 acres on left overbank immediately downstream of By Williams Sr. Dr. Area is clear of development, land held by Freshwater Land Trust. | Screened Out |
| Off-Channel Detention | VD9 | 24.8 acres on right overbank immediately downstream of By Williams Sr. Dr. Both areas clear of development; however, VD8 held by Freshwater Land Trust. | Screened Out |
| Off-Channel Detention | VD10 | 85.6 acres on left overbank immediately downstream of Martin Luther Ave. Area is clear of development, land held by Freshwater Land Trust. | Screened Out |
| Off-Channel Detention | VD11 | 39.6 acres on left overbank just upstream of Jaybird Rd. Area is clear of development other than roadways. | Screened Out |

| Type | Name | Description | Screening Status |
|---|---|---|---|
| Off-Channel Detention | VD11b | Additional 8.5 acres on right overbank added to VD11. Open area. | Screened Out |
| Off-Channel Detention | VD12 | 33.4 acres on left overbank just upstream of 19th St. Area is clear of development but may have HTRW issues. | Screened Out |
| Off-Channel Detention | VD13 | 26.5 acres on left overbank just downstream of 19th St. Area is clear of development, land held by Freshwater Land Trust. | Screened Out |
| Levee | VL1 | Berm repair of existing RR embankment on right overbank near Quincy Ave. (745 feet). | Screened Out |
| Levee | VL2 | Levee on right overbank extending from a location just upstream of Martin Luther Ave. and tying into a point near Sugar Ray Dr. downstream (3265 feet). | Screened Out |
| Levee | VL3 | Levee on right overbank extending from Sugar Ray Dr. upstream and tying into a location due east of 47th St. (3765 feet). | Screened Out |
| Levee | VL4 | Ring levee on left embankment extending from 19th St. N upstream and tying in to I-20 embankment (8740 feet). | Screened Out |
| Bridge Modification | VB1 | 3rd Ave. N over Valley Creek. | Screened Out |
| Bridge Modification | VB2 | RR DS 3rd Ave. N over Valley Creek. | Screened Out |
| Bridge Modification | VB3 | Fayette Ave. SW over Valley Creek. | Screened Out |
| Bridge Modification | VB4 | By Williams Sr. Dr. over Valley Creek. | Screened Out |
| Bridge Modification | VB5 | RR DS Jaybird Rd. over Valley Creek. | Screened Out |
| Bridge Modification | VB6 | RR at Opossum Creek over Valley Creek. | Screened Out |
| Bridge Modification | VB7 | 2nd RR at Opossum Creek over Valley Creek. | Screened Out |
| Bridge Modification | VB8 | Murphys Ln. over Valley Creek | Retained |
| Bridge Modification | VB9 | 18th Ave. over Valley Creek. | Retained |
| Bridge Modification | HB1 | 8th Ave. N over Halls Creek. | Screened Out |
| Bridge Modification | HB2 | 9th Ave. N/Bessemer Hwy. over Halls Creek. | Screened Out |
| Bridge Modification | UB1 | 5th St. N over Halls Tributary. | Screened Out |
| Bridge Modification | UB2 | 9th Ave. N/Bessemer Hwy. over Halls Tributary. | Screened Out |
| Channel Modification | VC1 | 120-ft. wide channel, approximately 3000-feet in length from Murphys Ln downstream | Retained |
| Dam | VI1 | Dam as appurtenant structure to RR embankments (bridge removed) near central basin quarries with crest elevation at 516.5 ft-NAVD88. | Screened Out |
| Dam | VI2 | Dam as appurtenant structure to RR embankments (bridge converted to pedestrian) just downstream of Midfield High School with crest elevation at 505.0 ft-NAVD88. | Screened Out |
| Dam | OI1 | Dam as appurtenant structure to active RR embankments on Opossum Creek near Valley Creek confluence. Crest elevation at 465.0 ft-NAVD88. | Screened Out |

Figure 4-1 shows the general location of different categories of structural measures within the study area. Following identification of measures, a preliminary screening of measures was conducted to determine those that should move forward for alternative development.

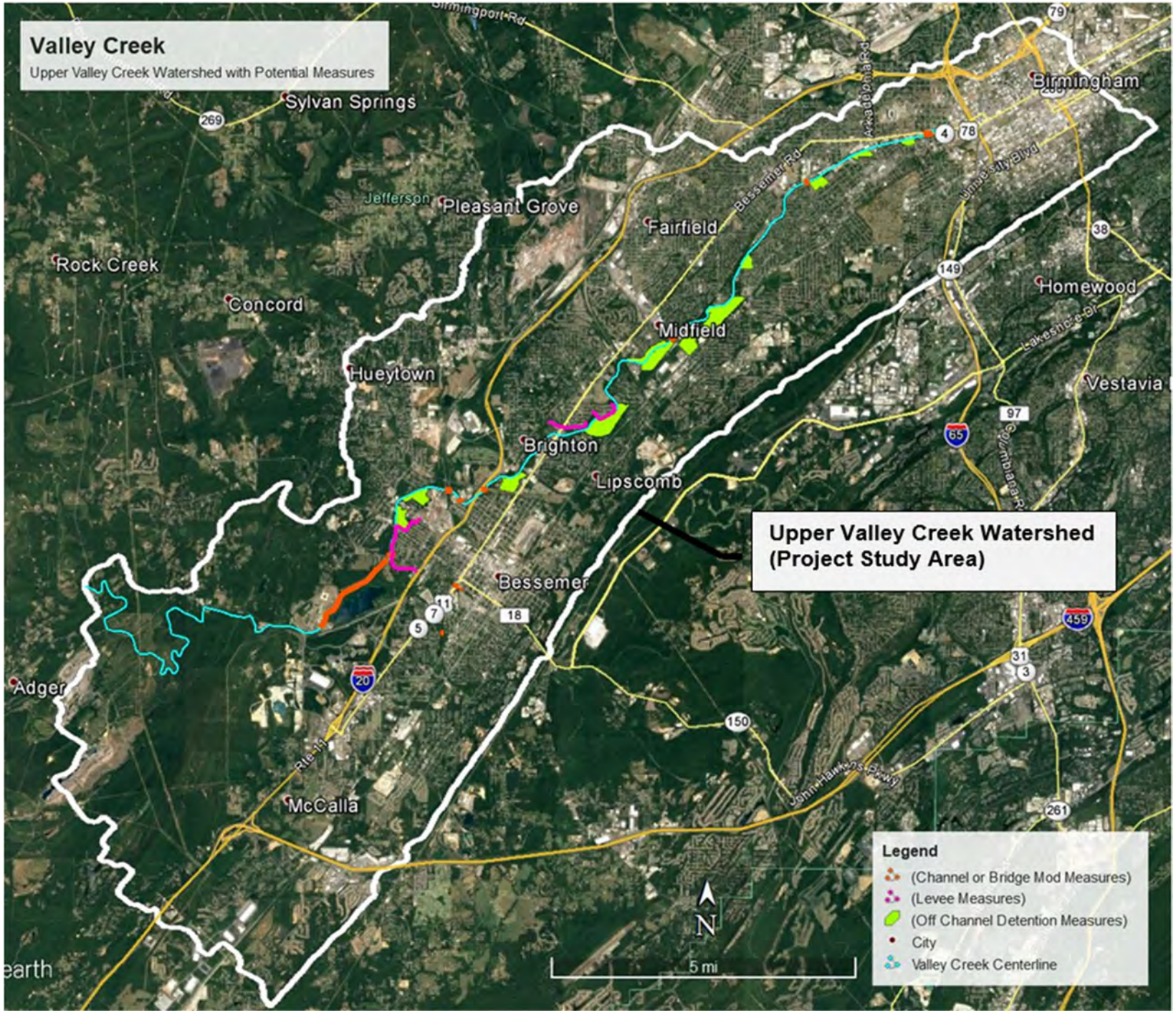


**Figure 4-1. Location of Structural Measures within Study Area.**

#### 4.5.1.1. Off-Channel Detention

Initially there were 14 off-channel detention sites identified. These sites were identified predominately from aerial photography where there was a lack of above ground infrastructure that would be costly to relocate. Measures were assessed by the entire study team regarding associated risks including environmental hazards such as HTRW, land use feasibility, and real estate restrictions. The study team eliminated three off-channel detention sites (VD6, VD7, VD12) based on site considerations.

Real estate informed the team that VD6 serves as a dump site for the City of Midfield and informed the team that VD12 is adjacent to U.S. Pipe. This site is a foundry that has been in operation since the late 1800's. Though nothing specific was found in the databases for presence of HTRW at VD12, the PDT believed there to be a high risk of encountering something that would require clean-up by the non-federal sponsors. Any property acquired for construction would have to be acquired by a non-Federal sponsor and be free and clear of any contamination (including dump sites) prior to construction. Additionally, modeling at nearby sites (VD11 and VD13) showed that detention would likely be ineffective at VD12. No further investigation was done on sites VD6 and VD12 as the non-federal sponsor indicated they were not willing to accept the responsibility to remediate. Both VD6 and VD12 were removed from further consideration.

VD7 was removed from consideration due to construction costs associated with the site that made it cost-prohibitive compared to other available sites. Floodwaters would have to be routed underneath an industrial boulevard servicing the nearby dump (VD6) as well as a major railroad next to the roadway. These requirements were unique to this site, and nearby sites provided similar storage potential.

Off-channel detention measures were analyzed for effectiveness based on their performance in the hydraulic model. Overall, hydraulic performance was the key criteria used for measure refinement, although a small number of sites were screened based on-site considerations. Approaches to geometry construction and the choice of frequency events simulated for screening varied based on measure type; however, performance was consistently based on (1) a measure's ability to reduce flood risk to areas of development across the range of analyzed frequency events, and (2) the impacts associated with implementation of the measure.

Site VD11b was developed as a supplemental configuration of VD11 to include a small area of additional open space on the right overbank. This option did not perform well and was eliminated. No significant reduction in flood risk was realized when compared to VD11. Site VD13 was eliminated based on performance; only negligible changes to flood elevations for a range of frequency events were observed in the densely developed residential areas located immediately downstream.

After a first iteration of evaluation sites VD6, VD7, VD11b, VD12, and VD13 were screened out. The remaining measures were considered effective and were further evaluated for efficiency. Efficiency was assessed by comparing the cost of each basin to its effectiveness, as indicated by the benefit-cost ratio. Off-channel detention measures were analyzed for efficiency using the economic model. Costs were developed for each measure and used to compare against the benefits. Measures for which costs outweighed benefits were screened from further consideration if combining it with another measure would not appreciably increase the benefits or reduce costs. Sites VD5 through VD11 are in the middle to downstream area of the corridor and increase in size significantly compared to the upstream locations VD1 through VD4. The increased size results in increased costs and the middle to lower basins leave upstream areas unprotected, resulting in marginal to less than one benefit cost ratios. Sites VD 5 through VD11 were screened from further consideration.

The retained sites for further consideration include VD1, VD2, VD3, and VD4. Though VD3 is effective and efficient on its own merit it is the more costly and least effective of the four basins. When combined with the other measures it provided a modest increase in benefit, but at a very large increase in cost

rendering it not efficient. Therefore, VD3 was screened out and the final sites retained for alternative development include VD1, VD2, and VD4.

#### 4.5.1.2. Dams

Three inline storage structures, also known as dams, were initially considered and ultimately evaluated for effectiveness. Configuration of inline storage would be a structure perpendicular to the stream to impede downstream flow during flooding conditions. Real estate challenges in this urban setting would only allow for short low head dams. Evaluations determined there were induced damages upstream and any reductions in flood elevations downstream were negligible. All inline storage dams were screened from further consideration.

#### 4.5.1.3. Levees

Four areas of vulnerable population were thought to be good candidates for levee measures. These sites are in Bessemer, Brighton, and Midfield areas, which is the mid to lower part of the study area.

Initially, VL1 was thought to consist of minor repairs to an existing railroad embankment. However, after reevaluation the repair was determined to be more significant and infeasible. VL1 was qualitatively screened from further consideration.

Site VL4 worsened flood conditions in several upstream locations. An estimated 30 structures located at the upstream extent of the feature observed a 4-foot rise in water surface elevation during the 0.002 AEP event. These same structures observed increases of approximately 2 feet and 3 feet for the 0.04 and 0.01 AEP events, respectively. Additionally, VL4 induced new flood risk on approximately 20 structures from overtopping of the existing Bessemer Gardens levee upstream and those on the right overbank, adjacent to the measure's location. VL 4 was screened from further consideration.

Sites VL2 and VL3 performed well with minimal impacts to upstream or adjacent structures. Impacts within the proposed protected area of VL2 were observed during simulations with VL3 alone. For this reason, it was decided that either VL2 should be carried forward as a stand-alone measure, or VL2 and VL3 should be carried forward as a combined measure. Levees VL2 and VL3 were evaluated at a second iteration for cost efficiency.

At a second iteration, costs were developed for each measure and compared against the benefits. The costs outweighed the benefits rendering VL2 and VL3 not feasible. In addition, both VL2 and VL3 would require closure structures or large roadway modifications at Bessemer Super Highway and Martin Luther Ave that were not considered in the cost estimate further separating the high costs from the low benefits. Operation and maintenance are important considerations, as identified in Section 4.3. There was uncertainty around the feasibility of the non-federal sponsor to operate a closure structure given the short response times that would be associated with the flashiness of flood events in the study area. Both VL2 and VL3 were screened from further consideration due to the costs outweighing the benefits and operational concerns.

#### 4.5.1.4. Bridge Modifications

The effects of bridge modifications were analyzed with profile plots, inundation extents, and spatial observation of flood elevation changes. The following sites were removed from further consideration: VB3, VB4, VB5, VB6, VB7, HB1, and HB2. Upstream profiles in existing conditions were not improved by the removal of these structures. In some cases, insignificant (i.e. < 0.2 feet) upstream flood elevation reductions were coupled with similar increases downstream. The elimination of the Halls Creek sites (HB1 and HB2) removed all structural measures from this system (only bridge modifications identified). Elimination of HB2 decreased flood elevations during the 0.01 AEP event by approximately 2.5 feet; however, only 2 structures were located within the upstream inundation extents where the change

occurred (results were limited to 8th Ave. N upstream [approximately 425 feet]). It was not considered advantageous to pursue further analysis at this site considering probable costs to replace culverts under the four-lane divided highway. As for HB1, bridge improvements completed in 2017 alleviated prior flooding problems.

The remaining bridge modifications after the first screening were VB1, VB2, VB8, VB9, UB1, and UB2. It was determined, due to their proximity, that bridge modification VB8's hydraulic performance is dependent on channel modification and channel modification's performance is dependent on VB8. Therefore, VB8 was always combined with channel modification. Other bridges, VB1, VB2, VB9, UB1, and UB2 were combined to maximize performance but found this not to be efficient. Subsequent evaluations were carried out to isolate effective and efficient bridge measures and found VB9 to meet both criteria (effectiveness and efficient). This left VB8 and VB9 as the only two retained measures with VB8 always combined with channel modification.

### 4.5.1.5. Channel Modification

Preliminary testing showed that a 120-feet bottom width was the best alternative for the channel modification template. Results between 120-feet and 140-feet templates were nearly identical, with the 140-feet template requiring additional earthwork. The 100-feet template was less effective at lowering upstream flood elevations than the 120-feet template through the range of tested frequency events. Additionally, the existing channel upstream and downstream of the proposed location for widening has a bottom width near 120 feet. For these reasons, the 100-feet and 140-feet templates were removed from the study. Channel modification was found to be effective at drawing down the water surface profiles upstream mainly benefiting the neighborhood on the left bank adjacent to Murphy's lane. Further upstream, the channel modification had less of an impact in drawing down the water surface profiles.

After a second iteration, it was found that channel modification could be shortened and retain the same effectiveness. The channel modification measure combined with VB8 was found to be effective, efficient, and complete. It was retained for further evaluation understanding it should be combined with another measure during alternative formulation to make it a more effective plan.

### 4.5.1.6. Screening Summary

The final array of measures is summarized in Table 4-2 and served as the basis for formulation of alternatives. The measures remaining at the conclusion of measure screening included off-channel detention, bridge modification, and channel modification. Locations are shown in Figures 4-2 and 4-3.

**Table 4-2. Final Array of Structural Measures Carried Forward for Alternative Formulation.**

| Type | Name | Description | Screening Status |
|---|---|---|---|
| Off-Channel Detention | VD1 | 10.0 acres on left overbank downstream of Center St. One home on property and minor roadways. | Final measure |
| Off-Channel Detention | VD2 | 13.6 acres on left overbank downstream of Princeton Pkwy. Note: 2 sizes initially considered with largest moving forward. This area includes 3 homes and minor roadways. Size updated again through refinement phase. | Final measure |
| Off-Channel Detention | VD4 | 16.4 acres on left overbank at Lincoln Ave. | Final measure |
| Bridge Modification | VB8 | Murphys Ln. over Valley Creek | Final measure |
| | VB9 | 18th Ave. over Valley Creek. | Final measure |
| Channel Modification | VC1 | 120-ft. channel from Murphys Ln. to Hall Creek Tributary (approximately). | Final measure |

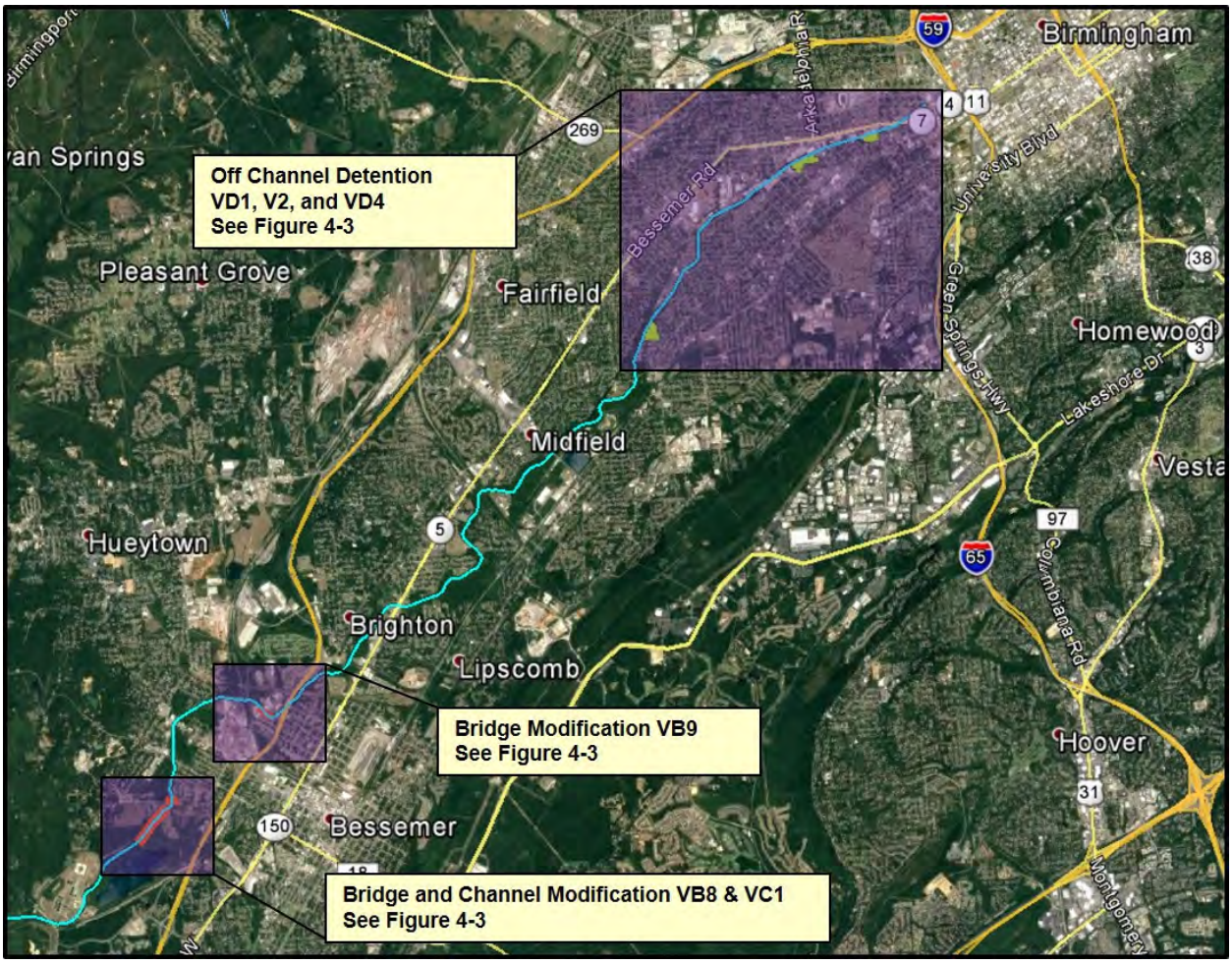


**Figure 4-2. Vicinities of Final Structural Measures Carried into Alternative Development**


**Figure 4-3. Location of Final Structural Measures Carried into Alternatives Development.**

## 4.5.2. Nonstructural Measure Identification and Screening

Nonstructural flood risk measures reduce flood damages without significantly altering the nature or extent of the flooding. In other words, while structural measures keep flood water away from people, nonstructural measures keep the people away from the water. These measures are meant to reduce the consequence of an event, while bypassing the reduction in probability of the event's occurrence. Measures can exist as stand-alone alternatives or can be integrated into an alternative with structural measures. Measures that are stand-alone alternatives must still meet all four of the planning criteria of effectiveness, efficiency, completeness, and acceptability and are evaluated the same as those alternatives with combined measures. Nonstructural measures are categorized as physical, nonphysical, and nature-based. Buyouts would be considered nature based because they make the floodplain available to hold floodwater by removing structures. USACE guidance requires that at least one nonstructural alternative be developed and formulated to full consideration. The USACE National Nonstructural Committee developed a screening matrix for physical, nonstructural measures to assist study teams in identifying

nonstructural measures that may work with the characteristics of a study area (Figure 4-4). The chart compares each measure against criteria based on structure characteristics, site characteristics, the nature of flooding, and benefits to the community. The Valley Creek study team used the matrix to identify nonstructural measures that should be considered. Types of physical nonstructural measures considered by the Valley Creek study team include structure elevation, relocation, wet and dry proofing, and acquisition. Nonphysical nonstructural measures considered include an emergency warning system (Table 4-3).

**Table 4-3. Valley Creek Non-structural Measures Identified for Consideration.**

| Type | Name | Description |
|---|---|---|
| Structure Elevation, wet and dry proofing, and Relocation | VSER (VL2) | Neighborhood on right descending bank generally bound by Martin Luther Ave, Valley Creek Dr, and Sugar Ray Dr. |
| Structure Elevation, wet and dry proofing, and Relocation | VSER (VL3) | Neighborhood on right descending bank generally bound by Sugar Ray Dr, Blocton Ave, and Bessemer Super Highway. |
| Structure Elevation, wet and dry proofing, and Relocation | VSER (VL4) | Neighborhood on left descending bank generally bound by 19th Street N, I-59, and 11th street N. |
| Structure Elevation, wet and dry proofing, and Relocation | VSER (0.50 AEP) | Frequently damaged structures by the 50% annual chance exceedance probability event along the corridor within the study area. |
| Structure Elevation, wet and dry proofing, and Relocation | VSER (0.20 AEP) | Frequently damaged structures by the 20% annual chance exceedance probability event along the corridor within the study area. |
| Acquisition | VA (VL2) | Neighborhood on right descending bank generally bound by Martin Luther Ave, Valley Creek Dr, and Sugar Ray Dr. |
| Acquisition | VA (VL3) | Neighborhood on right descending bank generally bound by Sugar Ray Dr, Blocton Ave, and Bessemer Super Highway |
| Acquisition | VA (VL4) | Neighborhood on left descending bank generally bound by 19th Street N, I-59, and 11th street N. |
| Acquisition | VA (0.50 AEP) | Frequently damaged structures by the 50% annual chance exceedance probability event along the corridor within the study area. |
| Acquisition | VA (0.20 AEP) | Frequently damaged structures by the 20% annual chance exceedance probability event along the corridor within the study area. |
| Emergency Flood Warning System | VEFWS | Implementation of an emergency flood warning system tied to the national weather service emergency alert system. |

**Table 4-4. Nonstructural Flood Risk Management Matrix**

| May 2019 | | PHYSICAL NONSTRUCTURAL MITIGATION MEASURES | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| NONSTRUCTURAL FLOOD RISK MANAGEMENT MATRIX | | Elevation | | | | | | Relocation | Acquisition | Dry Flood Proofing | Wet Flood Proofing |
| | | Extend Foundation | Piers | Posts | Columns | Piles | Fill (Compacted | | | | |
| Flooding Characteristics | **Flood Depth** | | | | | | | | | | |
| | Shallow ( less than 3 ft) | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| | Moderate (3 to 6 feet) | Y | Y | Y | Y | Y | Y | Y | Y | N | Y |
| | Deep (6 to 12 feet) | Y | Y | Y | Y | Y | Y | Y | Y | N | Y |
| | Very Deep (more than 12 feet) | N | N | N | N | N | N | Y | Y | N | N |
| | **Flood Velocity** | | | | | | | | | | |
| | Low (less than 3 feet per second) | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| | Moderate (3 to 6 feet per second) | N | Y | Y | Y | Y | Y | Y | Y | N | N |
| | High (more than 6 feet per second) | N | Y | N | N | Y | N | Y | Y | N | N |
| | **Flash Flooding** | | | | | | | | | | |
| | Yes (less than 1 hour warning) | Y | Y | Y | Y | Y | Y | Y | Y | N | N |
| | No (more than 1 hour warning) | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| | **Debris / Ice Flow** | | | | | | | | | | |
| | Yes | N | Y | N | N | Y | Y | Y | Y | N | N |
| | No | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| Site Characteristics | **Site Location** | | | | | | | | | | |
| | Coastal Beach Front | N | N | N | N | Y | N | Y | Y | N | N |
| | Coastal Interior (Low Velocity) | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| | Riverine Flood Plain | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| | **Soil Type** | | | | | | | | | | |
| | Permeable | Y | Y | Y | Y | Y | Y | Y | Y | N | Y |
| | Impermeable | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| Building Characteristics | **Structure Foundation** | | | | | | | | | | |
| | Slab on Grade (reinforced) | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| | Crawl Space | N | N | N | N | N | Y | Y | Y | N | Y |
| | Basement | N | N | N | N | N | Y | Y | Y | N | Y |
| | Abandonment of Crawlspace / Basement | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| | **Structure Construction** | | | | | | | | | | |
| | Concrete, Stone, or Masonry | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| | Metal | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| | Wood | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| | **Overall Structure Condition** | | | | | | | | | | |
| | Excellent to Fair | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| | Fair to Poor | N | N | N | N | N | N | N | Y | N | N |
| Community (Project | **Economics** | | | | | | | | | | |
| | Insurance Premium Reduction (Residential) | Y | Y | Y | Y | Y | Y | Y | Y | N | N |
| | Insurance Premium Reduction (Non-Residential) | Y | Y | Y | Y | Y | Y | Y | Y | Y | N |
| | Avoids Adverse Impact on Adjacent Property | Y | Y | Y | Y | Y | N | Y | Y | Y | Y |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Reduction in Admin Costs of NFIP | N | N | N | N | N | Y | Y | Y | N | N |
| | Reduction in Emergency Costs | N | N | N | N | N | N | Y | Y | N | N |
| | Public Infrastructure Damage Reduced | N | N | N | N | N | N | Y | Y | N | N |
| | **Intangible Benefits** | | | | | | | | | | |
| | Ecosystem Restoration Potential | N | N | N | N | N | N | Y | Y | N | N |
| | Recreation Potential | N | N | N | N | N | N | Y | Y | N | N |
| | Community (Project Are) Cohesion | Y | Y | Y | Y | Y | Y | N | N | Y | Y |
| | Flood Risk Eliminated | N | N | N | N | N | N | Y | Y | N | N |

Source: The US Army Corps of Engineers National Nonstructural Committee [NNC] is available to assist in any aspect of formulating and implementing nonstructural flood damage reduction measures and realizing the opportunities that exist with nonstructural.

For more information, please contact the NNC Chairman and committee members at: nnc@usace.army.mil or visit the NNC website at: http://www.usace.army.mil/Missions/CivilWorks/ProjectPlanning/nnc/

### 4.5.2.1. Acquisition

Acquisition, also known as buyouts, feature the acquisition of land and structures for the purpose of removing the consequence of flood damage. Households and businesses are relocated outside of the floodplain by giving fair market value for their property and structure and paying for their relocation expenses in accordance with the Uniform Relocation Assistance Act. The Federal Emergency Management Agency (FEMA) has established an assistance program for buyout options. This program can be used in conjunction with a USACE project through the coordination of the local non-federal sponsor.

USACE participation in buyouts are limited to the cost reimbursement given to all lands, easements, right of ways, relocations, and disposals (LERRD) costs above the non-federal sponsor's thirty-five percent cost share. For acquisitions to be considered a complete plan, the buyout option must be permanent, meaning that the land must be zoned to be prohibitive of any future development. The buyout plan must also carry 100 percent participation. Homeowners or businesses within the buyout area who do not wish to participate will be subject to condemnation. Large scale acquisition/buyouts with mandatory 100 percent participation can have devastating impacts to communities. Common to USACE buyout options, recreational features may be incorporated into the plan; those features can carry economic benefits added to the plan's economic evaluation. Environmental features may also be incorporated. Five acquisitions measures were evaluated: VA(VL2), VA(VL3), VA(VL4), VA(0.50 AEP), and VA(0.20 AEP). Three of the measures took a neighborhood approach in which an entire neighborhood at risk would be acquired. Two measures took a corridor approach in which only frequently damaged structures would be acquired.

Three neighborhood areas were identified as having the potential to receive a levee as a measure or nonstructural acquisition as a measure. Levee measures VL2, VL3, and VL4 were screened from further consideration as a result of not meeting effectiveness and/or efficiency criteria. Acquisition at the same identified areas VA(VL2), VA(VL3), and VA(VL4) were evaluated using the 0.01 AEP. Structures experiencing flood damage during model runs were selected for buyouts. Areas VA(VL3) and VA(VL4) featured several repetitive loss properties. Each area was evaluated as an independent measure. Efficiency analysis determined the cost of the measure outweighed the benefits and therefore VA(VL2), VA(VL3), and VA(VL4) were screened from further consideration.

The corridor approach evaluated frequently damaged structures via the 0.50 AEP and 0.20 AEP events as individual measures. The regulatory floodway would typically be smaller than the 0.50 AEP event, however in the case of Valley Creek, they are nearly identical. Therefore, the 0.50 AEP was used as the basis of the nonstructural analysis.

Development of costs for the nonstructural acquisition measures relied on three types of cost: the cost to acquire the structure(s) and land, cost for relocation assistance under the Uniform Relocation Assistance Act, and demolition or construction cost to free the site of damageable property during a flood. Summary of costs are found in Table 4-5 and details can be found in the Cost Appendix.

**Table 4-5. Costs of Non-Structural Acquisition**

| Measure | Description | Total First Cost | Annual O&M Cost | Annual Total Cost | Annual Mean Benefit | Annual Mean Net Benefit | Mean BCR |
|---|---|---|---|---|---|---|---|
| VA (VL2) | Acquisition of neighborhood | 12,747 | 0 | 492 | 441 | (51) | 0.9 |
| VA (VL3) | Acquisition of neighborhood | 20,803 | 0 | 802 | 203 | (600) | 0.3 |
| VA (VL4) | Acquisition of neighborhood | 66,194 | 0 | 2,553 | 573 | (1980) | 0.2 |
| VA (0.50 AEP) | Acquisition in 0.50 AEP floodplain | 53,685 | 0 | 2,071 | 2,771 | 700 | 1.3 |
| VA (0.20 AEP) | Acquisition in 0.20 AEP floodplain | 92,713 | 0 | 3,576 | 4,106 | 530 | 1.1 |

### 4.5.2.2. Structure Elevation, Wet or Dry Proofing, and Relocation

Structure elevation are measures that require the structure to be altered by extending the foundation, placing on piers, posts, columns, piles, or compacted fill. Structure relocation is a measure that requires the structure to be relocated to a new location away from the hazard. Dry flood proofing is a form of waterproofing a structure in which all exterior walls, doors, and windows up to a certain height (usually up to three feet) are sealed with a permanent impermeable membrane. Doors and windows are covered with closure panels that allow for access during non-flood events. Dry flood proofing is not recommended for structures containing either a basement or a crawlspace, unless a cut-off wall is designed to complement the existing walls. The construction of the cut-off wall can be expensive and complex. Wet flood proofing utilizes water resistant construction and finishing materials. All utilities must be elevated above the design flood elevation. This measure is not recommended for structures that see high velocity or flashy stream conditions as these conditions are not conducive to hydrodynamic pressures to equalize quickly.

The structures identified are frequently damaged structures, have crawl spaces, and see high velocities in a flooding situation. All are in a flashy stream system and are in fair to poor condition with most in poor condition. Physically altering the structure by elevation, relocating, wet flood proofing, or dry flood proofing is not achievable. Some structures would not accept wet or dry flood proofing without major expensive repairs to the structure itself due to their condition. Major repairs would be an owner responsibility as it would outside the scope of floodproofing.

A preliminary screening analyzed parcels within the 0.50 AEP, 0.20 AEP, and 0.10 AEP FWOP floodplains. Parcels that were protected behind the proposed leveed areas also were analyzed. In total 95 percent of all parcels within the 0.002 AEP floodplain have the presence of either a crawl space or basement. Given the characteristics, large number of homes and businesses within the project area, and the high cost of elevation relative to structure values dry flood proofing and elevation was screened out from further consideration. Implementing nonstructural floodproofing to nearly entire communities is not reasonable or a practical approach. Also, dry flood proofing is not a viable solution due to flood depths and velocities in some locations.

### 4.5.2.3. Emergency Warning System

Emergency warning systems are non-physical measures that combine the use of gauges and sensors with notification devices to give advanced notice to the general public of flood emergencies. This system is constantly monitored by an emergency manager who works with emergency personnel to carry out actions such as evacuations, flood fighting, and other necessary actions of emergency response. USACE planning guidance allows for emergency warning system alternatives to either be stand-alone or as a

component of a larger solution; these can also be interim measures to other structural or nonstructural measures.

USACE participation allows for selection, siting, installation, and calibration of gages and other equipment to collect, evaluate, and disseminate pertinent data. USACE can also provide guidance and assistance to ensure adequacy of the system. USACE can aid with the emergency response including coordinating with local officials, providing technical advice and planning guidance, and developing adequate mapping to identify flood threatened areas, evacuation routes, temporary shelters, etc. Emergency warning system measures are evaluated based on an economic loss of life curve. Flash flooding in the Valley Creek study area has not caused any loss of life, to date. However, there remains socially vulnerable populations in the study area whom have experienced repetitive losses due to the frequency of flooding. Jefferson County has an established flood warning system. Installed or operated by Everbridge Inc., the system gathers the actual rainfall measured at U.S. Geological Survey gauges and automatically relays warnings issued by the National Weather Service. Warnings are sent to residents in the form of SMS messages, through social media, and emergency warning sirens. Approximately 210,000 people county-wide have signed up for the service. This measure was screened from further consideration because an emergency warning system is already in place within the study area and the scope of USACE involvement to potential make any modifications would be minimal. If the non-federal sponsor, Jefferson County, or other municipality were to invest in improvements to the existing system, it would be complementary to the plan identified in this report. Also, the USACE and other Federal agency programs such as Silver Jackets could help with education, mapping and emergency action messaging based on the existing gage locations.

### 4.5.2.4. Screening Results

Table 4-6 summarizes the results of the measures screening process.

**Table 4-6. Summary of Valley Creek Nonstructural Measures Screening Results.**

| Type | Name | Description | Screening Status |
|---|---|---|---|
| Structure Elevation, wet and dry proofing, and Relocation | VSER (VL2) | Neighborhood on right descending bank generally bound by Martin Luther Ave, Valley Creek Dr, and Sugar Ray Dr. | Screened Out – infeasible |
| Structure Elevation, wet and dry proofing, and Relocation | VSER (VL3) | Neighborhood on right descending bank generally bound by Sugar Ray Dr, Blocton Ave, and Bessemer Super Highway | Screened Out – infeasible |
| Structure Elevation, wet and dry proofing, and Relocation | VSER (VL4) | Neighborhood on left descending bank generally bound by 19th Street N, I-59, and 11th street N. | Screened Out – infeasible |
| Structure Elevation, wet and dry proofing, and Relocation | VSER (0.50 AEP) | Frequently damaged structures by the 50% annual chance exceedance probability event along the corridor within the study area. | Screened Out – infeasible |
| Structure Elevation, wet and dry proofing, and Relocation | VSER (0.20 AEP) | Frequently damaged structures by the 20% annual chance exceedance probability event along the corridor within the study area. | Screened Out – infeasible |
| Acquisition | VA (VL2) | Neighborhood on right descending bank generally bound by Martin Luther Ave, Valley Creek Dr, and Sugar Ray Dr. | Screened Out – Effective, not Efficient |
| Acquisition | VA (VL3) | Neighborhood on right descending bank generally bound by Sugar Ray Dr, Blocton Ave, and Bessemer Super Highway | Screened Out – Effective, not Efficient |
| Acquisition | VA (VL4) | Neighborhood on left descending bank generally bound by 19th Street N, I-59, and 11th street N. | Screened Out – Effective, not Efficient |

| Type | Name | Description | Screening Status |
|---|---|---|---|
| Acquisition | VA (0.50 AEP) | Frequently damaged structures by the 50% annual chance exceedance probability event along the corridor within the study area. | Retained |
| Acquisition | VA (0.20 AEP) | Frequently damaged structures by the 20% annual chance exceedance probability event along the corridor within the study area. | Retained |

## 4.6. Alternatives Development (Initial Array)

Final measures were used to develop a suite of alternatives comprised of structural measures only, non-structural measures only, or a combination of structural and non-structural measures. A hydraulic and cost-benefit analysis was performed on the remaining four detention basins VD1, VD2, VD3, and VD4 to inform what combinations of these detention basins were most effective and efficient as part of alternatives. That evaluation is described further in Appendix A, Engineering. VD3 was screened out as a result of the analysis of the remaining four detention basins which showed that the individual performance of this site was inferior to VD1, VD2 and VD4. The final two bridge modifications and channel modification measures include VB8, VB9, and VC1, respectively. The Murphys Lane Bridge (VB8) is located immediately upstream of the channel modification. It was determined that the channel modification measure (VC1) and the Murphys Lane bridge modification measure (VB8) are interdependent, that is their effectiveness relies on both measures being in place. Therefore, the channel modification measure (VC1) and VB8 were always combined in alternatives. Bridge modification VB9 as a stand-alone plan was not considered an effective plan but VB9 was combined with other measures.

Section 73 of the Water Resources Development Act of 1974 requires that at least one nonstructural plan be developed for consideration as an alternative. In addition, nonstructural measures may be used in combination with structural measures to form a more effective plan. Nonstructural measures go through the same process of evaluation as structural measures, in that they are formulated to the National Economic Development (NED) Plan. Considerations are also given to Environmental Quality, Regional Economic Development (RED), and Other Social Effects (OSE). Other Social Effects consist of considerations for life and public safety, community cohesion, local/regional solutions, and cultural/social factors. Nonstructural measure should align with community needs and plans and consider growing impacts to changes in climate and sea level rise. The following sections describe those alternatives included in the initial array.

Alternatives that included large scale acquisition/buyouts, the non-structural measure was considered the primary action for implementation and then structural measures were added to determine if the structural component improved the net benefits. The idea behind this approach was to try and address residual risk.

Likewise, the opposite approach was used when the structural measure was considered the primary action. Alternatives that included detention or channel and bridge modification were considered the primary action for implementation and acquisition/buyouts were used to remove any remaining high-risk structures not protected by the structural measures. Again, this was to determine if net benefits could be improved by combining the two types of measures.

Table 4-6 summarizes the initial array of alternatives.

**Table 4-6. Valley Creek Initial Array of Alternatives.**

| Name | Description |
|---|---|
| No Action | NEPA requires the consideration of the No Action alternatives. In this case, it would consist of no federal construction or implementation of actions to reduce flood risk. The FWOP condition would continue over the period of analysis. |
| Alternative 1: Channel and Bridge Modification | Channel mod via 120-ft. wide, 3000-ft length channel from Murphy's Ln to Halls Creek Tributary. Murphy's Lane bridge modification from 160-ft span length to 310-ft span length. |
| Alternative 2: Channel & Bridge Mod (VC1+VB8+VB9) | Same as Alt 1 except addition of bridge modification at 18th Ave. Modification includes lengthening spans from 125-ft to 200-ft. |
| Alternative 3: Detention Basins (VD1+VD2+VD4) | Construction of detention basins 1, 2, and 4. Approximately excess material 600,000 cu yds total for disposal. Will require containment berms 2-ft to 6-ft in height, erosion control, and outlet works for drainage back to river. |
| Alternative 4: Detention Basins (VD1+VD2) | Construction of detention basins 1, and 2. Approximately excess material 325,000 cu yds total for disposal. Will require containment berms 2-ft to 6-ft in height, erosion control, and outlet works for drainage back to river. |
| Alternative 5: Alt 1 + Alt 4 | Combines the smaller of the channel & bridge mod plans with the smaller of the detention plans |
| Alternative 6: Alt 2 + Alt 4 | Combines the larger of the channel & bridge mod plans with the smaller of the detention plans |
| Alternative 7: Alt 1 + Alt 3 | Combines the smaller of the channel & bridge mod plans with the larger of the detention plans |
| Alternative 8: Non-structural 2-yr | Acquisition of structures frequently damaged in the 50% Annual Chance Exceedance (2-yr) flow frequency |
| Alternative 9: Non-structural 5-yr | Acquisition of structures frequently damaged in the 20% Annual Chance Exceedance (5-yr) flow frequency |
| Alternative 10: Alt 8 + Alt 1 + VD1 | Combines non-structural with the smaller of the channel & bridge mod plans with a single detention basin |
| Alternative 11: Alt 8 + Alt 1 + Alt 4 | Combines non-structural with the smaller of the channel & bridge mod plans with small of the detention plans |
| Alternative 12: Alt 3 + Residual Risk 2-yr floodplain buyout | Combines the detention basins with residual risk 2-yr floodplain buyout. |
| Alternative 13: Alt 1 + Residual Risk 2-yr floodplain buyout | Combines channel and bridge modification with residual risk 2-yr floodplain buyout. |

### 4.6.1.1. Alternative 1

Alternative 1 includes channel modification (VC1) from Murphys Lane to Halls Creek Tributary and expansion of Murphys Lane Bridge. Channel modification widens the channel from roughly 45 feet to approximately 120 feet for about 3,000 feet. Bridge modification (VB8) would lengthen the span from about 160 feet to 310 feet.

It was assumed construction would be accomplished with a large hydraulic excavator located near the top of left or right descending bank and material removed to achieve the desired width. Clearing and grubbing would be required. Disposal of material could be hauled to Vulcan Materials located near the intersection of Powder Plant Road and Academy Drive. Minor erosion control (riprap) would be placed on newly exposed side slopes which would be 1-foot vertical on 3-foot horizontal. Approximate volume of earthwork to be disposed is 270,000 cubic yards.

Murphys Lane Bridge is currently approximately a 160-foot length with 2 sets of piers configured to give a square hydraulic cross section. Modified configuration is to increase to 5 set of piers and lengthen the bridge deck to 310 feet maintaining the same square hydraulic cross section.

Real estate acquisition would be minimal as the adjacent property owner is Jefferson County. For the same reason, permanent and construction access was not considered an issue.

#### 4.6.1.2. Alternative 2

Alternative 2 includes the work proposed under Alterative 1 plus bridge modification at 18th Street N (VB9). The 18th Street N. bridge is currently approximately 125 feet in length with 3 sets of piers configured to give a semi-circular hydraulic cross section. The modified configuration would increase to 5 sets of piers and lengthen the bridge deck to approximately 200 feet maintaining the same semi-circular hydraulic cross section.

There would be no additional O&M cost to the bridge modification as it would continue to be part of the owner's regular maintenance program.

#### 4.6.1.3. Alternative 3

Alternative 3 includes construction of three detention basins: VD1, VD2, and VD4. Approximately 600,000 cubic yards of material would require disposal from excavation of the detention basins. Possible disposal locations include Vulcan Materials in Bessemer or the New Georgia Landfill in Birmingham. Both are suitable locations; a conservative haul distance was assumed in the cost estimate for purposes of evaluating and comparing alternatives. Each of the basins would require containment berms of 2-feet to 6-feet in height, erosion control, and outlet works for drainage back to the river. Sites are predominately open space with some clearing and grubbing. Sites VD1 and VD2 are former buyout locations and utility demolition was assumed. In general, relocations were assumed to be within existing utility corridors (Appendix D).

#### 4.6.1.4. Alternative 4

Alternative 4 includes construction of two detention basins: VD1 and VD2. Approximately 325,000 cubic yards of material would need to be disposed. Possible disposal locations include Vulcan Materials in Bessemer or the New Georgia Landfill in Birmingham. Both would be suitable locations and conservative haul distance was assumed in the cost estimate.

#### 4.6.1.5. Alternative 5

Alternative 5 includes alternative 1 plus alternative 4, which is channel modification (VC1), Murphys Lane Bridge (VB8), plus detention basins VD1 and VD2.

#### 4.6.1.6. Alternative 6

Alternative 6 includes proposed alternative 2 plus alternative 4, which is channel modification (VC1), Murphys Lane Bridge (VB8), 18th Street N Bridge (VB9), plus detention basins VD1 and VD2.

#### 4.6.1.7. Alternative 7

Alternative 7 includes proposed alternative 1 plus alternative 3, which is channel modification (VC1), Murphys Lane Bridge (VB8), plus detention basins VD1, VD2, and VD4.

#### 4.6.1.8. Alternative 8

Alternative 8 includes physical nonstructural acquisition of frequently damaged structures by the 0.50 AEP event (VA 2yr). Approximately 100 structures would be acquired and moving assistance provided to owners. The properties are a mix of residential, commercial, and industrial properties within all participating municipalities. All structures would be demolished and removed from the site. Passive recreation could be an approved land use post removal of the structures. Utilities would be disconnected from the structure but infrastructure such as power poles, water lines, sewers, etc. would remain in place.

#### 4.6.1.9. Alternative 9

Alternative 9 includes physical nonstructural acquisition of frequently damaged structures by the 0.20 AEP event (VA 5yr). Approximately 300 structures would be acquired and moving assistance provided to owners. The properties are a mix of residential, commercial, and industrial properties within all participating municipalities. All structures would be demolished and removed from the site. Passive recreation could be an approved land use post removal of the structure. Utilities would essentially be disconnected from the structure but infrastructure such as power poles, water lines, sewer, etc. would remain in place.

#### 4.6.1.10. Alternative 10

Alternative 10 features a combination of buyouts at the 0.50 AEP (VA 2yr) with channel modification (VC1) and a detention basin (VD1). Formulation of a larger plan to include acquisition of frequently damaged structures by the 0.20 AEP event and other structural measures was too costly for the benefits provided and was not formulated.

#### 4.6.1.11. Alternative 11

Alternative 11 features a combination of buyouts at 0.50 AEP (VA 5yr) with a channel modification (VC1), bridge modification (VB8), and detention basins VD1 and VD2.

#### 4.6.1.12. Alternative 12

A second method of formulation of alternatives with combined nonstructural and structural assumes the structural plan is the primary and is the action that comes first while the nonstructural action is secondary and protects remaining structures (residual risk) not protected by the structural plan.

Alternative 12 considers the structural plan with the highest mean net benefits, Alternative 3, as the primary action and then identifying residual risk structures for acquisition. Alternative 12 features a combination of three detention basins (Alternative 3) with 39 residual buyouts at 0.50 AEP.

#### 4.6.1.13. Alternative 13

Alternative 13 considers the structural plan (Alternative 1) that produces nearly the same mean net benefits but less costly. Alternative 1 is identified as the primary action and then residual risk structures are identified for acquisition. Alternative 13 features a combination of the channel modification (Alternative 1) with residual buyouts at 0.50 AEP. There are 79 parcels in this plan. Other residual risk plans were to analyze property acquisitions in the Valley Creek reaches at the FEMA regulatory Floodway level paired with Alternative 3, as well as to analyze the acquisition of properties above the detention basins in Alterative 3. These plans were screened out due to the lack of economic efficiency.

# 5.0. EVALUATION AND COMPARISON OF ALTERNATIVE PLANS

The initial array of alternatives was evaluated using the four criteria established in the Principles, Requirements, and Guidelines dated March 2013: effectiveness, completeness, efficiency, and acceptability.

- Effectiveness is the extent to which an alternative plan alleviates specified problems and achieves opportunities.
- Completeness is the extent to which a given alternative plan provides and accounts for all necessary investments or other actions to ensure the realization of the planned effects.
- Efficiency is "the extent to which an alternative plan is the most cost-effective means of alleviating the specified problems and realizing the specified opportunities, consistent with protecting the Nation's environment." Cost effectiveness analysis answers the question: "Does the alternative plan accomplish the objectives for the least cost?"
- Acceptability is the workability of a plan with respect to acceptance by state and local entities and the public, and compatibility with existing laws, regulations, and policies.

Alternatives were evaluated and compared based on effectiveness, efficiency, completeness, and acceptability. Total first cost was developed for each measure and includes construction, mitigation, relocation, and lands and damages accounts as well as Pre-construction Engineering and Design (PED), supervisory and administrative (S&A), an escalation factor, and risk-based contingency. First costs for each measure are considered additive when formulating alternatives.

Annual operations and maintenance (O&M) costs are developed based on experience from designing and building similar flood risk management projects as well as working with partners operating and inspecting similar projects. O&M for channel and bridge modification include riprap or stone revetment replacement (when necessary). A stable side slope associated with channel modification or channel work upstream and downstream localized to a bridge modification would need occasional riprap or stone replacement. There would be no additional O&M cost to the bridge modification as the bridge would continue to be part of the owner's regular maintenance program.

O&M for off-channel detention basins is in-line with expectations for USACE dams; however, the basins within the recommended plan do not meet the definition of a dam as per ER 1110-2-1156. O&M would include periodic inspection of the weir to ensure flow conveyance and any evident erosion is repaired. The detention basin may see the occasional woody debris. Woody debris is anticipated to be minimal because the detention basins are located upstream in a highly developed urban watershed. There may be some trash and debris due to the proximity of the storm sewer where Valley Creek starts. It would be expected that the non-federal sponsor would periodically inspect and clean debris to allow full capacity and prevent any clogging of the outlet. The outlet should be periodically inspected for the same reasons, to ensure flow conveyance. Berms should be inspected for erosion of the side slopes, growth of woody vegetation, or deterioration of the riprap. Berms should be repaired as necessary. Table 5-1 summarizes annual costs associated with operation, maintenance, repair, rehabilitation, and replacement (OMRR&R). Additional information on O&M for the recommended plan is provided in Section 4.3.2 of the Engineering Appendix.

A 35% contingency was applied to all alternatives and a sensitivity analysis was done (i.e. adjusting the contingency to 25% and 45%) to ensure the answer nor the justification changed if the contingencies were adjusted. The final report was updated per results of the CSRA. The sensitivity analysis included a range of contingency between 25 and 45 percent and a separate total annual cost calculated for each contingency. Annual total costs with contingencies are summarized in Table 5-2, costs are displayed in thousands.

Annual costs include the total first costs annualized, interest during construction, and annual O&M costs. Interest during construction is based on an assumed design and construction period of 3 years at an interest rate of 2.75 percent. Interest and amortization factor used 0.03704 over a period of 50 years. Annual Total Cost at 35 percent contingency was used for comparison of alternatives.

**Table 5-1. Operation, Maintenance, Repair, Rehabilitation, and Replacements Costs Used in Alternatives Evaluation.**

| Measure | Activity | Associated Annual Cost |
|---|---|---|
| Channel Modification | Visual inspection of channel bank every 2 years | $5,000 |
| Channel Modification | 20% replacement or riprap every 10 years | $10,000 |
| | **Total:** | **$15,000** |
| Bridge Modification | Visual inspection of channel bank every 2 years for each bridge | $5,000 |
| Bridge Modification | 20% replacement or riprap every 10 years at each bridge | $10,000 |
| | **Total per bridge:** | **$15,000** |
| Detention Basin | Visual inspection of the system every 2 years | $5,000 |
| Detention Basin | Clean inlet, outlet & basin of woody debris or trash every 2 years | $5,000 |
| Detention Basin | Repair minor erosion of berm every 5 years | $5,000 |
| Detention Basin | 20% replacement or riprap every 10 years | $10,000 |
| | **Total per basin:** | **$25,000** |

**Table 5-2. Annual Total Costs with Range of Contingencies used in Alternatives Evaluation.**

| Alternative | Description | Annual Total Cost ($thousands) | | |
|---|---|---|---|---|
| | | 25% Contingency | 35% Contingency | 45% Contingency |
| Alternative 1 | Chan and Bridge Mod VC1, VB8 | 332 | 356 | 380 |
| Alternative 2 | Chan and Bridge Mod VC1, VB8, VB9 | 400 | 428 | 457 |
| Alternative 3 | Detention Basins VD1, VD2, VD4 | 1,840 | 1,976 | 2,112 |
| Alternative 4 | Detention Basins VD1, VD2 | 1,158 | 1,244 | 1,329 |
| Alternative 5 | Alt 1 + Alt 5 | 1,491 | 1,600 | 1,709 |
| Alternative 6 | Alt 2 + Alt 4 | 1,559 | 1,672 | 1,786 |
| Alternative 7 | Alt 1 + Alt 3 | 2,172 | 2,332 | 2,492 |
| Alternative 8 | Buyout FWOP 2YR Floodplain structures (~ 100) | 2,444 | 2,071 | 2,629 |
| Alternative 9 | Buyout FWOP 5YR Floodplain structures (~ 300) | 3,437 | 3,576 | 3,715 |
| Alternative 10 | NSM: 2YR Floodplain Buyout + Alt1 + VD1 | 2,776 | 2,893 | 3,009 |
| Alternative 11 | NSM: 2YR Floodplain Buyout + Alt 1 + Alt 4 | 3,500 | 3,670 | 3,841 |
| Alternative 12 | Alt 3 + Residual Risk 2-yr floodplain buyout (~ 40) | 2,615 | 2,774 | 2,934 |
| Alternative 13 | Alt 1 + Residual Risk 2-yr floodplain buyout (~79) | 1,985 | 2,060 | 2,135 |

The annual mean net benefits indicate the efficiency of each alternative. The annual mean benefit (effectiveness) and annual mean net benefit (efficiency) were used for comparison of alternatives but ultimately the National Economic Development (NED) plan is the plan that reasonably maximizes the annual mean net benefits.

Table 5-3 presents the benefit-cost analysis results for the initial array of alternatives. Alternative 13 maximizes the annual mean net benefits (Table 5-3). This alternative includes channel modification and bridge modification at Murphys Lane. Nearly 80 structures are identified as residual risk structures to be acquired with moving assistance provided to those impacted families. Due to the requirement for 100% participation this and other large scale buyouts would be difficult to implement and potentially locally unacceptable.

**Table 5-3. Summary of Economic Analysis Results for the Initial Array of Alternatives.**

| Alternatives | Description | Total First Cost | Annual O&M Cost | Annual Total Cost | Annual Mean Benefit | Annual Mean Net Benefit | Mean BCR |
|---|---|---|---|---|---|---|---|
| No Action | Estimate of FWOP Expected Annual Damages | | | | 6,824 | | |
| **STRUCTURAL ALTERNATIVES** | | | | | | | |
| Alternative 1 | Chan and Bridge Mod VC1, VB8 | 8,457 | 30 | 356 | 976 | 619 | 2.74 |
| Alternative 2 | Chan and Bridge Mod VC1, VB8, VB9 | 9,940 | 45 | 428 | 1,008 | 579 | 2.35 |
| Alternative 3 | Detention Basins VD1, VD2, VD4 | 50,070 | 75 | 2,006 | 2,717 | 711 | 1.35 |
| Alternative 4 | Detention Basins VD1, VD2 | 31,469 | 50 | 1,264 | 1,701 | 437 | 1.35 |
| Alternative 5 | Alt 1+ Alt 4 | 39,926 | 80 | 1,620 | 1,989 | 369 | 1.23 |
| Alternative 6 | Alt 2 + Alt 4 | 41,409 | 95 | 1,692 | 2,030 | 338 | 1.20 |
| Alternative 7 | Alt 1 + Alt 3 | 58,526 | 105 | 2,362 | 2,865 | 503 | 1.21 |
| **NON-STRUCTURAL ALTERNATIVES** | | | | | | | |
| Alternative 8 | Buyout FWOP 2YR Floodplain structures (~ 100) | 53,685 | 0 | 2,071 | 2,771 | 700 | 1.34 |
| Alternative 9 | Buyout FWOP 5YR Floodplain structures (~ 300) | 92,713 | 0 | 3,576 | 4,106 | 530 | 1.15 |
| **STRUCTURAL & NON-STRUCTURAL COMBINED** | | | | | | | |
| Alternative 10 | NSM: 2YR Floodplain Buyout + Alt 1 + VD1 | 73,833 | 55 | 2,903 | 3,540 | 638 | 1.22 |
| Alternative 11 | NSM: 2YR Floodplain Buyout + Alt 1 + Alt 4 | 93,610 | 80 | 3,690 | 3,907 | 217 | 1.06 |
| Alternative 12 | Alt 3 + (Residual Risk 2-yr floodplain buyout (~ 40)) | 70,761 | 75 | 2,804 | 3,094 | 290 | 1.10 |
| Alternative 13 | Alt 1 + (Residual Risk 2-yr floodplain buyout (~79)) | 52,635 | 30 | 2,060 | 3,266 | 1,206 | 1.59 |

Alternative 3, the plan with the next highest annual mean net benefit, includes construction of three detention basins, VD1, VD2 and VD4, is effective and has slightly less first cost compared to the NED at

approximately $50 million. Alternative 10 includes acquisition of approximately 100 frequently damaged structures by the 0.50 AEP. This plan is very effective but extremely costly, $21 million more than the NED at approximately $74 million. Alternative 1 is very similar to Alternative 3 in terms of net benefits but considerably less costly than Alternative 3 at approximately $8.5 million first cost. However, Alternatives 1 is also considerably less effective than Alternative 3 as the effects are localized to the neighborhoods near the channel and bridge modification of Murphys Lane.

Three plans with the next highest annual mean net benefits are Alternatives 8, 10, and 1. The annual mean net benefits of these plans are very similar and considered "indistinguishable" given the level of accuracy and refinement available during evaluation of the initial array. Alternative 8 with acquisition of approximately 100 frequently damaged structures by the 0.50 AEP. Though the annual mean net benefits are lower than the NED, it is a more effective plan but costs approximately $54 million total first cost. Again, an plans involving large scale buyouts with 100% required participation would be difficult to implement and potentially locally unacceptable.

Plans must meet the four criteria established in Principles & Guidelines: Effectiveness, completeness, efficiency, and acceptability. Large-scale buyouts require 100-percent participation. Homeowners or businesses within the buyout area who do not wish to participate would be subject to condemnation, resulting in extreme negative public sentiment and devastating impacts to the community. Therefore, any plans involving large-scale buyouts fail to meet the U.S. Water Resources Council Principles and Guidelines (P&G) standard of acceptability. Such plans were considered, however, to better understand the costs and benefits, even if such plans were purely hypothetical and would never be implemented. The "no action" alternative does not meet the four criteria but is shown for comparison and to illustrate the extent to which the various alternatives address the problems.

Alternative 1 benefits are very isolated at the downstream end of the study area and fails to contribute anything along the corridor lacking a comprehensive plan.

Table 5-4 summarizes the evaluation of the initial array of alternatives against the four criteria described previously: effectiveness, efficiency, completeness, and acceptability. The non-federal sponsors have expressed concern over the difficulty with implementing a large acquisition plan. A large-scale acquisition/buyout would have devastating effects on communities.

The sponsors have experience with implementing acquisition plans, most notably on an adjacent watershed (Village Creek) through Public 99-662 Section 401. Based on sponsor's experience and limited availability of decent, safe and sanitary housing, it is highly unlikely for an acquisition plan requiring 100% participation to be locally acceptable.

Alternatives 1, 3, and 7 produce reasonable net benefits and do not include a nonstructural acquisition plan. Array of alternatives for further consideration listed in order of annual mean net benefits from highest to lowest is Alternative 3, Alternative 1, and Alternative 7 with Alternative 13 retained for comparison.

**Table 5-4. Summary of Evaluation Criteria for the Initial Array of Alternatives.**

| Alternatives | Description | Annual Mean Benefit (Effectiveness) | Annual Mean Net Benefit (Efficiency) | Completeness | Acceptability |
|---|---|---|---|---|---|
| Alternative 1 | Chan and Bridge Mod VC1, VB8 | 976 | 619 | Complete | Acceptable |
| Alternative 2 | Chan and Bridge Mod VC1, VB8, VB9 | 1,008 | 579 | Complete | Acceptable |
| Alternative 3 | Detention Basins VD1, VD2, VD4 | 2,717 | 711 | Complete | Acceptable |
| Alternative 4 | Detention Basins VD1, VD2 | 1,701 | 437 | Complete | Acceptable |
| Alternative 5 | Alt 1+ Alt 4 | 1,989 | 369 | Complete | Acceptable |
| Alternative 6 | Alt 2 + Alt 4 | 2,030 | 338 | Complete | Acceptable |
| Alternative 7 | Alt 1 + Alt 3 | 2,865 | 503 | Complete | Acceptable |
| Alternative 8 | Buyout FWOP 2YR Floodplain structures (~ 100) | 2,771 | 700 | Complete | Acceptable |
| Alternative 9 | Buyout FWOP 5YR Floodplain structures (~ 300) | 4,106 | 530 | Complete | Acceptable |
| Alternative 10 | NSM: 2YR Floodplain Buyout + Alt 1 + VD1 | 3,540 | 638 | Complete | Acceptable |
| Alternative 11 | NSM: 2YR Floodplain Buyout + Alt 1 + Alt 4 | 3,907 | 217 | Complete | Acceptable |
| Alternative 12 | Alt 3 + (Residual Risk 2-yr floodplain buyout (~ 40)) | 3,094 | 290 | Complete | Acceptable |
| Alternative 13 | Alt 1 + (Residual Risk 2-yr floodplain buyout (~79)) | 3,266 | 1,206 | Complete | Acceptable |

### 5.1.1. No Action Alternative

Under the No Action alternative, no flood risk management features would be constructed or implemented by the federal government within the study area. The forecast of the No Action alternative into the future is represented by the FWOP condition. Under the FWOP, the expected annual damages are almost $6,400,000. The threat to health and welfare of the public would remain unchanged.

The FWOP condition was simulated with LifeSim using an ample warning time and a minimal warning time. The ample warning time is considered 24 hours or more before the threat occurs. Minimal warning time is 3 hours to 30 minutes before the threat occurs. For the study area, the minimal warning is the more likely condition due to the flashiness of the stream. The flooding condition is based on the amount of rainfall runoff and the time it takes for precipitation that has reached the ground to get to the stream. In the Valley Creek watershed, the amount of time is short and can cause the stream to rise rapidly causing a flash flood.

The most frequent flood events (0.50 AEP through 0.04 AEP) with minimal or ample warning time has a median life loss risk of zero for a population at risk (PAR) of approximately 500 to 4200 (Table 5-5). These results are similar if the flood event were to occur during the day or at night. While there has been no loss of life to date, conversations with local residents during public outreach efforts indicate water rescues have been necessary at these frequent events. No loss of life to date may just be attributed to luck. Even though LifeSim modeling doesn't show improvement, any reductions in flood profiles would matter.

At larger flood events starting at 0.02 AEP, the median life loss risk increases with minimal and ample warning time and increases as the severity of the event increases. The risk increases four to five times

from ample warning time to minimal warning time under the most extreme event evaluated (Table 5-5). The results of LifeSim show that warning time matters. Experience in other similar locations, however, has shown that in areas of very low income it may not matter as much if at all due to lack of personal transportation, due to health and mobility issues, or fear of looting if personal belongings are left behind.

**Table 5-5. Life Loss Analysis for the Future Without Project Condition.**

| Annual Exceedance Probability Future Without Project (No Action) | Structures Inundated | Minimal Warning | | | | Ample Warning | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | PAR | | Median Life Loss | | PAR | | Median Life Loss | |
| | | Day | Night | Day | Night | Day | Night | Day | Night |
| 0.50 AEP | 273 | 505 | 882 | 0 | 0 | 505 | 882 | 0 | 0 |
| 0.20 AEP | 755 | 1,320 | 2,228 | 0 | 0 | 1,320 | 2,228 | 0 | 0 |
| 0.10 AEP | 1,109 | 1,879 | 3,096 | 0 | 0 | 1,879 | 3,096 | 0 | 0 |
| 0.04 AEP | 1,556 | 2,773 | 4,166 | 0 | 0 | 2,773 | 4,166 | 0 | 0 |
| 0.02 AEP | 1,890 | 3,261 | 4,910 | 1 | 2 | 3,261 | 4,910 | 1 | 1 |
| 0.01 AEP | 2,194 | 3,773 | 5,666 | 4 | 4 | 3,773 | 5,666 | 0 | 0 |
| 0.005 AEP | 2,505 | 4,384 | 6,551 | 3 | 5 | 4,384 | 6,551 | 1 | 1 |
| 0.002 AEP | 2,966 | 5,247 | 7,571 | 12 | 19 | 5,247 | 7,571 | 3 | 4 |

Each municipality has its own police and fire departments that serve as first responders; however, the Lipscomb and Brighton fire departments are voluntary and may not be as equipped to respond to water rescues as the others. The lower flood events still carry the potential to impact the livelihood of these residents, causing a disruption to their routine.

### 5.1.2. Refined Array of Alternatives

Refined alternatives from evaluation and comparison to the refined array are listed in order of annual mean net benefits from highest to lowest. Alternative 3, initially identified as the TSP, was the locally preferred plan which cost less than Alternative 13, the plan with the highest net benefit.

**Table 5-6. Refined Array of Alternatives.**

| Alternative | Description | Annual Mean Net Benefit |
|---|---|---|
| Alternative 13 | Channel and Bridge Modification plus Residual Risk 2-yr floodplain buyout (~79 structures) | 1,206 |
| Alternative 3 | Detention Basins VD1, VD2, VD4 | 711 |
| Alternative 1 | Channel and Bridge Modification VC1, VB8 | 619 |
| Alternative 7 | Channel and Bridge Modification plus Detention Basins VD1, VD2, VD4 | 503 |

### 5.1.3. Final Array of Alternatives

An error was discovered during the review process which affected only those alternatives including VD2, causing induced damages to be counted when none existed. Alternatives 1 and 7 were screened since channel and bridge modification was found to not be incrementally justified. Costs increased for Alternative 13 due to updated real estate costs. Costs decreased for alternatives 3 and 4 due to refinement of the haul distance for excess materials. The error was corrected prior to the ADM and resulted in the final array, shown in Table 5-7. Alternative 4 is the NED plan, as it produces the highest annual mean net benefit. Alternative 4 was endorsed by the vertical team during the ADM and is therefore considered the Recommended Plan.

**Table 5-7. Final Array of Alternatives**

| Alternative | Description | Total First Cost | Total Investment Cost | Annual O&M | Total Annual Cost | Annual Mean Benefit | Annual Mean Net Benefit | Mean BC Ratio |
|---|---|---|---|---|---|---|---|---|
| No Action | FWOP Expected Annual Damages | | N/A | N/A | N/A | ($6,284) | N/A | N/A |
| Alternative 3 | VD1+VD2+VD4 | $45,065 | $46,924 | $75 | $1,813 | $2,717 | $904 | 1.50 |
| Alternative 4 | VD1+VD2 (Corrected) | $29,035 | $30,233 | $50 | $1,150 | $2,203 | $1,033 | 1.88 |
| Alternative 13 | Alt 1 + Residual Risk 2-yr Buyout | $59,346 | $61,794 | $30 | $2,319 | $3,266 | $947 | 1.41 |

Notes: Total First Cost only includes construction costs
Total Investment Costs include IDC
No Action Annual Mean Benefit are negative benefits, as they are an estimate of damages occurring.
October 2019 (FY20) price level, FY20 Federal Interest rate of 2.75%, 50-year period of analysis, numbers are represented in the $1,000s.

## 5.2. Four Principles and Guidelines Accounts

The updated Principles, Requirements, and Guidelines for Water and Related Land Resources Implementation Studies specifies the use of four accounts to facilitate evaluation of alternative plans. The NED account has been discussed previously. The Regional Economic Development (RED) account includes changes in the distribution of regional economic activity that results from each alternative plan. The environmental quality (EQ) account displays non-monetary effects on significant natural and cultural resources. The other social effects (OSE) account includes plan effects from perspectives that are relevant to the planning process but are not reflected in the other accounts.

**NED:** Alternative 4 is the NED alternative, which is the alternative that reasonably maximizes annual mean net benefits. This alternative has a total first cost of $29.0 million and mean net benefits totaling $1.1 million in FY20 dollars. Alternative 4 entails construction of two off-channel detention basins.

## Regional Economic Development:

The Regional Economic Development (RED) account should include a description and assessment of the changes in regional economic activity that would occur under the alternatives, including changes in jobs, income, economic output, and population (ER 1105-2-100, page 1-3). A RED evaluation was conducted on the construction activity associated with the recommended plan, based on the project first costs to construct the project using the USACE' certified model, Regional Economic System (RECONS). In addition, the recreational features of the project would have the potential to increase regional economic activity to the region; these benefits are described qualitatively.

The project first cost (construction, supervision, administration, planning, engineering, and design costs) to construct the recommended plan alternative is estimated to be approximately $25.48 million in FY21 dollars. The project expenditures, including planning, engineering and design, management, and

construction activities, associated with the Recommended Plan are expected to support 268.5 jobs and $20.366 million in labor income in Jefferson County during the two years of construction activity (2024-2028). On-going operations and maintenance activities and expenditures would result in minimal effects on regional economic conditions. Additional details on the methodology and results of the RED evaluation are provided in Section III of Appendix B (Economics).

The project recreational features and amenities could provide additional RED benefits to the communities in which they are located, especially if the detention area trails support visitation from outside of the local area. Recreational use by people outside the local areas can inject visitor spending into local businesses, and even encourage business development, such as businesses growth within or in proximity to the Birmingham CrossPlex, which could support jobs and income and tax revenues in the region. As the Jones Valley Corridor trails are developed in the future, additional connectivity of the trails would lead to higher levels of visitation and increases in the regional economic benefits over time.

**Environmental Quality Account:** One method to evaluate the environmental impacts of alternatives is the Habitat Evaluation Procedure (HEP). HEP was developed by the U.S. Fish and Wildlife Service (USFWS) and evaluates the quality and quantity of available habitat for selected wildlife species or groups of species. HEP provides information for two general types of wildlife habitat comparisons. One, the relative value of different areas at the same point in time, and two, the relative value of the same area at future points in time. By combining these two types of comparisons, the impact of proposed land and water use changes on wildlife habitat can be quantified. HEP describes relative habitat value for selected wildlife species as a Habitat Suitability Index (HSI) with a value ranging from 0.0 (unsuitable) to 1.0 (optimal). This value is multiplied by the area of available habitat to obtain Habitat Units (HUs). To calculate habitat value over a period of time, such as a 50-year period of analysis, HUs are averaged on a yearly basis to provide Average Annual Habitat Units (AAHU). The barred owl HSI was chosen for habitat modeling. The habitat modeling evaluation is described in Appendix H and the results summarized in Sections 6.5.2 and 6.6.2. Alternative 3 impacts 7.1 AAHUs (4.3 AAHUs of deciduous forest and 2.8 AAHUs of forested wetland). Alternative 13 impacts 5.3 AAHUs of deciduous forest. Alternative 4 impacts 4.3 AAHUs of deciduous forest.

All alternatives would be implemented under a Programmatic Agreement to fulfill NHPA Section 106 compliance and therefore at this time all alternatives are viewed as equal in terms of affects to historic properties.

## Other Social Effects (OSE):

The OSE account describes the selected plan's effect on social factors such as health and safety; economic vitality; social connectedness, identity; social vulnerability and resiliency; participation; and leisure and recreation as defined in USACE guidance (USACE ER 1005-2-100; IWR Report 2013-R-03, Applying Other Social Effects in Alternatives Analysis). This OSE evaluation provides a qualitative analysis regarding the impact of the NED plan.

Health and Safety: Mental and physical health will benefit from the recommended plan because it will reduce the occurrence of overbank floodwaters thereby reducing mental and physical stress associated with a residence or business being flooded. In addition, physical safety is important. An evaluation on the risks of life loss from flooding was conducted with USACE HEC-LifeSim. The risk to loss of life associated with the recommended plan compared to the FWOP is very similar. Analysis indicates that most frequent flood events (0.05 AEP through 0.04 AEP) with minimal or ample warning time have a median life loss risk of zero, although there are slight increases in life loss during larger events. Implementation of the recommended plan does not significantly increase or decrease the risk to loss of life compared to the FWOP. Additional information regarding this analysis can found in Appendix A H&H and Appendix B Economics.

Economic Vitality: The evaluation of economic vitality considers the business climate, employment opportunities, financial impacts, and tax revenues. The selected plan is projected to have a positive impact on the regional economy (as demonstrated in the RED analysis). Citizens may be less likely to move because there is a reduction in the occurrence of more frequent flooding, which is better for tax revenues.

Social Connectedness: The evaluation of social connectedness considers community cohesion and community facilities. The NED plan is anticipated to have a moderate beneficial effect on social connectedness because members of the community are less likely to leave when provided with some flood reduction measures. In addition, the incorporation of recreational features is a positive impact on cohesion and facilities.

Social Vulnerability and Resiliency: The evaluation of social vulnerability and resiliency considers residents of the study area and socially vulnerable groups. The NED plan is anticipated to have a moderate to positive impact on the residents in the area by providing relief to the occurrence of out of bank floodwaters and reducing flood damages to residential and business structures. This is especially important since all the cities within the study area except for Hueytown have populations of concern because of substantially higher proportions of minority and impoverished residents than Jefferson County as a whole.

Leisure and Recreation: The NED plan would include project recreational features and amenities that provide social benefits for neighborhoods and residents, providing low or no-cost recreational opportunities to residents, while making communities more attractive places to live. Recreational trail and amenities built within the two detention areas can revitalize depressed areas, creating a demand for space in what were once vacant lots or industrial or residential buildings. Recreational trails associated with the project encourage exercise and other healthy outdoor activities, increasing the health and wellbeing of residents and trail users. According to a survey conducted by the University of Alabama School of Public Health, 89 percent of all survey respondents in Jefferson County, Alabama (from a representative sample) indicated they would partake in walking or biking if they have access to a nice, safe place (UAB 2010).

Identity and Participation: The identity and participation of the community are not anticipated to change or have a negative impact due to the implementation of the NED plan.

## 5.3. Recommended Plan

Alternative 4 is the NED plan. Local Partners have expressed their desire to invest in Alternative 4. Alternative 4 provides the highest mean annual benefits in flood risk management and provides those benefits throughout the corridor resulting in complete, effective, efficient, and acceptable plan. Alternative 4 meets all four planning criteria and meets the planning objectives. Alternative 4 is compatible with the Red Rock Ridge and Valley Trail System Plan (Red Rock Plan). One of the trail corridors with the Red Rock Plan is the Jones Valley Corridor, which is drained by Valley Creek. A recreation component in the form of trails can support the Jones Valley Corridor.

### 5.3.1. Recommended Plan plus Recreation

A recreation evaluation was performed on the Recommended Plan. The recreation evaluation involves an analysis of the National Economic Development (NED) benefits from recreation opportunities created from the proposed recreation facilities. Benefits are compared to costs to inform decision-makers on the feasibility of the recreation facilities. Details on the recreation evaluation can be found in Appendix J Recreation.

The trails around the perimeters of the detention areas would primarily be used by neighborhood residents for walking and running, walking dogs, etc. The recreational use of the detention area trails was based upon Freshwater Land Trust Red Rock usership estimates from two nearby trails that are similar in length to the detention area trails; this trail usage represents low to moderate use estimates (Freshwater Land

Trust 2020). Recreation benefits used for screening are summarized in Table 5-7 and displayed in FY20 price levels.

**Table 5-7. Summary of Recreation Benefits**

| Detention Basin | Unit Day Points | General $/Day | Visitors | Average Annual Benefits |
|---|---|---|---|---|
| **Detention Basin 1** | | | | |
| Benefits with Recreation Trails and Amenities (Low Estimate) | 22 | $5.69 | 13,100 | $75,000 |
| Benefits with Recreation Trails and Amenities (Moderate Estimate) | 22 | $5.69 | 48,000 | $273,000 |
| **Detention Basin 2** | | | | |
| Benefits with Recreation Trails and Amenities (Low Estimate) | 22 | $5.69 | 13,100 | $75,000 |
| Benefits with Recreation Trails and Amenities (Moderate Estimate) | 22 | $5.69 | 48,000 | $273,000 |
| **All Detention Basins** | | | | |
| Benefits with Recreation Trails and Amenities (Low Estimate) | 22 | $5.69 | 26,200 | $150,000 |
| Benefits with Recreation Trails and Amenities (Moderate Estimate) | 22 | $5.69 | 96,000 | $546,000 |

In the longer-term, additional trail development along the Jones Valley Corridor would occur, with the goal to connect trails to promote a regional trail system. The Freshwater Land Trust has identified a portion of the Jones Valley Corridor as a priority trail for development from the High Ore Trail to the Birmingham CrossPlex.

The future recreational use of the detention basin trails is uncertain and would be dependent on the timing of the trail development within the Jones Valley Corridor, and its connection with the detention basin trails. However, it is likely to increase in the future with additional trail connectivity. The highest level of use that was surveyed in 2017 by Freshwater Land Trust occurred at the Lakeshore Trail, south of Birmingham between the communities of Homewood and Vestavia Hills, with approximately 145,600 users per year (Freshwater Land Trust 2019). With an assumption of this level of trail use at each of the detention basin trails, the economic benefits are estimated to be $828,000 on each trail and $1.656 million for both detention basins. However, because this future use and timing is uncertain, this estimate is meant for consideration and should not be incorporated into the recreation cost benefit analysis or the NED benefits.

Recreation costs were estimated based upon the scope and scale of the recommended recreation trails and amenities. For example, footpath cost estimates are based upon a per linear foot cost estimate and the estimated length of trail proposed for each detention basin, while signage is estimated based upon the number and size of signage proposed. Table 5-8 provides an overview of recreation trail and feature costs by detention basin, updated to FY22 price levels, including the construction costs (including signage and benches), interest during construction, and the total annual cost.

**Table 5-8. Recreation Facilities Cost Estimate by Area.**

| Cost | Detention Basin 1 | Detention Basin 2 | Total |
|---|---|---|---|
| Construction, Signage, Benches Cost* | $79,000 | $102,000 | $181,000 |
| IDC (1 yr, 2.25%) | $2,000 | $2,000 | $4,000 |
| Investment Cost | $81,000 | $104,000 | $185,000 |
| Annualized Investment Cost (50 years, 2.25%) | $2,700 | $3,500 | $6,200 |
| Annual OMRR&R** | $1,000 | $1,000 | $2,000 |
| Total Annual Cost | $3,700 | $4,500 | $8,200 |

Table 5-9 provides an overview of the benefit cost ratio by detention basin using updated / refined benefits and costs at FY22 price levels, and in total across both detention areas.

**Table 5-9. Benefit-Cost Comparison**

| Benefit/Cost | Recommended Plan |
|---|---|
| Total Annual Recreation Cost | $8,200 |
| Annual Recreation Benefits | $404,000 |
| Net Annual Recreational Benefits | $395,800 |
| Benefit-Cost Ratio | 49.3 |

### 5.3.2. Recommended Plan and Compatibility

Alternative 4 is also compatible with other flood risk management measures, though other measures in combination do not provide a benefit cost ratio above 1.0. The local sponsors may choose to invest in other structural measures in the future and would only complement Alternative 4. As an example, channel and bridge modification at the downstream end of the study area or construction of another detention basin would only continue to reduce flood risk. The local sponsors could also invest in additional non-structural measures such as buyouts that would be compatible with the recommended plan and reduce residual risk.

# 6.0. ENVIRONMENTAL CONSEQUENCES

This chapter describes the anticipated impacts to the environment from implementation of the alternatives included in the final array. Impacts associated with the No Action alternative, which serves as the baseline for comparison to FWP actions, are also described. The final array alternative impacts are typically discussed collectively, with any notable differences between alternatives highlighted.

The potential impacts are described using the following terms:

- Beneficial: A positive change in the condition or appearance of the resource or a change that moves the resource toward a desired condition.
- Adverse: A change that moves the resource away from a desired condition or detracts from its appearance or condition.
- Direct: An effect on a resource by an action at the same place and time.
- Indirect: An effect from an action that occurs later or perhaps at a different place and often to a different resource but is still reasonably foreseeable.
- Short-term: Impacts generally occur during construction or for a limited time thereafter, generally less than two years, by the end of which the resources recover their pre-construction conditions.
- Long-term: Impacts last beyond the construction period, and the resources may not regain their preconstruction conditions for a longer period of time.

## 6.1. Hydrology and Hydraulics

### 6.1.1. No Action Alternative

No actions to modify the hydraulics of Valley Creek would be taken under this alternative. FWOP modeling indicates that peak flow rates within the study area would be slightly larger than existing conditions for the 0.02, 0.01, 0.005, and 0.002 AEP events based on changes in future land use. Modeled water surface elevations for simulated AEP events continue to show flooding potential within the study area.

### 6.1.2. Final Array Alternatives

All the structural measures included within one of the final array alternatives reduce water surface elevations to some degree, which in all cases would be considered long-term beneficial impacts. The detention basins included in Alternatives 3 and 4 result in lower water surface elevations within the 0.04 AEP floodplain. The magnitude of the decrease depends on location. Modeling indicated that up to a 3.5-foot decrease in water surface elevation could be realized at certain locations. Full details of the H&H analysis and its results can be found in Appendix A. The channel and bridge modifications included in Alternative 13 also reduce water surface elevations; however, those benefits are more localized as the benefits of the channel modification do not extend further upstream than the 19$^{th}$ St. N stream crossing. The channel modification would change the hydraulics of Valley Creek within that reach by widening the bottom width of the stream to 120 feet. Valley Creek has been widened to this width both upstream and downstream of the proposed channel modification area and therefore this is not considered an adverse impact.

## 6.2. Climate

### 6.2.1. No Action Alternative

As described previously, projections indicate the possibility of an increase in temperature of approximately 2 to 4 degrees Celsius by the late 21st century. There is the possibility that precipitation

extremes may increase in the future both in terms of intensity and frequency, however this does not necessarily translate to an increase in peak streamflow. Increasing temperatures as well as longer, more intense droughts may offset the impact on peak streamflow and runoff volume by increasing evapotranspiration and, thus, the storage capacity in the soil and canopy of the watershed. Furthermore, very few definitive conclusions can be drawn regarding future hydrology in the region largely due to the substantial amount of uncertainty in these projections when coupling climate models with hydrology models. Detailed analyses to support these conclusions on future climate effects are presented in Appendix A, Section 6.

### 6.2.2. Final Array Alternatives

As discussed, Alternatives 3 and 4 (the recommended plan) consist of two or three overbank detention areas in the northern end of the basin. These detention basins were optimized to reduce floods of magnitude less than 0.01 AEP (specifically, 0.04 AEP). The trigger of a change in hydrology could have an impact on the effectiveness of these structures where an increase in the intensity and frequency of precipitation could lead to increased flood volumes for all analyzed frequencies. In this scenario, the ponds will still produce benefits across the range of analyzed frequencies (as documented in Section 5.0 of Appendix A); however, benefits associated with lesser AEPs may be realized more frequently. Beyond the 0.04 AEP event, this could be perceived as a negative occurrence.

The hazard of more frequent, higher flood volumes would lead to pond berms overtopping more frequently than the expected AEPs presented in Appendix A. Additionally, berm-influenced backflows discussed in Section 5.2.3 of Appendix A could occur more frequently. This could result in more frequent incremental risk associated with the selected plan, as impacts were shown to increase as the magnitude of analyzed events increased (Appendix A: Table 5-2). However, an increase in overtopping frequency is not considered an increase to incremental risk as equivalent flooding occurs in areas adjacent the ponds for all events. Section 5.2.4 of Appendix A details the negligible risk associated with berm overtopping as well as piping failure. Additionally, it is considered unlikely that the trigger of increased precipitation would be realized based on the results of this climate change assessment. The assessment shows that there is little consensus that there will be an increase in peak streamflow from rain events. Furthermore, historical evidence has shown a drop peak streamflow in the local area occurring after 1983. The trigger of increased streamflow is also driven by the intensity and duration of storms. There is some consensus that there will be a small increase in intense and slower moving storms in the southeast region, but still, the recent hydrologic record, and the results of the CHAT tool assessment, do not provide evidence that a change in peak hydrology is expected.

The overall qualitative likelihood of the harm occurring is considered unlikely. Without more solid evidence of increasing peak flows and volumes of floods, it cannot be said that the area is likely to see this change. Furthermore, there is an expectation by design that the pond berms will overtop for an infrequent flood. Therefore, the likelihood of the trigger occurring, leading to a hazard, and resulting in the harm of an increase in economic damages or threat to life safety is considered unlikely. Table 6-1 provides a summary of the climate change risks and likelihood for the individual measures of the recommended plan.

Alternative 13 includes channel and bridge modifications to relieve constrictions in the creek that cause water to back up during high flow events. This back up causes localized flooding in the areas of the constriction. The alterative also includes buyouts of the 0.5 AEP (2-year) floodplain. The trigger and hazard for these measures that make up Alternative 13 are the same as the trigger and hazard for the recommended plan. An increase in peak precipitation could lead to increased streamflow and, cause larger future floods. This could cause these measures to not perform as anticipated. With increase flood volumes and peak streamflow, the modifications may see reduced performance and lead to water backing up more

frequently. Also, an increase in magnitude of flooding could increase the area inundated for the 0.5 AEP floodplain. However, as with the recommended plan, the overall qualitative likelihood of the harm occurring is considered unlikely. Without more solid evidence of increasing peak flows and volumes of floods, it cannot be said that the area is likely to see this change. Also, the consequence for the harm listed being realized is fairly low. There may be some increased flooding but, it would be extremely unlikely that this harm would cause failure of one if its components, leading to a life safety risk.

**Table 6-1. Climate change risks and likelihood for the Recommended Plan measures.**

| Feature or Measure | Trigger | Hazard | Harm | Qualitative Likelihood |
|---|---|---|---|---|
| Overbank Detention-VD1 (Included in Alternatives 3 and 4) | Increase in peak precipitation leading to increased peak streamflow | Larger future flood volumes | Overtopping of berms causing damage to structure and structures surrounding the berms. | Highly Unlikely |
| Overbank Detention-VD2 (Included in Alternatives 3 and 4) | Increase in peak precipitation leading to increased peak streamflow | Larger future flood volumes | Overtopping of berms causing damage to structure and structures surrounding the berms. | Highly Unlikely |
| Overbank Detention-VD4 (Included in Alternative 3) | Increase in peak precipitation leading to increased peak streamflow | Larger future flood volumes | Overtopping of berms causing damage to structure and structures surrounding the berms. | Highly Unlikely |
| Channel and Bridge Modifications + 2 Year buyouts (Alternative 13) | Increase in peak precipitation leading to increased peak streamflow | Larger future flood volumes | Decrease in performance of modifications and increase in area of 0.5 AEP floodplain | Highly Unlikely |

## 6.3. Geology and Soils

### 6.3.1. No Action Alternative

No impacts to geology and soils would occur under the No Action alternative.

### 6.3.2. Final Array Alternatives

Alternatives 3 and 4 would result in a relatively small disturbance to bedrock from excavation of the VD1 and VD2 detention basins. Geotechnical analysis indicates approximately 6,400 cubic yards (cy) of bedrock would be excavated at VD1 and 9,700 cy at VD2. Channel and bridge modification included in Alternative 13 are not anticipated to include excavation below bedrock; therefore, no impacts are anticipated to geology from alternatives that include this measure.

The detention basins included in Alternatives 3 and 4 require excavation and disposal of soils. Excess material would be disposed of in an appropriate commercial site licensed to accept the material. Likewise, the channel and bridge modification included in Alternative 13 would result in the excavation and disposal of soils. Long-term adverse impacts to soils would occur as a result of disturbance of soil layers and removal of soils within the footprint of each measure. Soils are not a limited resource within the study area, which is dominated by urban land use. As a result, these impacts are considered relatively small.

Floodplain buyouts under Alternative 13 would have negligible effects on geology and soils within the study area. Minor soil disturbance would occur with demolition of structures within the buyout areas.

## 6.4. Water Quality/Aquatic Habitat

### 6.4.1. No Action Alternative

No impacts to water quality or aquatic habitat would occur under the No Action alternative. These resources would continue to be degraded as described in Chapter 2.0.

### 6.4.2. Final Array Alternatives

The study area is currently characterized by degraded water quality and aquatic habitat. Construction of the detention basins under Alternatives 3 and 4 would not likely have a measurable effect on water quality or aquatic habitat within Valley Creek. Detention basins have the potential to benefit water quality by allowing sediment that may contain contaminants or other pollutants to settle out of the water column before release back to the receiving stream. Channel and bridge modification that is part of Alternative 13 could potentially result in short-term increased turbidity from construction activities; however, with implementation of construction best management practices including erosion control measures the impact would likely be negligible. None of the final array alternatives would have potential to result in exceedances of any water quality standards within Valley Creek. A Section 404(b)(1) evaluation was completed (Appendix G). The recommended plan (Alternative 4) would require obtaining a 401 Water Quality Certification from the Alabama Department of Environmental Management (ADEM) prior to construction. Conditions included in the 401 Water Quality Certification will be followed during construction. Prior to construction, a National Pollutant Discharge Elimination System (NPDES) stormwater permit would be obtained.

All construction activities would incorporate best management plans (BMPs) to minimize and contain runoff. Actions to minimize runoff are anticipated to include the following, consistent with conditions ADEM has issued for stormwater detention basins permitted under Nationwide Permits:

- Effective BMPs would be implemented and continually maintained for the prevention and control of turbidity, sediment, and other sources of pollutants, including measures to ensure permanent revegetation or cover of all disturbed areas, during and after project implementation.
- Implement a Spill Prevention Control and Countermeasures (SPCC) Plan for all temporary and permanent onsite fuel or chemical storage tanks or facilities. Construction contractor would maintain onsite or have readily available sufficient oil & grease absorbing material and flotation booms to contain and clean-up fuel or chemical spills and leaks. Immediate notification of ADEM and other required entities would occur after becoming aware of a significant visible oil sheen in the vicinity of any proposed activity or in the event of a spill with the potential to impact groundwater or other waters of the state.
- All construction and worker debris (e.g. trash, garbage, etc.) would be immediately removed and disposed in an approved manner. If acceptable offsite options are unavailable, effective onsite provisions for collection and control of onsite worker toilet wastes or gray waste waters (i.e. port-olet, shower washdown, etc.) must be implemented and maintained. Soil contaminated by paint or chemical spills, oil spills, etc. would be immediately cleaned up or be removed and disposed in an approved manner. Any trash, debris, and solid waste would be disposed of according to applicable state and federal requirements.
- Evaluate, characterize, and as necessary, conduct regular analysis of any material proposed to be dredged/removed/disturbed in order to ensure that potential pollutants are not present in concentrations that could cause or contribute to a violation of applicable water quality standards.

## 6.5. Wetlands and Waters of the U.S.

### 6.5.1. No Action Alternative

No impacts to wetlands or waters of the U.S. would occur under the No Action alternative.

### 6.5.2. Final Array Alternatives

Desktop evaluation (including review of NWIs, aerial imagery, and elevation data) determined wetlands are not present in the footprints of VD1 and VD2. Review of NWI mapping indicates that the footprint of

VD4 potentially contains forested wetland (Figure 6-1). No other measures included in the final array of alternatives had NWI-mapped wetlands within their footprints. The habitat evaluation detailed in Appendix H assumed that all the forested area within the VD4 footprint was forested wetland. This comprises approximately 3.7 acres and 2.8 AAHUs. ER 1105-2-100 requires that adverse functional impacts to wetland resources be fully mitigated. A site visit and wetland delineation was not performed because VD4 was not included in the recommended plan. Construction of the entrance weir and outfall structure for the detention basins would require modification to the streambank of Valley Creek; however, no loss of stream bed would be anticipated. A CWA Section 404(b)(1) evaluation has been completed (Appendix G).


**Figure 6-1. NWI-mapped Forested Wetland at Detention Basin 4 (VD4).**

## 6.6. Terrestrial Habitat

### 6.6.1. No Action Alternative

No impacts to terrestrial habitat would occur under the No Action alternative.

### 6.6.2. Final Array Alternatives

Alternatives that include excavation within proposed detention basins (Alternatives 3 and 4) would have long-term adverse impacts due to the clearing and grubbing of existing habitat within the basin footprints. Within VD1, the primary land cover is turf grass with interspersed trees (Figure 6-2). VD2 has a larger extent of forested tree cover with areas of open field that show signs of prior disturbance (Figure 6-3). VD4 is also primarily previously disturbed open field with potential forested wetland (Figure 6-4). Channel modification under Alternative 13 would also result in similar impacts to bottomland forest (Table 6-2). Bridge modifications under Alternative 13 would result in negligible disturbance to terrestrial habitats. Bottomland hardwood forest was considered a significant ecological resource in this evaluation (and per USACE guidance in ER-1105-2-100; Appendix C) and habitat modeling was conducted to determine an appropriate level of mitigation to offset impacts from clearing of trees required for

construction of the project. The terrestrial habitat types affected by the alternatives are common within the study area and the region.


**Figure 6-2. Aerial View of Proposed Detention Basin VD1.**

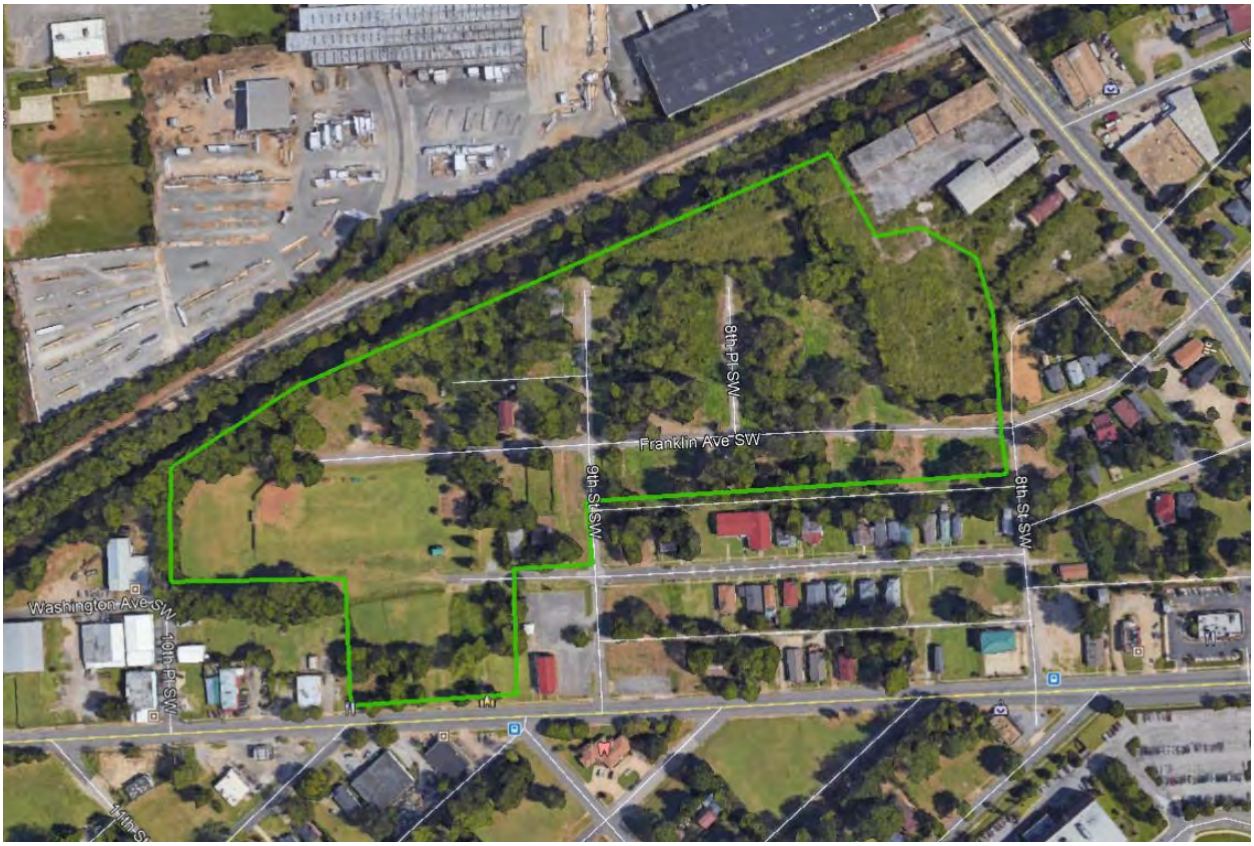


**Figure 6-3. Aerial View of Proposed Detention Basin VD2.**


**Figure 6-4. Aerial View of Proposed Detention Basin VD4.**

**Table 6-2. Acres and AAHU of deciduous Forest/Forested Wetland affected by Alternative.**

| Alternative | Description | Acres Impacted (Deciduous Forest/Forested Wetland) | AAHUs Impacted (Deciduous Forest/Forested Wetland) |
|---|---|---|---|
| Alternative 3 | Detention Basins (VD1, VD2, VD4) | 5.6/3.7 | 4.3/2.8 |
| Alternative 4 | VD1 and VD2 | 5.6/0.0 | 4.3/0.0 |
| Alternative 13 | VC1, VB8, Residual Risk 2-yr floodplain buyout (~79) | 15.2/0.0 | 5.3/0.0 |

As described previously, the HEP developed by USFWS was used to evaluate the quality and quantity of impacted habitat types. Specifically, the barred owl HSI model was used for the habitat evaluation because its primary variables include percent canopy cover and average diameter at breast height (DBH) of overstory trees, which directly relate to anticipated habitat impacts (Appendix H). Results are summarized in Table 6-2. An analysis of possible mitigation alternatives determined that purchasing bottomland hardwood mitigation credits from the Big Sandy Mitigation Bank, located approximately 45 miles to the southwest would be the most cost-effective mitigation option (Appendix H). Once constructed, detention basins would be re-vegetated with native species although it is assumed that tree growth within the basins would not be allowed because trees would reduce the volume of the basin available to hold stormwater. However, the detention basins would be re-seeded with native species following construction. The mix of species will be determined during Preconstruction Engineering and Design because geotechnical investigations have indicated a perched water table may be present at VD1. If it is determined during PED that hydrology may be appropriate to support wetlands, then wetland species would be planted. If appropriate hydrology to support wetland species is not present, then a mix of native grass/forb species would be planted.

## 6.7. Fish and Wildlife

### 6.7.1. No Action Alternative

No impacts to fish and wildlife would occur under the No Action alternative. It is assumed that aquatic habitat would continue to be degraded, which would limit fish and other aquatic species populations.

### 6.7.2. Final Array Alternatives

Wildlife would experience a loss of habitat under all alternatives because of construction of detention basins or channel modification. Those impacts are described in Section 6.6, Terrestrial Habitat. Wildlife would be displaced by the loss of habitat and by construction-related disturbance. However, wildlife present in the study area are common species adaptable to urban environments. As a result, these long- and short-term adverse impacts to wildlife would be considered small. Detention basins would provide wildlife habitat following construction and re-vegetation. Channel modification would result in a conversion of approximately 15.2 acres of terrestrial habitat to aquatic habitat.

To the extent feasible, clearing and grubbing of vegetation would occur outside the breeding bird season to avoid impacts to migratory birds. If that is not possible, care would be taken not to destroy active bird nests by clearing and grubbing activities.

Fish are not anticipated to be affected by detention basins. Channel and bridge modification activities may result in short-term adverse impacts due to disturbance to species present at the time.

USACE requested input from the USFWS under the Fish and Wildlife Coordination Act (FWCA). An agreement was reached between USACE Mobile District and the USFWS Daphne Ecological Services Field Office that FWCA input would be provided as part of review of the draft report for ongoing USACE Emergency Supplemental General Investigation studies in Alabama. USACE requested that USFWS provide any FWCA input in response to a letter providing the draft report and requesting concurrence on ESA determinations (Appendix E). USFWS indicated that they have no FWCA comments on this project in a letter dated April 8, 2021 (Appendix E).

## 6.8. Threatened and Endangered Species

### 6.8.1. No Action Alternative

No impacts to threatened and endangered species would occur under the No Action alternative because no flood risk management measures would be implemented that could adversely impact known or unknown federally listed species in the study area. Species and habitat would continue to be affected beneficially and adversely by flood events within the study area.

### 6.8.2. Final Array Alternatives

#### 6.8.2.1. Federally Listed Bat Species

USFWS was coordinated with regarding potential impacts to federally listed bat species that may occur within the study area. In a letter dated May 2, 2019, USFWS stated that to avoid impacts to spring/summer roosting and maternity colonies of the Indiana bat and northern long-eared bat, it is recommended that tree clearing occur from October 15 to March 31 (Appendix E). USFWS stated if all tree removal for the project is restricted to occur between those dates, no further consultation is necessary on the federally listed bat species. USACE intends to comply with the identified seasonal restrictions for tree clearing and will incorporate those restrictions in all construction contracts. Should compliance with the seasonal restrictions not prove feasible, USACE would perform all required habitat surveys and additional consultation with USFWS prior to clearing trees. Therefore, the project is determined to not

likely adversely affect the Indiana bat, northern long-eared bat, or gray bat. USFWS concurred with this determination on June 18, 2020 (Appendix E). USFWS also indicated they have no FWCA comments on this project in a letter dated April 8, 2021 (Appendix E).

#### 6.8.2.2. Watercress Darter

Watercress darter is known to occur within springs adjacent to Valley Creek, but not within Valley Creek itself. USFWS recommended that USACE consider avoiding construction near these adjacent streams and that if any measures were anticipated to directly or indirectly affect suitable habitat for the watercress darter, then surveys and/or additional consultation may be required. The final array of alternatives does not include any measures to be implemented on tributaries to Valley Creek. All measures would occur on or in the immediate floodplain of Valley Creek. As a result, no impacts to watercress darter are anticipated for any alternative within the final array.

## 6.9. Hazardous, Toxic, and Radiological Waste

### 6.9.1. No Action Alternative

No direct impacts to HTRW would occur under the No Action alternative because no flood risk management measures would be implemented that could disturb or impact known or unknown HTRW sites within the study area. Existing HTRW sites would continue to be indirectly impacted by flooding due to exposure from erosional forces and potential off-site migration and dispersion with flood waters.

### 6.9.2. Final Array Alternatives

A Phase 1 HTRW assessment was performed to identify the potential for such issues to be present within the footprint of measures included in the final array alternatives (Appendix F). VD1 (Alternatives 3 and 4) has an unknown risk associated with the Twin City Clarage Inc facility located across the street from this proposed detention basin. Three borings were conducted at VD1 and terminated at depths between 7 and 8 feet. In one boring, groundwater was encountered at a depth of 7.2 feet (Appendix A). Excavation to groundwater is not intended for the detention basins; however, if excavation was to extend below the water table, the potential for encountering contamination cannot be ruled out at this time. Further evaluation would occur during the design phase and if potential for contamination exists, appropriate mitigation would be implemented. The cost of any necessary corrective actions to address any contamination discovered on lands necessary for the project would be the responsibility of the non-federal sponsor. The risk of needing such corrective actions is deemed small but is documented accordingly in the HTRW assessment and in the project cost and schedule risk analysis. Other facilities located in proximity to VD1 present no or low risks of contamination. Known risks associated with VD2 (Alternatives 3 and 4) are considered low as well. No HTRW issues or contamination risks were identified for VD4 (Alternative 4). The only potential issue for the channel modification under Alternative 13 are three existing underground storage tanks at the adjacent treatment plant. However, the risk in this area is low because there have been no reported leaks or spills associated with these tanks and the proposed work would not directly disturb the USTs. Should contamination at any of the areas within the recommended plan be identified during the design phase, it would be the responsibility of the non-federal sponsor to perform any necessary corrective actions prior to making the lands available for the project. As a result, any HTRW issues present would be corrected as part of the project, which would represent a beneficial impact.

## 6.10. Public Health and Safety

### 6.10.1. No Action Alternative

Under the No Action alternative, no flood risk management features would be constructed or implemented by the federal government within the study area. The forecast of the No Action alternative into the future is represented by the FWOP condition. The threat to health and welfare of the public would remain unchanged. The risk to loss of life was evaluated using LifeSim. The most frequent flood events (0.5 AEP through 0.04 AEP) with minimal or ample warning time has a median life loss risk of zero for a PAR of approximately 500 to 4,200. These results are similar if the flood event were to occur during the day or at night. At larger flood events starting at 0.02 AEP, the median life loss risk increases with minimal and ample warning time and increases as the severity of the event increases. The risk increases four to five times from ample warning time to minimal warning time under the most extreme event evaluated. The results of LifeSim show that warning time matters. Experience in other similar locations, however, has shown that in areas of very low income it may not matter as much if at all due to lack of personal transportation, due to health and mobility issues, or fear of looting if personal belongings are left behind. This represents long-term adverse impacts for the No Action alternative.

### 6.10.2. Final Array Alternatives

LifeSim was used to analyze life loss risk associated with the recommended plan (Alternative 4). The alternative was simulated using an ample warning time and a minimal warning time. The ample warning time is considered 24 hours or more before the threat occurs. Minimal warning time is 3 hours to 30 minutes before the threat occurs. Model results show that life safety benefits are realized for the with-project condition, and preserved during failures; however, the order-of-magnitude total life loss for breach simulations increases slightly for the largest analyzed events (0.005 and 0.002 AEPs). Additionally, for individual levee failures, there is an increase of 1 in order-of-magnitude total life loss for 0.02 AEP. This increase is not observed in combined breach results, however. Increases in order-of-magnitude average life loss are not considered an accurate representation of the risk, rather an artifact of statistical uncertainty. This assessment is based on a thorough review of LifeSim outputs, breach and with-project hydrodynamics, and general hydraulic performance of the basins. For additional details on the LifeSim analysis and an assessment of results, refer to Appendix A (Engineering).

## 6.11. Floodplain

### 6.11.1. No Action Alternative

No changes to the floodplain would occur under the No Action alternative. Areas within the study area would continue to be subject to flood events and could also have further floodplain development, which could lead to additional FWOP impacts. However, cities within the study area would likely continue to participate in NFIP and local floodplain ordinances that regulate development within the Valley Creek floodplain would likely remain in effect, limiting the potential for additional impacts in the future.

### 6.11.2. Final Array Alternatives

The measures included in the final array of alternatives are located within the 0.01 AEP floodplain of Valley Creek. EO 11988, Floodplain Management, requires federal agencies to consider the potential effects of their proposed actions to floodplains. ER 1165-2-26 identifies 8 procedures to follow to determine compliance of civil works projects with EO 11988.

1.0 *Determine if the proposed action is in the base floodplain* – Yes, the proposed action is located in the base floodplain.

2.0 *If the action is in the base floodplain, identify and evaluate practicable alternatives to the action or to location of the action in the base floodplain* – To meet the purpose of the proposed action, which is to achieve reduction to the potential risk of loss of life as well as reduce economic damages due to flooding along Valley Creek, the proposed action must occur in the base floodplain. Chapter 4 describes the numerous measures and alternatives that were considered in formulating alternative plans.

3.0 *If the action must be in the floodplain, advise the general public in the affected area and obtain their views and comments* – A 30-day public review period was conducted for the draft report. No comments were received.

4.0 *Identify beneficial and adverse impacts due to the action and any expected losses of natural and beneficial floodplain values* – Impacts associated with the final array of alternatives are discussed in this section.

5.0 *If the action is likely to induce development in the base floodplain, determine if a practicable non-floodplain alternative for the development exists* – The proposed action is not anticipated to induce development within the base floodplain.

6.0 *As part of the planning process under the Principles and Guidelines, determine viable methods to minimize any adverse impacts of the action including any likely induced development for which there is no practicable alternative and methods to restore and preserve the natural and beneficial floodplain values* – Adverse impacts of the proposed action along with proposed mitigation measures are discussed in relevant resource sections throughout this chapter.

7.0 *If the final determination is made that no practicable alternative exists to locating the action in the floodplain, advise the general public in the affected area of the findings* – The final report will be made available to the public through the study web page and affected public notified of its availability.

8.0 *Recommend the plan most responsive to the planning objectives established by the study and consistent with the requirements of the Executive Order* – Chapter 9 includes the District Engineers Recommendation.

None of the alternatives would be anticipated to result in additional development within the floodplain. All alternatives would provide varying degrees of beneficial impacts from removing structures from the floodplain, either by reducing water surface elevations or relocating properties out of the floodplain. An analysis of proposed detention basins that comprise Alternatives 3 and 4 was performed to determine the approximate number of structures that would be removed from the 0.04 AEP floodplain.VD1 removes 339 structures, VD2 removes 378 structures, and VD4 removes 303 structures from the 0.04 AEP floodplain. Detention basins were initially evaluated individually; therefore, these numbers would not be additive when combined. They provide an order of magnitude approximation of structures that may be removed from the 0.04 AEP floodplain. When combined, VD1 and VD2 (Alternative 4, the Recommended Plan) reduce the number of structures impacted by the 0.04 AEP event from 2,015 to 1,615; a 400 structure reduction. Please refer to Appendix B tables 18 and 19 for additional detail on the number and type of structures benefitted for various events. The area used to implement flood risk management alternatives would not be developed in the future to maintain forecasted benefits. Alternative 13 would buy-out approximately 80 structures from the floodplain.

## 6.12. Land Cover and Land Use

### 6.12.1. No Action Alternative

No direct impacts to land cover or land use would occur under the No Action alternative. It is anticipated that the study area would continue to be dominated by urban development and related land uses.

### 6.12.2. Final Array Alternatives

All alternatives would result in relatively small changes to land cover and land use within the study area. Alternatives 3 and 4 would convert undeveloped or recent buyout areas to stormwater management features. The areas comprising VD1, VD2, and VD4 are already predominantly zoned for open space/passive recreation, which would be consistent with stormwater detention areas. Alternative 13 includes acquisitions, which would convert existing residential uses to undeveloped areas within the floodplain. These changes would all be considered beneficial and do not conflict with any area land use plans.

## 6.13. Socioeconomics

### 6.13.1. No Action Alternative

Continued flooding within the study area would likely result in continued adverse impacts to private, commercial, and industrial properties and structures. Long-term adverse socioeconomic effects would be anticipated to be experienced by impacted communities within the study area.

### 6.13.2. Final Array Alternatives

All final array alternatives would result in beneficial impacts to socioeconomic resources by reducing flood damages. Construction of alternative features would result in a relatively small beneficial impact through construction and labor-related spending within the study area.

## 6.14. Transportation

### 6.14.1. No Action Alternative

Continued flooding within the study area under the No Action alternative could result in adverse impacts to transportation infrastructure.

### 6.14.2. Final Array Alternatives

Final array alternatives that include structural measures to reduce water surface elevations would be anticipated to have beneficial impacts to transportation and critical infrastructure by lowering the potential for damage to these resources in the study area. Alternatives that include bridge modifications may result in short-term adverse impacts from potential closures or traffic disruption during construction. Long-term effects would be beneficial.

## 6.15. Environmental Justice

### 6.15.1. No Action Alternative

No environmental justice impacts would occur under the No Action alternative.

### 6.15.2. Final Array Alternatives

All the communities within the study area except for Hueytown could potentially be considered EJ communities. The effects of all the alternatives are largely beneficial because of the reduced flood risk to properties in the study area. Short-term disruptions to communities may occur from construction activities that may be perceived as adverse. However, no long-term adverse impacts are anticipated to be experienced by EJ communities resulting from any alternatives evaluated. Construction of project features must occur within the floodplain given the purpose of the study to reduce flood damages and therefore impacts would not be considered disproportionate.

## 6.16. Cultural Resources

### 6.16.1. No Action Alternative

No direct impacts to cultural resources would occur under the No Action alternative because no flood risk management measures would be implemented that could adversely impact known or unknown cultural resources in the study area. Existing cultural resources would continue to be adversely affected by flood events within the study area.

### 6.16.2. Final Array Alternatives

As no historic properties have been recorded within either of the selected detention areas and none are likely to be present due to extensive urban and residential development, the project is likely to have no effect on historic properties. However, USACE has executed a PA to fulfill its Section 106 compliance responsibilities at this stage of project planning and filed the PA with the Advisory Council on Historic Preservation.

The PA would be applicable to any alternative that is chosen as the recommended plan. The PA identifies the procedures that will be followed in evaluation of historic properties that may be affected by the recommended plan. Any identified historic properties within the project footprints would be evaluated in compliance with the PA. If it is determined that project activities will result in adverse effects, USACE, in consultation with SHPO, Concurring Parties, and Federally Recognized Indian Tribes, would develop a Historic Properties Treatment Plan (HPTP) to resolve all adverse effects resulting from the project, which would be appended to the PA. HPTP shall outline the minimization and mitigation measures necessary to resolve the adverse effects to Historic Properties. Proposed mitigation measures may include, but are not limited to, data recovery, oral history, historic markers, interpretive brochures, and publications, depending on their criterion for eligibility. Development of appropriate measures shall include consideration of historic property types and provisions for avoidance or protection of historic properties where possible. If it is determined that archaeological and/or tribal monitors are appropriate, HPTP shall include a Monitoring Plan. If adverse effects are identified, HPTP would be in effect before construction commences. USACE would submit HPTP for review to the SHPO, Concurring Parties, and Federally Recognized Indian Tribes.

## 6.17. Recreation

### 6.17.1. No Action Alternative

No changes to recreation would occur under the No Action alternative. Recreation opportunities may improve within the study area if existing trail plans are implemented.

### 6.17.2. Final Array Alternatives

The Alternative 3 and 4 detention basins would incorporate recreation features including trails, benches, and signage which would represent a beneficial impact. Construction of the detention areas would include a berm around their perimeter, on which the trail would be developed. Trail development associated with the three detention areas (Alternative 3 and 4) is consistent with the Red Rock Plan, adding additional recreational features associated with the Jones Valley Corridor trail (to be developed). USACE would work closely with the project sponsors to identify specific alignment of the trails, and placement of the benches and signage. All placement and alignment of proposed recreational features as well as existing amenities would be compatible with channel/bridge modifications, detention basins, and project flood risk management project purposes. The proposed channel modification under Alternative 13 is in a reach of Valley Creek that does not provide ready access to the public. As a result, recreational use of this area of Valley Creek is limited. Alternative 13 is anticipated to result in negligible impacts to recreation.

## 6.18. Aesthetics

### 6.18.1. No Action Alternative

No changes to aesthetics would occur under the No Action alternative. Aesthetics within the study area would continue to be adversely impacted under FWOP conditions from flood events due to damaged lands, structures, and vegetation, as well as deposition of sediment, debris, and trash.

### 6.18.2. Final Array Alternatives

Off-channel detention areas were considered nature-based features in accordance with implementation guidance for Section 1184 of the Water Resources Development Act of 2016 because they are features that would be created by human design, engineering, and construction that work to mimic as closely as possible conditions which would occur in the area absent human changes (i.e. the natural storage of floodwaters within the floodplain). Aesthetics in the detention basin areas comprising Alternatives 3 and 4 would change from open vegetated areas with interspersed tree cover and buildings to open vegetated areas with no tree cover and trails that would attract human use. This change would be consistent with the predominant zoning of the areas for open space/passive recreation. Channel modification under Alternative 13 would not change the long-term aesthetics of Valley Creek within that segment. The creek would be wider; however, following re-vegetation the riparian area would appear like the pre-construction condition. Acquisitions would present the greatest change in aesthetics as the area would change from a residential area to an undeveloped area clear of structures. None of the changes would be out of context for the settings in which they occur. Adverse aesthetic effects associated with the No Action FWOP would be reduced with the proposed flood risk management alternatives.

## 6.19. Cumulative Effects

The CEQ regulations for implementing NEPA require the assessment of cumulative impacts in the decision-making process. This section describes the methods for identification of cumulative actions and presents the results of the cumulative impact analysis. CEQ defines a cumulative impact as “the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions (RFFAs) regardless of what agency (Federal or non-Federal) or person undertakes such other actions” (40 CFR § 1508.7).

### 6.19.1. Cumulative Effects Methodology

The cumulative action identification and analysis methods are based on the policy guidance and methodology originally developed by CEQ (1997) and an analysis of current case law. Cumulative impacts were determined by adding the impacts of the alternatives being considered with other past, present, and RFFAs. A process based on four primary steps was employed to assess the cumulative impacts of the alternatives.

**Step 1: Identify Potentially Affected Resources**

In this step, each resource adversely affected by the alternatives is identified. If there is no or negligible adverse impacts to a resource, by definition there is no cumulative impact and that resource should not be included in the cumulative impact assessment. Also, resources that had entirely beneficial impacts were not included in the cumulative impact assessment.

**Step 2: Establish Boundaries (Geographic and Temporal)**

In identifying past, present, and reasonably foreseeable actions to consider in the cumulative impact analysis, affected resource-specific spatial and temporal boundaries were identified. The spatial boundary is where impacts to the affected resource could occur from the proposed alternatives and therefore where

past, present, and RFFAs could contribute to cumulative impacts to the affected resource. This boundary is defined by the affected resource.

The temporal boundary describes how far into the past and forward into the future actions should be considered in the impact analysis. The temporal boundary is guided by CEQ guidance on considering past action and a rule of reason for identifying future actions.

For each resource topic, the geographic and temporal boundaries were identified. The geographic/spatial boundary was considered the study area, unless otherwise specified. For all resource topics, the consideration of past actions is reflected in the existing condition. A future temporal boundary of 50 years from the baseline condition was used consistent with the period of analysis identified for evaluation of plan benefits; however, the impacts are based on their likelihood of occurring and whether they can be reasonably predicted.

**Step 3: Identify the Cumulative Action Scenario**

In this step, past, present, and RFFAs (RFFAs) to be included in the impact analysis for each specific affected resource were identified. These actions fall within the spatial and temporal boundaries established in Step 2. Table 6-3 summarizes the cumulative impacts scenario considered for each resource identified for evaluation.

**Step 4: Analyze Cumulative Impacts**

For each resource, the actions identified in Step 3 are analyzed in combination with the impacts of the alternatives being evaluated. This analysis describes the overall cumulative impact related to each resource and the contribution to this cumulative impact of alternatives being evaluated.

## 6.19.2. Past, Present, and Reasonably Foreseeable Future Actions

Primary past actions in the study area include the residential, commercial, and industrial development in the study area. These activities largely influence the existing condition of Valley Creek. Past channel widening and bridge crossings also directly affect the channel conveyance. There have also been corrective actions to address contamination within Valley Creek due to past industrial activity, for example the tar ball removal discussed previously. The Freshwater Land Trust has also been managing lands along Valley Creek for benefits to water quality.

Notable present and ongoing actions include floodplain development ordinances enforced by local communities within Valley Creek. Activities of the Freshwater Land Trust continue to occur on lands within their purview.

The following reasonably foreseeable future actions (RFFAs) were identified and considered in the cumulative effects analysis.

- **Red Rock Ridge and Valley Trail System Plan** – One of the priority trails for development identified by the Freshwater Land Trust is along Valley Creek within the Jones Valley Corridor, connecting the existing High Ore Trail eastward to the Birmingham CrossPlex. The Birmingham CrossPlex is in West Birmingham approximately 5 miles west of downtown Birmingham. The trail development along the Jones Valley Corridor/Valley Creek from the Birmingham CrossPlex to downtown Birmingham (not identified as a priority in 2020) would likely occur as a rail greenway, although the rail line is still in use. Therefore, its development is likely to occur in the future (Freshwater Land Trust 2020).
- **NFIP Participation and Local Floodplain Ordinances** – It was assumed that City of Bessemer and Birmingham would continue to participate in NFIP and that local floodplain ordinances that regulate development within the Valley Creek floodplain would remain in effect.

- **Freshwater Land Trust Activities within Study Area** – Freshwater Land Trust conserves land and builds trails within central Alabama. It was assumed that their activities would continue to occur into the future.

**Table 6-3. Cumulative Effects Scenario for Evaluated Resources.**

| Impact Topic | Spatial Boundary | Past Actions | Present or Ongoing Action | Reasonably Foreseeable Future Actions |
|---|---|---|---|---|
| Geology and Soils | Study Area | Urban development (industrial, commercial, and residential)<br>Channel widening<br>Freshwater Land Trust land management | Freshwater Land Trust land management<br>Local floodplain ordinances | Freshwater Land Trust land management<br>Local floodplain ordinances |
| Wetlands | Study Area | Urban development (industrial, commercial, and residential)<br>Channel widening<br>Freshwater Land Trust land management | Freshwater Land Trust land management<br>Local floodplain ordinances | Freshwater Land Trust land management<br>Local floodplain ordinances |
| Terrestrial Habitat | Study Area | Urban development (industrial, commercial, and residential)<br>Channel widening<br>Freshwater Land Trust land management | Freshwater Land Trust land management<br>Local floodplain ordinances | Freshwater Land Trust land management<br>Local floodplain ordinances |
| Fish and Wildlife | Study Area | Urban development (industrial, commercial, and residential)<br>Channel widening<br>Corrective actions for past contamination<br>Freshwater Land Trust land management | Freshwater Land Trust land management<br>Local floodplain ordinances | Freshwater Land Trust land management<br>Local floodplain ordinances |

## 6.19.3. Cumulative Effects by Resource

### 6.19.3.1. Geology and Soils

Past actions from urban development likely had substantial disturbance to soils and geology, to a lesser extent, within the study area. Present and ongoing actions contribute beneficially to geology and soils in the study area. The minor adverse impacts contributed by the alternatives would represent little or no incremental increase in adverse cumulative impacts to geology and soils. The impacts of the alternatives when combined with other present and RFFAs would likely result in both beneficial and adverse cumulative impacts in the study area.

### 6.19.3.2. Wetlands

Past actions from urban development likely resulted in a substantial reduction in wetland habitat within the study area. Past and presents actions by the Freshwater Land Trust have had a beneficial impact by conserving lands within the Valley Creek floodplain. Most of the larger tracts of forested riparian area within the study area are under Freshwater Land Trust management and include some area of forested wetland. Local floodplain ordinances that restrict development within the floodplain also have benefits from preventing further loss of wetland habitat to development. RFFAs are also considered to be beneficial. The adverse impacts contributed by the alternatives would represent little or no incremental increase in adverse cumulative impacts to wetland habitat.

#### 6.19.3.3. Terrestrial Habitat

Past actions from urban development likely resulted in a substantial reduction in terrestrial habitat within the study area. Past and presents actions by the Freshwater Land Trust have had a beneficial impact by conserving lands within the Valley Creek floodplain. Most of the larger tracts of forested riparian area within the study area are under Freshwater Land Trust management. Local floodplain ordinances that restrict development within the floodplain also have benefits from preventing further loss of terrestrial habitat to development. RFFAs are also considered to be beneficial. The adverse impacts contributed by the alternatives would represent little or no incremental increase in adverse cumulative impacts to terrestrial habitat.

#### 6.19.3.4. Fish and Wildlife

Past actions from urban development likely resulted in a substantial reduction in habitat for fish and wildlife within the study area. Past contamination of Valley Creek by industrial activities has substantially degraded the fish and aquatic life communities within Valley Creek. Past and presents actions by the Freshwater Land Trust have had a beneficial impact by conserving lands within the Valley Creek floodplain and benefitting water quality. Most of the larger tracts of forested riparian area within the study area are under Freshwater Land Trust management. Local floodplain ordinances that restrict development within the floodplain also have benefits from preventing further loss of habitat to development. RFFAs are also considered to be beneficial. The adverse impacts contributed by the alternatives would represent little or no incremental increase in adverse cumulative impacts to fish and wildlife.

## 6.20. Compliance with Environmental Laws

Table 6-4 summarizes the status of environmental compliance for the recommended plan to date.

**Table 6-4. Compliance with Environmental Quality Statutes.**

| Federal Policy | Compliance |
|---|---|
| Archeological Resources Protection Act, 16 U.S.C. 470, et seq. | Not Applicable |
| Bald and Golden Eagle Protection Act of 1940, 16 U.S.C. 668-668d, et seq. | Full Compliance |
| Clean Air Act, as amended, 42 U.S. C. 7401-7671g, et seq. | Full Compliance |
| CWA (Federal Water Pollution Control Act), 33 U.S.C. 1251, et seq. | Full Compliance |
| Coastal Zone Management Act, 16 U.S.C. 1451, et seq. | Not Applicable |
| Endangered Species Act, 16 U.S.C. 1531, et seq. | Full Compliance |
| Environmental Justice (Executive Order 12898) | Full Compliance |
| Estuary Protection Act, 16 U.S.C. 1221, et seq. | Not Applicable |
| Farmland Protection Policy Act, 7 U.S.C. 4201, et. seq. | Full Compliance |
| Federal Water Project Recreation Act, 16 U.S.C. 4601-12, et seq. | Full Compliance |
| Fish and Wildlife Coordination Act, 16 U.S.C. 661, et seq. | Full Compliance |
| Floodplain Management (Executive Order 11988) | Full Compliance |
| Invasive Species (Executive Order 13122) | Full Compliance |
| Land and Water Conservation Fund Act, 16 U.S.C. 4601-4, et seq. | Not Applicable |
| Marine Protection Research and Sanctuary Act, 33 U.S.C. 1401, et seq. | Not Applicable |
| Migratory Bird Treaty Act, as amended, 16 U.S.C. 703-712 | Full Compliance |
| National Environmental Policy Act, 42 U.S.C. 4321, et seq. | Full Compliance |
| National Historic Preservation Act of 1966, as amended, 16 U.S.C. 470a, et seq. | Full Compliance |
| Protection & Enhancement of the Cultural Environment (Executive Order 11593) | Full Compliance |
| Protection of Wetlands (Executive Order 11990) | Full Compliance |
| Rivers and Harbors Act, 33 U.S.C. 403, et seq. | Full Compliance |

| Federal Policy | Compliance |
|---|---|
| Watershed Protection and Flood Prevention Act, 16 U.S.C. 1001, et seq. | Full Compliance |
| Wild and Scenic River Act, 16 U.S.C. 1271, et seq. | Not Applicable |

Notes: Not applicable –No requirements for the statute are required
Ongoing – Activities to comply with the regulation are in process
Full Compliance – The project has met all anticipated requirements of the statue
Noncompliance – Violation of a requirement of the statue

# 7.0. RECOMMENDED PLAN

Alternative 4 is the NED and Recommended Plan. The plan consists of two overbank (off-channel) detention basins (VD1, VD2). The plan meets all four of the planning criteria of effectiveness, efficiency, completeness, and acceptability. It is effective as it provides lowered water surface profiles across a large area, producing $2.324 million in annual benefits. It is efficient as it produces $1.310 million in annual net benefits. The preceding figures are shown in FY22 price levels with a 2.25% interest rate and considering only FRM benefits. If recreational features are included, the annual benefits and net benefits increase to $2.728 million and $1.705 million, respectively. It is a comprehensive plan as it produces benefits throughout the upper Valley Creek watershed. It is an acceptable plan as it compatible with local planning objectives. The plan is not dependent on the performance of existing levees, berms or other features, though such features as the existing Bessemer Gardens levee would benefit from reduced profiles as a result of the recommended plan. This plan meets the primary objective and to the extent practical the secondary objective. Alternative 4 reduces the economic damages and the risk for loss of life from flooding along the upper Valley Creek watershed; as well as seeks ancillary environmental, water quality, and recreational benefits. Further details of the recommended plan are described in the following sections. Figure 7-1 illustrates location of the two detention basins.

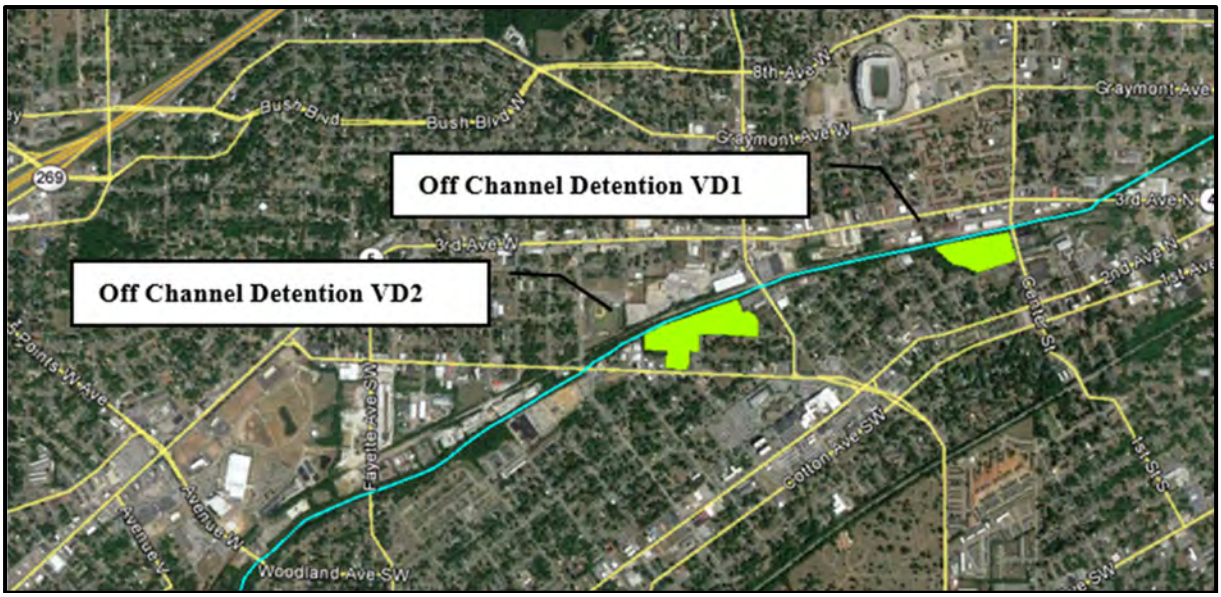


**Figure 7-1. Location of the Two Detention Basins.**

## 7.1. Plan Components

The plan components include two overbank detention basins each with an inlet weir, containment berm, and outlet structure. Recreation features are included in the conceptual plan. Construction of the basins require site preparation to include all activities leading up to a clear and ready site for the aforementioned features.

Site preparation includes acquiring necessary lands, easements, and right of ways. Performing necessary relocations; confirm or procure proper disposal location or locations; demolish and dispose of necessary material including material generated from clearing, grubbing, or stripping necessary vegetation.

VD1 comprises approximately 9.5 acres on the left overbank of Valley Creek downstream of Center Street. There is one home on the property and minor roadways. Figures 7-2 and 7-3 display a general grading plan and associated profile and section, respectively. VD2 comprises 19 acres on left overbank

downstream of Princeton Parkway. The area includes three homes and minor roadways. Figures 7-4 and 7-5 display a general grading plan and associated profile and section, respectively.

Table 7-1 summarizes detention basin details for the recommenced plan. Elevations are presented in North American Vertical Datum of 1988 in units of feet.

**Table 7-1. Detention Basin Details for Recommended Plan.**

| Detention Basin | Area (acres) | Total Storage (acre-ft) | Invert Elevation | Top of Berm Elevation | Top of Weir Elevation | Weir Length (feet) |
|---|---|---|---|---|---|---|
| VD1 | 9.5 | 98 | 543.5 | 558.5 | 550.0 | 50 |
| VD2 | 19.0 | 184 | 534.5 | 550.5 | 544.0 | 125 |

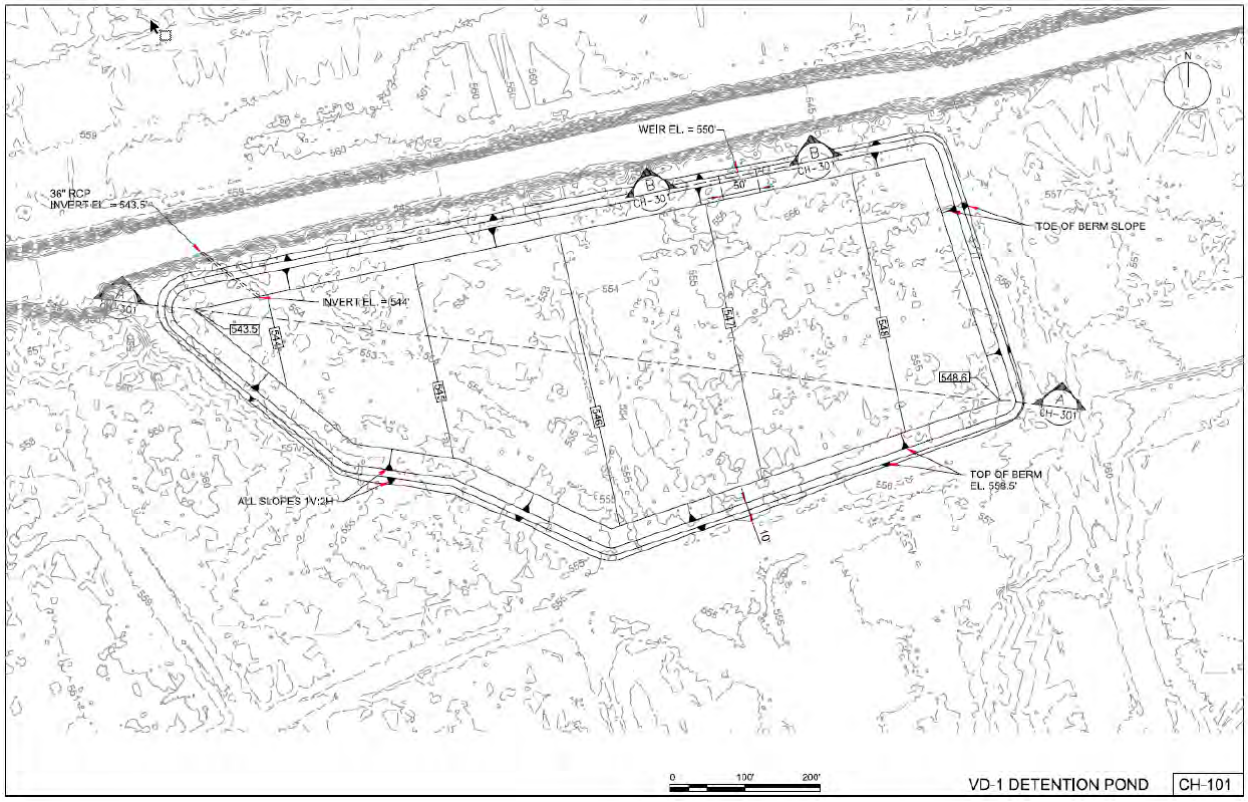


**Figure 7-2. Conceptual plan of Overbank Detention Basin VD1.**

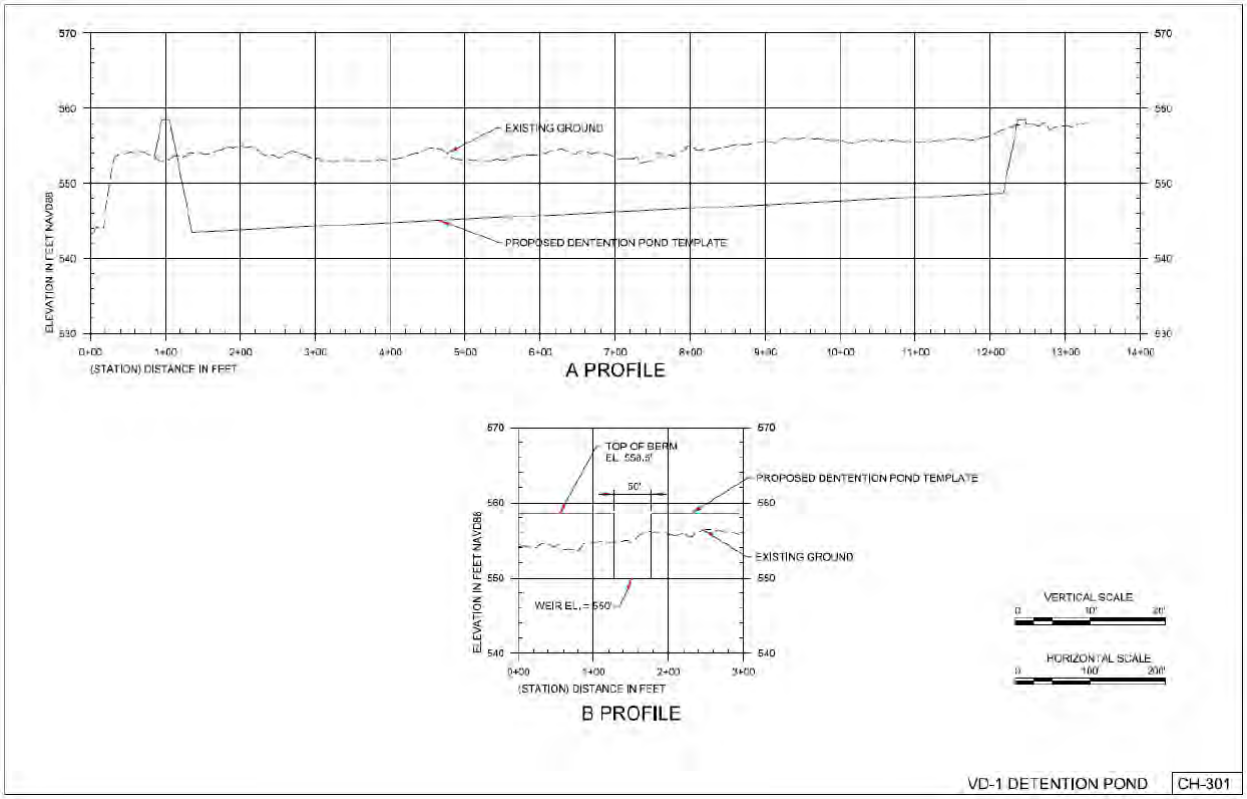


**Figure 7-3. Conceptual Profile and Section Detail of Basin and Lateral Inflow Weir at VD1.**

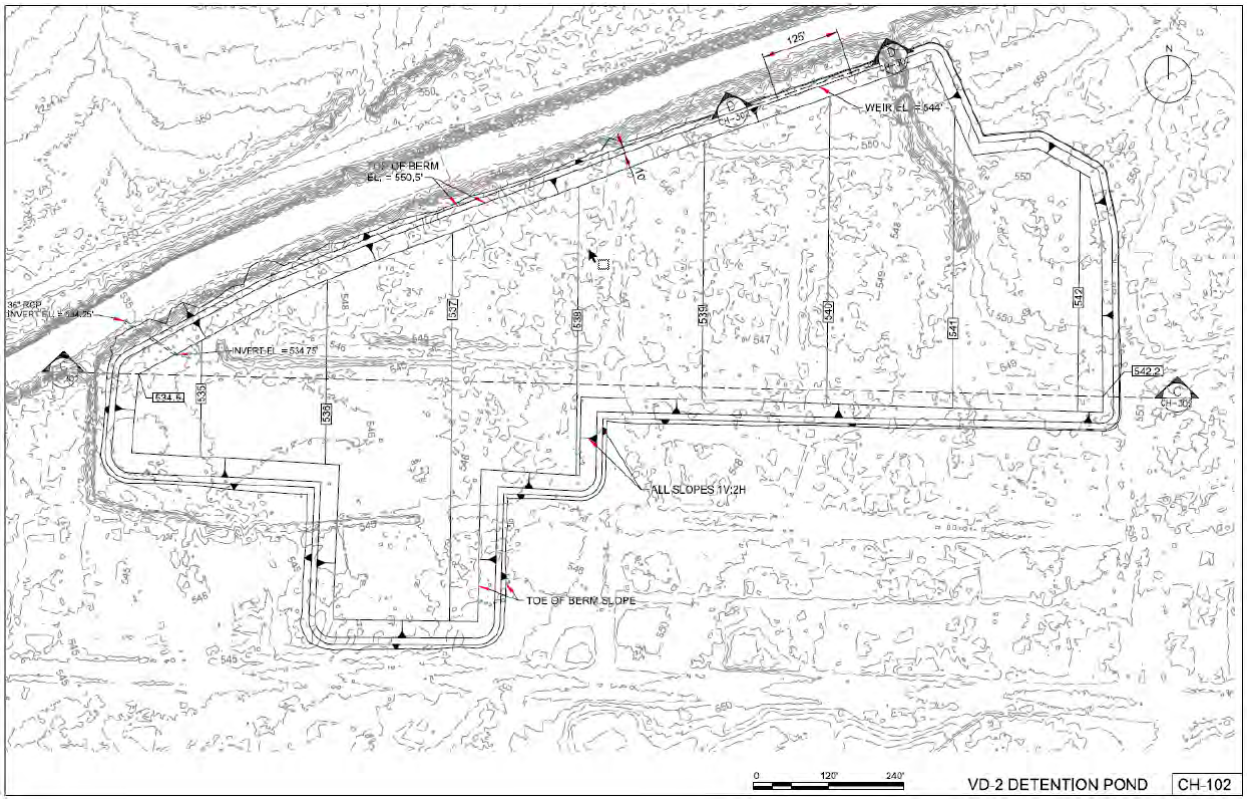


**Figure 7-4. Conceptual plan of Overbank Detention Basin VD2.**

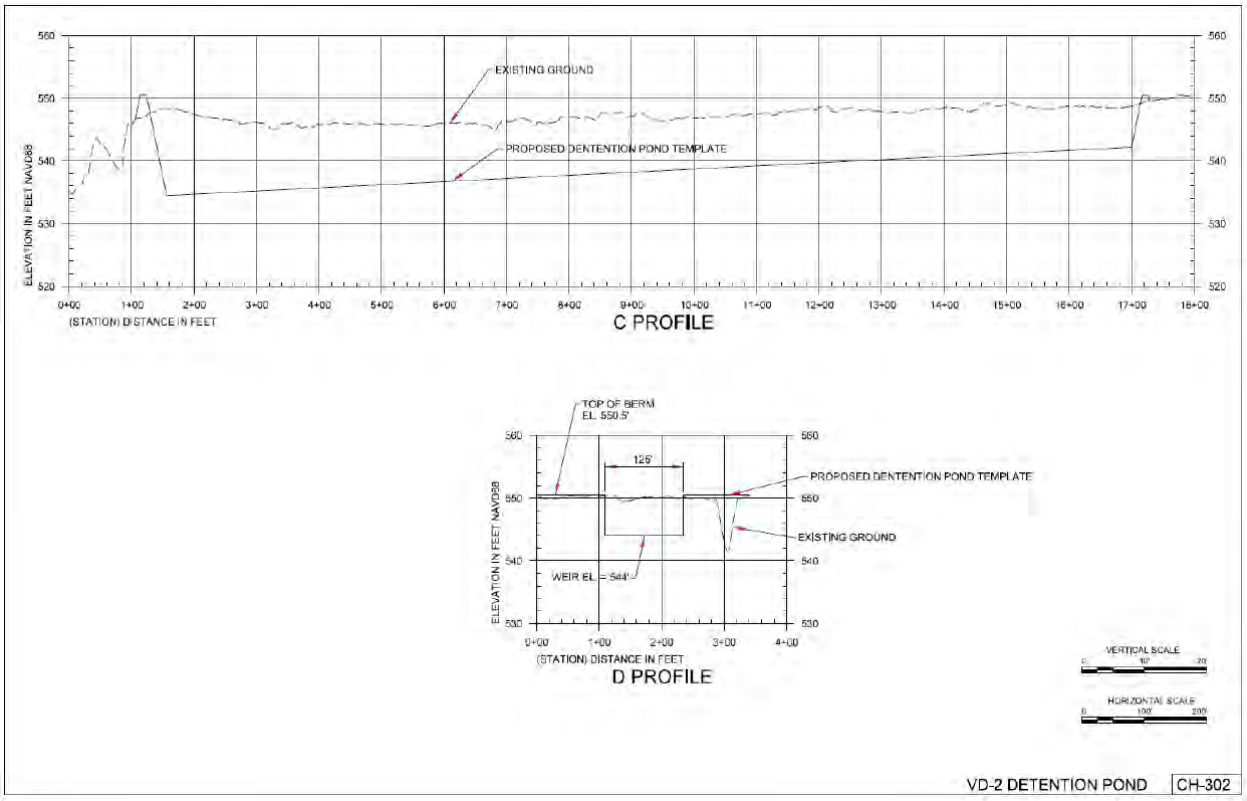


**Figure 7-5. Conceptual Profile and Section Detail of Basin and Lateral Inflow Weir at VD2.**

## 7.1.1. Detention Basins and Containment Berms

Site access is via public roads. Due to the size of each basin, there is sufficient room within each basin footprint for staging & storage as each basin is being constructed. Therefore, no additional areas are necessary specifically for staging or storage.

The basins will be excavated, and soil hauled to the containment berm locations for placement and compaction or hauled to the designated disposal location, the Birmingham Northern Landfill. Excavation will be to a desired elevation to maximize depth and storage volume as well as provide appropriate slope to allow the basin to naturally drain by gravity.

Subsurface investigations indicated isolated areas of rock outcropping and subsurface water at higher than expected elevations. Expected quantities for rock excavation and drying of materials are included in the cost estimate and the possibility of encountering additional rock or water is captured in the risk register, which drives the project contingency. Sufficient quantity of suitable material for building the containment berm was verified to be on site. This was expected based on the overwhelming volume of material excavated compared to the volume of material required for the containment berm.

The containment berms essentially follow the perimeter of each basin and ranges in height 2-feet to 4-feet depending on the existing ground elevation. Top width is currently 10-foot wide with aggregate surfacing which allows for small utility vehicles to exercise routine operation and maintenance activities.

The storage areas and the surrounding elevated berms act to divert water from the river, lowering water surface elevations in the floodplain during high flow events. As these berm structures will act to divert some water from the floodplain to reduce flooding to the area outside of the storage area, they are classified as levees.

However, due to the low maximum head differential and interpretation of the results of the life safety analysis, failure of any part of these structures does not cause any additional life loss or additional damage to critical infrastructure. Therefore, there is no residual life safety risk associated with the failure of any part of the berms surrounding the storage areas. Additionally, design considerations allow for overtopping of the levee during infrequent events

The quantities for all sites are based on 1:2 (V:H) side slopes, and bottom grading at 0.5% to allow for gravity drainage to the discharge inlet located near the downstream extent of each site. The sites will be armored for erosion protection at areas of high velocity (i.e. inlets & outlets). Armoring is listed under "Armor Area" of Table 7-3. "Detention Basin Armoring Summary." The armoring suggested is of the articulated concrete block (ACB) or articulated concrete mat (ACM) type. Normally 1:2 side slopes are quite steep for mowing; however, this is considered reasonable due to the minimal height of the berms.

There is a need for additional armoring at the outlet toe of the spillway for each site. The volume of stone required for outlet toe protection at each site was based on a common assumption of a set width (away from toe) of 10 feet, a set depth of 4 feet (2 layers), and a unique (per site) spillway length, although many of these lengths are equivalent between sites. The stone applicable for these sites (based on overtopping velocities at the spillway) is Alabama Department of Transportation (ALDOT) Class V riprap ($D_{50}$ = 1000 pounds). This stone will need to be choked with a smaller size, likely a Class II. Filter material required for appropriate grading is also included in the plan. This would be in the form of a poorly graded gravel layer, topped with an AASHTO #57 stone or similar. A filter fabric may also be required below the base (filter) layer, though no detail has been formulated for the fabric at this time. Tables 7-2 and 7-3 summarize the earthwork and armoring needs for each site, respectively.

**Table 7-2. Earthwork Summary.**

| Detention Basin | Total Cut ($yd^3$) | Total Fill ($yd^3$) |
|---|---|---|
| VD1 | 99,000 | 6200 |
| VD2 | 227,000 | 7400 |

**Table 7-3. Detention Basin Berm Armoring Summary.**

| Detention Basin | Armor Area ($ft^2$) | Class V Toe ($yd^3$) | | Class II Choke Stone ($yd^3$) | Toe Filter ($yd^3$) | Spillway Length (feet) |
|---|---|---|---|---|---|---|
| VD1 | 1,875 | 297 | | 75 | 75 | 200 |
| VD2 | 4,055 | 297 | | 75 | 75 | 200 |

## 7.1.2. Outlets

Culverts are thought to be the best option for outlets at all sites. Table 7-4 summarizes the needs at each basin including type, size, and length. Reinforced concrete pipe (RCP) culverts serve as the basis for the estimate. Additional protection at the inlets and outlets of these features is required, approximately 100 cubic yards for each culvert (both upstream and downstream protection included). Alabama DOT Class II riprap will be suitable for this application based on culvert outflow expectations.

**Table 7-4. Detention Basin Outlet Design Summary.**

| Detention Basin | Culvert Type and Size | Length (feet) | Inlet/Outlet Protection (cubic yards) |
|---|---|---|---|
| VD1 | RCP – 36 inch | 200 | 100 |
| VD2 | RCP – 36 inch | 140 | 100 |

### 7.1.3. Recreation

Construction access roads and access roads left behind for future O&M will be utilized for recreation. Roadway base conditions will be established through regular construction.

### 7.1.4. Site Preparation

#### 7.1.4.1. Clearing, Grubbing, and Stripping

Each site is mostly grass, shrub, and tree vegetation with little above ground infrastructure. Overall project site area and approximate clearing, grubbing, and stripping of vegetative material is listed in Table 7-5. For a basis of cost, material generated from clearing and grubbing will be chipped on site and disposed at the Birmingham Northern Landfill. Stripping material along with top soil will be stockpiled on site.

**Table 7-5. Summary of Clearing, Grubbing, and Stripping.**

| Detention Basin | Project Area (acres) | Clearing & Grubbing (acres) | Stripping (acres) |
|---|---|---|---|
| VD1 | 9.5 | 2.4 | 7.1 |
| VD2 | 18.9 | 4.7 | 14.2 |

#### 7.1.4.2. Demolition and Relocations

In general relocations were assumed to be within existing utility corridors. The most common and costly relocation is gravity sanitary sewers. When these utilities are within proposed detention basins identified as former “buy out” locations, they are quite often small service lines that serviced single family homes, which have since been demolished. Much of the work is not a relocation, but rather removal of lines that are no longer needed. In some cases, larger lines crossed through proposed detention basins and need to remain in service. Relocation of these lines entailed routing them around the proposed detention basins within existing utility corridors, and in some cases, up-sizing existing lines to accommodate longer runs and increased flows. Going through the basins or along other non-established routes wasn't an option since the utility needed to match up and down stream elevations to keep the lines flowing by gravity.

Detailed water or gas maps were not available, but from larger scale maps that were provided it appeared that the main lines were located along major roads, with smaller service lines extending to the former homes within the proposed basins. Again, no relocations in the sense of removing and replacing lines, but rather demolition and removal of the service lines within the proposed basins.

Other demolition includes remove and disposal of approximately 4 small houses and associated pavement. Refer to Appendix D, Cost Engineering, for maps associated with utility demolition and relocation.

## 7.2. Design and Construction Considerations

Sanitary sewer assessment relied on detailed GIS mapping while water, gas, electric and communication information was less detailed. Accordingly, higher contingencies were applied for demolition and relocation of these utilities.

## 7.3. Real Estate

Total fee simple acreage required for the Recommended Plan has been estimated at approximately 28.99 +/- acres within 154 parcels and rights-of-way. Excavated materials will be hauled to the Birmingham Northern Landfill for disposal.

Access is via public roads. Temporary staging will be within the basin footprints. A rough order of magnitude cost estimate was developed. It estimates lands and damages costs of $2,484,000. Estimated relocation costs are $1,643,000, Sponsor administrative costs for land acquisition plus and additional costs for administrative work associated with utility relocations are included. Federal administrative costs associated with LERRD and PL 91-646 oversight are included with PED. A total estimated LERRD cost is $4,127,000. Appendix C, Real Estate Plan, contains further details.

## 7.4. Operations and Maintenance

The non-federal project sponsors have expressed their commitment to supporting operation of the recommended plan through maintenance activities over the project life cycle. It is expected that development of an Operations and Maintenance (O&M) manual will occur in the PED phase to detail these activities, their expected schedule, and responsible parties. At present, the activities described herein and within Appendix A (see Section 4.2.2) are understood to be requirements of the non-federal project sponsors. Operations and maintenance for off-channel detention basins would include periodic inspection of the weir to ensure flow conveyance and any evident erosion is repaired. The detention basin may see the occasional woody debris. Woody debris is anticipated to be minimal because the detention basins are located upstream in a highly developed urban watershed. There may be some trash and debris due to the proximity of the storm sewer where Valley Creek starts. It would be expected that the non-federal sponsor would periodically inspect and clean debris to allow full capacity and prevent any clogging of the outlet. The outlet should be periodically inspected for the same reasons, to ensure flow conveyance. Berms should be inspected for possible repair of the ACB/ACM, growth of woody vegetation, or deterioration of the riprap at the outlets. Erosion control and berms should be repaired as necessary. Table 7-6 summarizes annual costs associated with operation, maintenance, repair, rehabilitation, and replacement (OMRR&R) of the basins. An additional annual OMRR&R cost of $2,000 is estimated for recreational features.

**Table 7-6. Operation, Maintenance, Repair, Rehabilitation, and Replacements Costs Used in Alternatives Evaluation.**

| Measure | Activity | Associated Annual Cost |
|---|---|---|
| Detention Basin | Visual inspection & mowing of the system every year | $5,000 |
| Detention Basin | Clean inlet, outlet & basin of woody debris or trash every 2 years | $5,000 |
| Detention Basin | Minor repairs to ACB/ACM & minor berm erosion every 5 years | $5,000 |
| Detention Basin | 20% replacement or riprap every 10 years at outlets | $10,000 |
| | **Total per basin:** | **$25,000** |

## 7.5. Cost Estimate

### 7.5.1. Summary of Cost

The screening level estimate was updated based on refinements. The estimated cost was developed using the Micro Computer Aided Cost Engineering System (MCACES) Second Generation (MII) software

version 4.3, build 7 (Appendix D). The following supporting databases were used in the preparation of the cost estimate: CB16EB (2016 English Cost Book) and EP16R03 (2016 Region 3 Equipment Library). Equipment costs include current fuel prices. Labor costs include local Davis-Bacon and professional labor rates. Material costs were developed using locally adjusted RS Means CostWorks 2016 materials costs or vendor quotes. The estimated cost was used as the basis for the project first cost.

The estimated cost at a price level date of October 2021 (FY22) in $ thousands is $27,311. The fully funded total project cost is $30,713, which is the estimated cost at the current price level escalated to the third quarter 2026 (FY26). Total project cost includes costs for construction; the LERRD; the 30 and 31 accounts, which include planning, engineering and design; and construction management, respectively; and a risk derived contingency.

The total project cost is based on the estimated project first cost escalated to the midpoint of construction. Cost sharing requirements for implementation are found in section 7.8 Plan Implementation.

**Table 7-7. Summary of Costs**

| CW-WBS | Project Cost Component | Brief Definition | First Cost ($Thousands) Effective Price Level 01 Oct 2021 | For PPA Total Cost ($Thousands) Fully Funded Estimate |
|---|---|---|---|---|
| 01,02 | Lands, Easements, Right of Ways, Relocations, and Dredged material Disposal Areas (LERRD) | Estimated value/costs of LERRD for the project (to include breakout of related Federal administrative costs) | $4,127 | $4,511 |
| 06 | Fish & Wildlife Facilities | Physical Construction | $347 | $398 |
| 14 | Recreation Facilities | Physical Construction | $181 | $208 |
| 15 | Floodway Control & Diversion | Physical Construction | $16,900 | $19,408 |
| 30 | Planning, Engineering & Design (post feasibility work) | Estimated costs for post feasibility planning, engineering, and design for the project. This cost includes the estimate of Preconstruction Engineering and Design (PED) as well as the planning, engineering, and design costs during construction phase to complete the | $3,597 | $3,776 |
| 31 | Construction Management | Estimated costs for construction management | $2,158 | $2,412 |

| | | | | |
|---|---|---|---|---|
| | Inflation through midpoint of construction | Estimate of inflation using Civil Works Construction Cost Index System (CWCCIS) factors applied to the Total Project Cost | NA | $3,402 |
| | **Project Cost Totals** | | **$27,311** | **$30,713** |

### 7.5.2. Recreation Cost

The federal share of the recreation cost is estimated to be 50 percent of $181,000, or $90,500. The total construction cost of the recommended plan's flood risk management features is estimated to be $27.130 million, of which $17.63 million is estimated to be the federal portion of the costs. The Federal cost share of $90,500 for the recreation facilities would account for less than 0.5 percent of the Federal cost share of the flood risk management features.

## 7.6. Risk and Uncertainty

Risk-informed planning should incorporate transparency in the estimation of benefits. The single value displayed for benefits has uncertainties associated with it. The mean (average) benefits usually do not correspond with to the 50 percent quartile (median), which is the result of the distribution not being symmetrical due to uncertainties. Therefore, to better inform, taking risk and uncertainty into account, the benefits are displayed as a range. Please refer to Appendix B, Table 22 which portrays the uncertainty in the recommended plan benefits.

The estimated performance of a flood-risk management project in reducing the chances of occurrence of damaging floods is known as assurance. Assurance can be expressed as a range of statistics, and HEC-FDA, in addition to estimating economic damage and damage reduced, also provides a range of assurance estimates as an output. These assurance estimates are also provided in Appendix B.

### 7.6.1. FWOP

The annual exceedance probability in the project area is rated at 3.14 percent under the FWOP conditions. This means that without the project, there is approximately a 3.14 percent chance of a damaging flood in any given year. The statistic accounts for the entire range of possible floods that would be large enough to result in economic damage and thus encompasses a broad range of smaller, moderate, and larger events. The long-term risk calculations displayed in Appendix B indicate the estimated chances of a damaging flood over specified time periods. Like the ACE, these statistics account for floods with a broad range of possible magnitudes. For example, on average over the long-run under the FWOP, there is a range from 11.69 to 100 percent chance that a damaging flood would occur over a 10-year period, and for longer time periods such as the 30 and 50-year periods, it is essentially 100 percent. This is a long- term average and does not necessarily mean that a damaging flood will occur in the next 10 years. range.

### 7.6.2. Costs

Cost risk was originally addressed by adding a contingency of 35 percent to all measures to aide in the economical comparison of each alternative. However, in order to determine a defensible contingency percentage to use in the cost estimate of preferred plans, a Cost and Schedule Risk Analysis (CSRA) was performed for each plan with members of the PDT. This meeting discussed where uncertainties are in the project and defined the risk of these uncertainties with an associated cost. Each risk was placed into one of four categories, Contract Acquisition and Strategy Risks, Construction Risks, Scope and Technical Risks, and External Risks. Appendix D discusses each defined risk in further detail. As details of the recommended plan were further defined, the CSRA was repeated and contingencies updated accordingly.

Bedrock conditions were originally considered the most significant uncertainty from an engineering standpoint. This uncertainty translated to a cost risk, which could affect the estimated net benefits produced by the Recommended Plan. This risk was acknowledged early on in the analysis of all proposed detention sites, and mitigation to reduce this risk was carried out with geotechnical (auger) testing as detailed in Appendix A. The tests do not provide an advanced understanding of bedrock conditions; so additional subsurface investigations were conducted to better define the project site. This testing determined that bedrock and perched groundwater were present at several isolated locations, therefore the cost estimate was updated to account for this new information, and the possibility of encountering additional bedrock or groundwater at other locations was noted in the risk register.

Computational uncertainty (as related to supporting model data, parameters, and assumptions) was tested with results presented in Appendix A. Test results show that, in general, both identified residual and incremental risks as well as derived benefits are not sensitive to model uncertainty.

The proposed configuration of the Recommended Plan is subject to design refinement in a PED phase; however, the proposed storage capacities of detention basins as well as inflow structure configurations are understood to be optimized for flood risk management. This understanding is based on physical model testing of design capacities and inflow configurations that (a) targeted various flood frequencies for storage maximization and (b) modified fill times within the realization of a flood event for such frequencies. Parameter variation to support testing was performed for inflow weir elevations, berm elevations, and pond side slopes. Full economic modeling was not performed on design sensitivity testing for the recommended plan; FDA inputs/hydraulic model outputs were provided only for the final configuration with the strongest H&H performance.

### 7.6.3. Life Safety and Project Performance

Per USACE guidelines, risk should be considered throughout the planning and design processes (ER 1105-2-101) to ensure population and infrastructure risk is not increased with any proposed plan, life safety is prioritized, and facilitation of risk-informed decision making. In this study, a comprehensive hazard analysis was completed to assess the residual and incremental risks to life and infrastructure potentially associated with the recommended plan. This analysis was considered applicable as features of the proposed measures are designated as levees by EM 1110-2-1913. In designs, robust features were considered to increase measure resiliency, decreasing hazard risk (i.e. life or infrastructure), and decrease cost risk. The hazard analysis completed for this assessment shows that a low hazard designation likely applies to the measures of the proposed plan. Both with-project and breach conditions were assessed against FWOP conditions to gain a comprehensive understanding of residual and incremental risk-potential associated with the recommended plan. A life loss and direct damage estimation model (HEC-LifeSim) was constructed to assess life risk in the study area, while a hydrodynamic assessment was used to assess potential impacts to critical infrastructure, OSE, and the environment. Breach simulations included individual pond sites as well as combined scenarios.

Model results show that life safety benefits are realized for the with-project condition, and preserved during failures; however, the order-of-magnitude total life loss for breach simulations increases slightly for the largest analyzed events (0.005 and 0.002 AEPs). Additionally, for individual levee failures, there is an increase of 1 in order-of-magnitude total life loss for 0.02 AEP. This increase is not observed in the recommended plan breach results, however. Increases in order-of-magnitude average life loss are not considered an accurate representation of the risk, rather an artifact of statistical uncertainty. This assessment is based on a thorough review of LifeSim outputs, breach and with-project hydrodynamics, and general hydraulic performance of the basins.

Because of low hydraulic detention times, geotechnical design to reduce piping risk, and expected overtopping, the more likely failure mode for the proposed basin levees is considered overtopping. As described, however, failures were initiated with piping failure modes such that the largest practical breach

could develop. The locations of maximum head differential for each site were selected for breaching (along channel at VD1; southwest corner of VD2), although stages capable of overtopping the pond levees do not outlast the recession of similar exterior water surface elevations at any site. As a result, surrounding inundation would significantly mitigate the effect of berm failure, resulting in a negligible influence of the breach on exterior floodplain conditions. As previously described, it was not possible to develop overtopping breaches with exaggerated parameters, even at locations of maximum head differential.

The risk of an overtopping breach within the basin spillways is considered very low based on the proposed design features. As shown in Section 4.1.2.2, armoring in the form of ACB/ACM was included in basin cost estimates for the spillways (not removed following CSRA). Generally, the performance of ACBs/ACMs is considered strong for overtopping velocities less than 15-20 ft/s (see, e.g., Hewlett et al., 1987; Clopper, 1989; Clopper, 1991; Abt et al., 2001; and Cox et al., 2014). USACE project performance has also shown that ACB and ACM products can serve as successful lateral spillway revetments for medium-sized spillways with heads between 5 and 10 feet (Gambucci, 2009). Maximum velocities over the design spillways are on the order of 4-5 ft/s. While not expected, future design efforts (in PED) should highlight any potential high-velocity areas along pond berms and assess protection needs. Assessment should be completed with detailed 2-D hydraulic analysis.

The results of the LifeSim analysis do not agree with the physical performance of the proposed plan in both breach and non-breach scenarios. The life safety analysis is valuable in assessing uncertainty in project performance; however, it is understood that the hydraulic model results suggest that no incremental risk is associated with the project. Based on the provided model information, uncertainty in the statistical life loss model, and increased confidence in engineering models supported by calibration to physical data, the recommended plan hazard potential is considered low, though additional life safety analysis may be warranted. Additionally, as described, breach scenarios supporting incremental risk assessment were simulated with less likely parameters, which increases confidence in the plan performance. Risk of environmental damage associated with a breach or project failure is very low because sensitive environmental resources are not located within the study area.

### 7.6.4. Residual Risk

Structural quantification of residual risk and benefits associated with the Recommended Plan is provided in Chapter 5 of Appendix A. As shown, the Recommended Plan does not eliminate all residual risk in the study area; however, the benefits associated with the plan are very strong, and would provide a significant amount of flood relief from storms of various frequency within the basin (discussed in the following section). As shown in Figures 5-14 and 5-15 of Appendix A (and discussed in Section 5.2.2.1), a small group of structures located immediately landward of the basins observed minor increases in infrequent flood elevations above existing and FWOP flood elevations for refined with-project modeling. As detailed in Section 5.2.2 of Appendix A, model refinement was required to better understand the hydrodynamics in the vicinity of the basins, in addition to supporting the described life safety analysis. These model refinements were not practical for alternative screening given the level of effort associated with construction, the number of overbank detention basins analyzed, and the conservative economics associated with the “baseline” geometric configurations (reference Section 4.1.1.1 of Appendix A).

Specifically, 4 structures observed flood elevation increases above vertical uncertainty (i.e., 0.5 foot) for the 0.10 AEP event (0.7-foot increase). Outside of this event, increases in landward flood elevations do not exceed vertical uncertainty at VD1; however, the number of structures with increases approaching 0.5 foot maximizes at the 0.02 AEP event with 14 structures. At VD2, increases above vertical uncertainty do not occur until the 0.02 AEP event (6 structures at 0.8 foot), and maximize at the 0.01 AEP event (9 structures at 0.8 foot).

The PDT did not consider the refined model results to warrant additional real estate analysis and/or costs. This decision was based on professional judgement of the inundation depth, frequency, and duration as well as the existing flood risk applicable to the subject structures. Economic analysis for all plans with overbank detention was based on the original hydraulic model configuration described in Section 4.1.1.1 of Appendix A. As such, the current net benefits are conservatively low based on overexaggerated water surface elevations in the landward areas in addition to reduced downstream profiles with the most accurate (i.e., two-dimensional) model configuration. While specific damage quantification related to the refined results was not performed, it is understood that damages to these structures will not exceed those currently computed within the justified net benefits of the recommended plan.

Mitigation for residual risk not addressed by the recommended plan is understood to be an important consideration in plan recommendation, implementation, and resiliency. It is the PDT's understanding that the non-Federal sponsor intends to participate in residual risk-targeted buyouts in the future. These acquisitions would alleviate some residual risk depending on scope, while better aligning with the local objective of community connectivity when compared to a large-scale buyout. Additionally, plans are in place to address residual risk through utilization of flood warning systems.

### 7.6.5. Resiliency

In addition to risk-informed planning and design, USACE resiliency principles were incorporated into the development of the recommended plan (USACE, 2020). Specifically, principles of Prepare, Absorb, Recover, and Adapt (PARA) were addressed in selection and consideration of the recommended plan and its principal features. The team's commitment to *Prepare* has been demonstrated by the described comprehensive risk analyses completed to understand the project's performance under all expected loading conditions. Throughout these analyses, necessary measures for risk reduction and project improvements have been considered to increase overall resilience and satisfy the *Absorb* principle. Considerations include overtopping protection and contingency in geotechnical design. In the event of damage or failure to any component of the project system, restoration is an O&M requirement understood by the non-federal project sponsors to support longevity and resilience (i.e., *Recover)*. Furthermore, high confidence in the project's ability to *Adapt* is provided by performance analysis against increases to future flood risk. This risk has been analyzed in terms of climate change (see Appendix A, Section 6.0) and basin development (see Appendix A, Section 3.0), and factored directly into the design of the recommended plan. Additionally, other considerations for adaption related to O&M may be developed in the PED phase to improve overall project resiliency.

## 7.7. Plan Benefits

The expected annual damages to the study area in the FWOP condition are estimated at $7,199,000. The expected annual damages to the study area with Alternative 4 implemented are estimated at $4,875,000 producing $2,324,000 in annual benefits, considering only FRM. This is approximately a 32 percent reduction in damages. The mean annual cost, not including the cost of recreational features is approximately $1,014,000. This is based on the project first cost of $27,130,000 which includes all features except recreation, annualized over a 50-year period of analysis, at an interest rate of 2.25 percent. The annual mean net benefit of Alternative 4 considering only FRM benefits is approximately $1,310,000 and a resulting BCR of 2.3 (benefits summarized in Table 7-8). Figures 7-6 through 7-11 provide an overview of plan performance for several AEP events.

The recreation evaluation involves an analysis of the National Economic Development (NED) benefits from recreation opportunities created from the proposed recreation facilities. Benefits are compared to costs to inform decision-makers on the feasibility of the recreation facilities. Trails provide low or no-cost recreational opportunities and the potential for transportation options to the public, while improving quality of life for residents. Trails can also stimulate business creation, influence corporate location decisions, boost spending at local businesses, increase property values, reduce medical costs by

encouraging exercise, and generate tax dollars. Note that table 7-8 displays only FRM benefits. If recreation benefits are included, the BCR increases to 2.6.

**Table 7-8. Benefits Summary.**

| Total Project First Cost w/o Recreation | $27,130 |
|---|---|
| Annual FRM Benefits | $2,324 |
| Annual Costs | $1,014 |
| Benefit-Cost Ratio | 2.3 |
| Net FRM Benefits | $1,310 |

Note: October 2021 FY(22) price level, Interest Rate 2.25 percent; Dollars shown in $ thousands

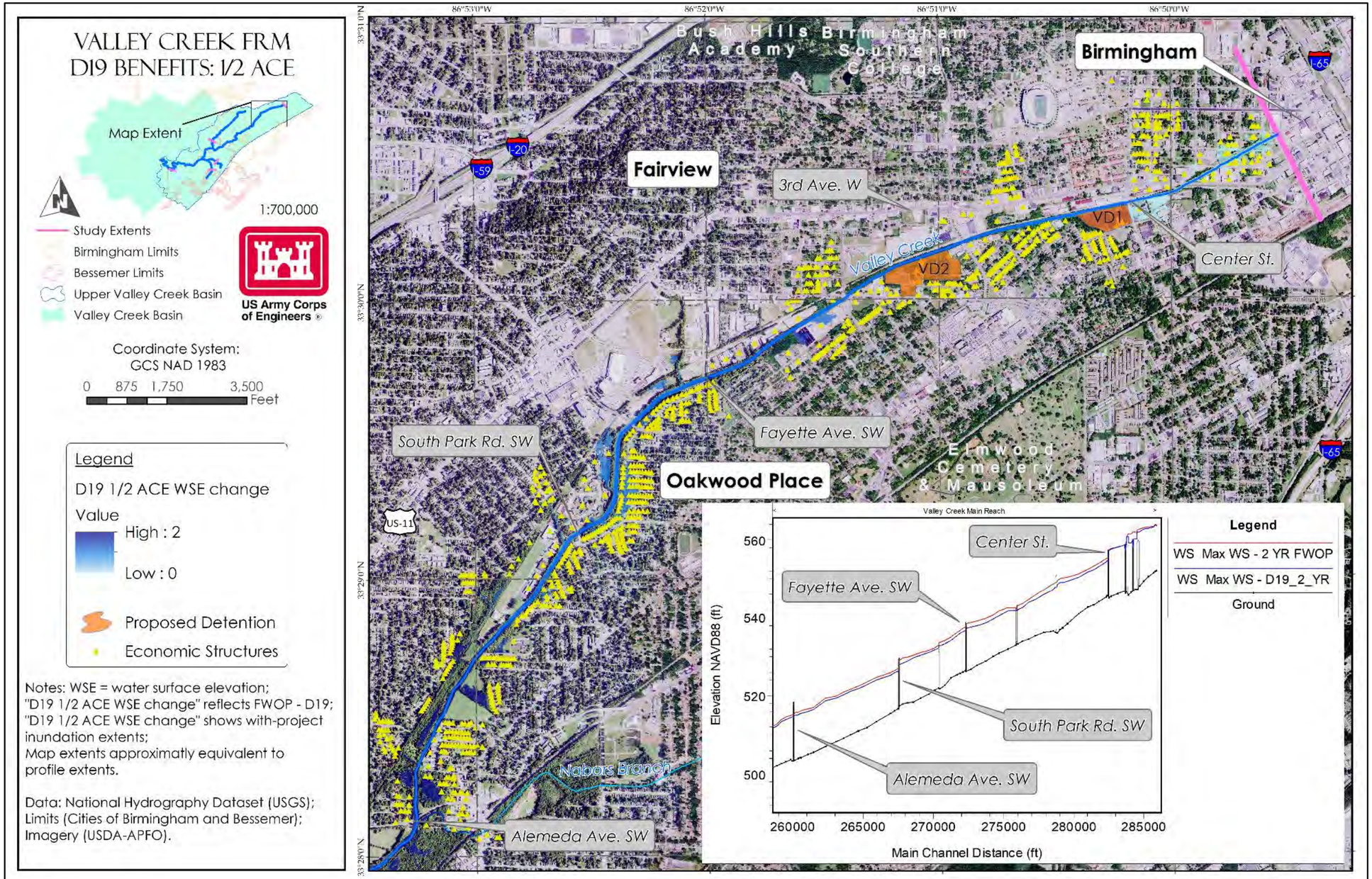


**Figure 7-6. Performance Benefits at the 0.50 AEP in the Upper Extent of the Study Reach.**

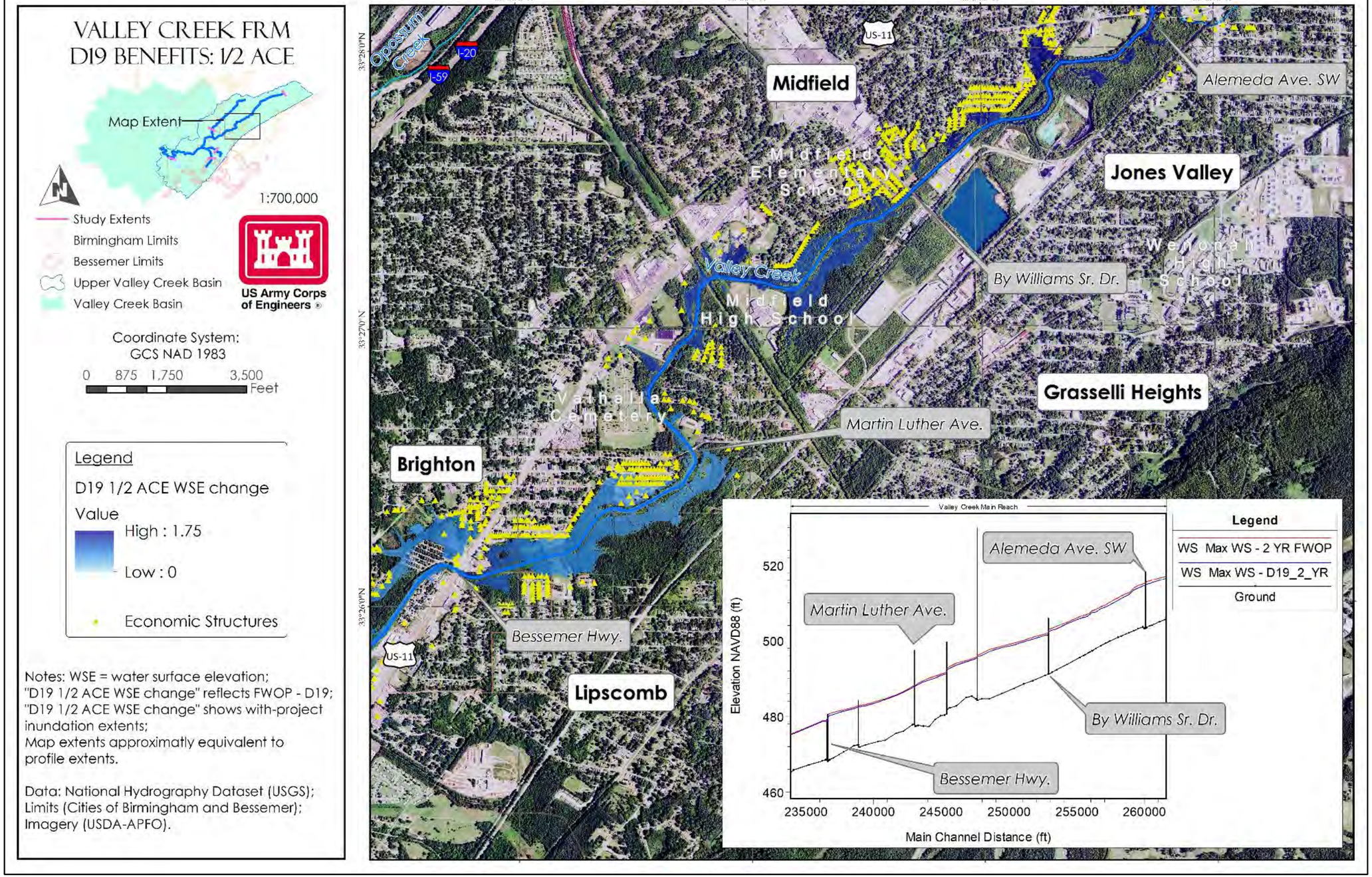


**Figure 7-7. Performance Benefits at the 0.50 AEP in the Middle Extent of the Study Reach.**

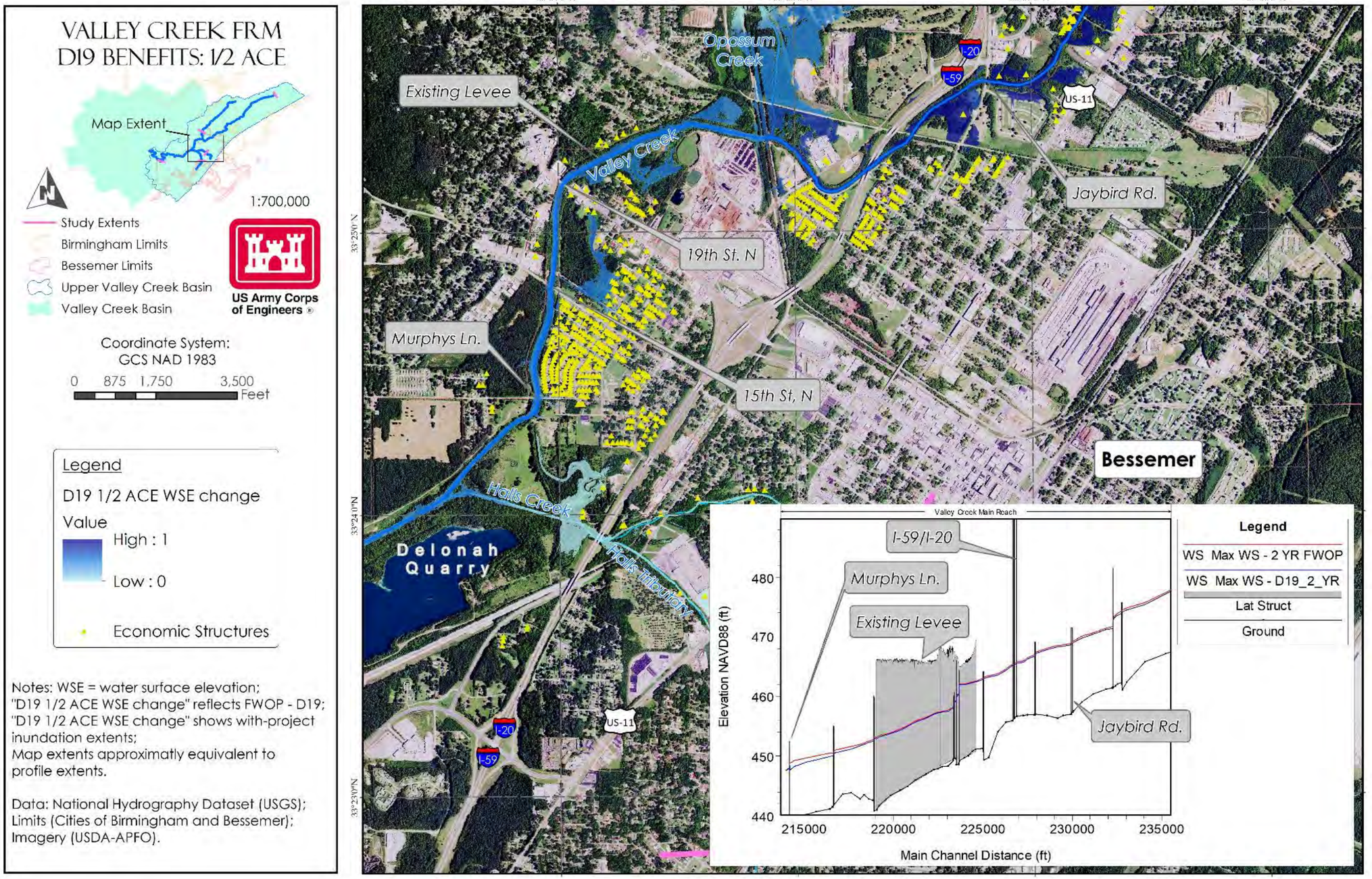


**Figure 7-8. Performance Benefits at the 0.50 AEP in the Lower Extent of the Study Reach.**

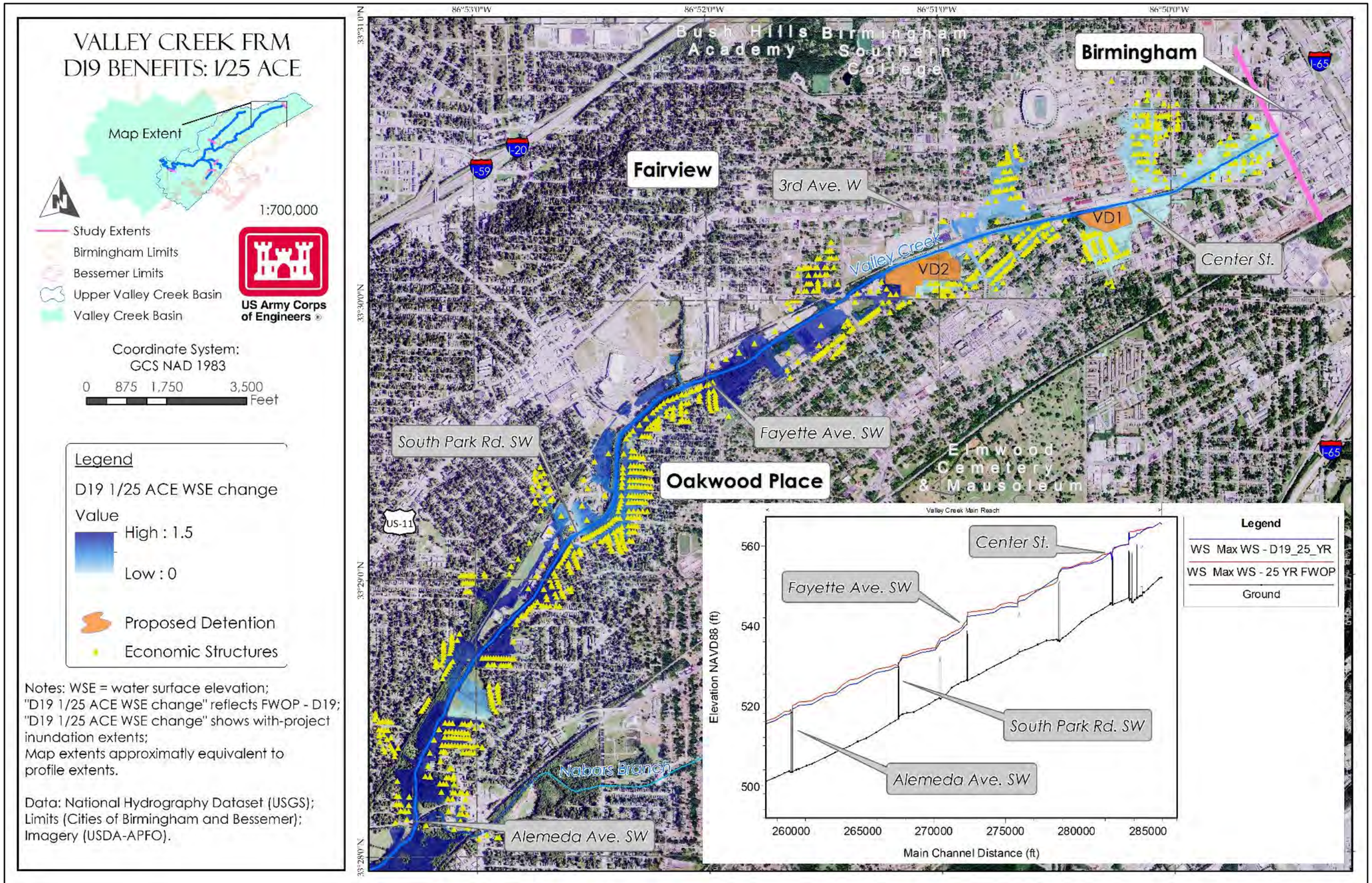


**Figure 7-9. Performance Benefits at the 0.04 AEP in the Upper Extent of the Study Reach.**

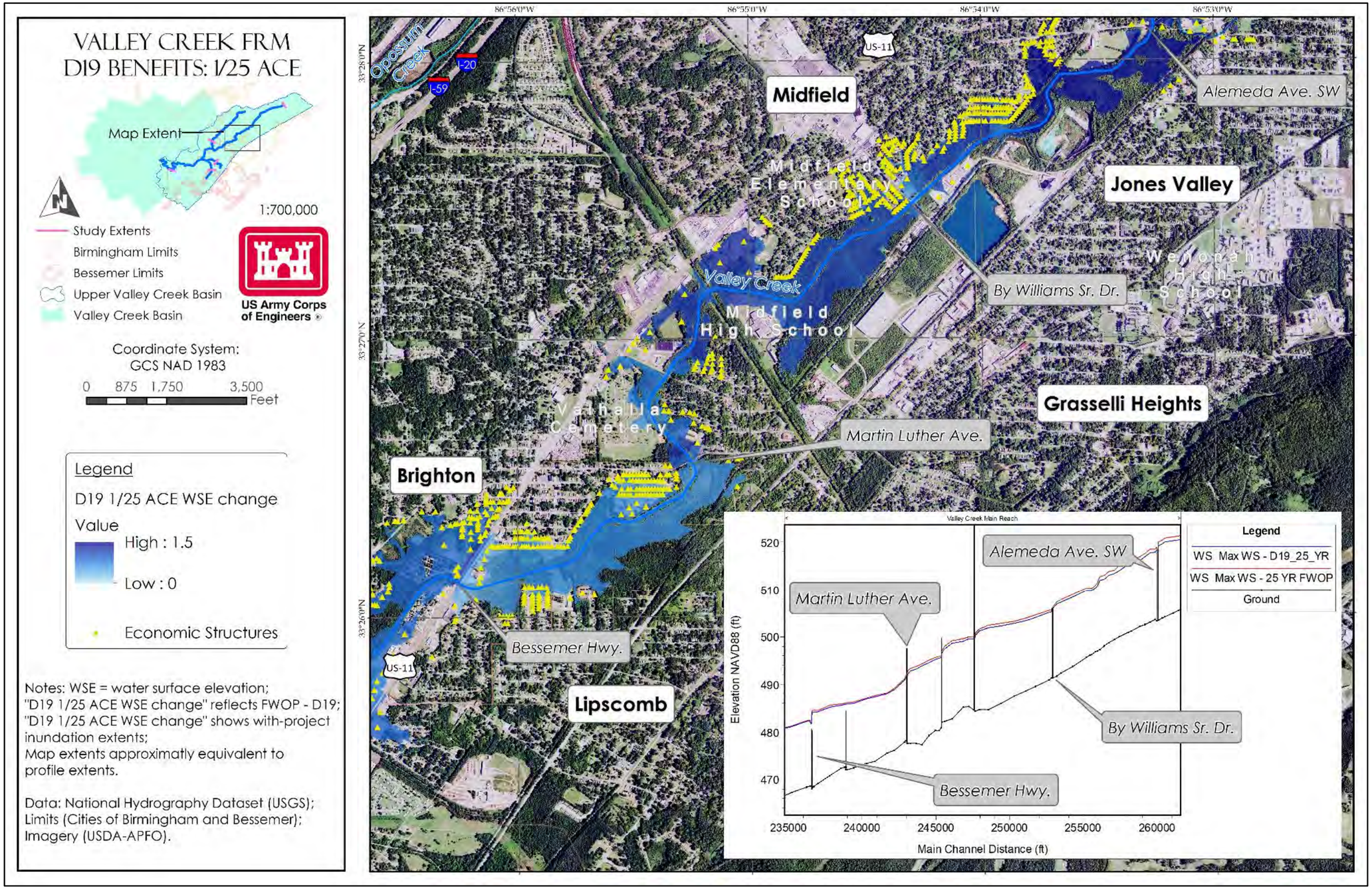


**Figure 7-10. Performance Benefits at the 0.04 AEP in the Middle Extent of the Study Reach.**

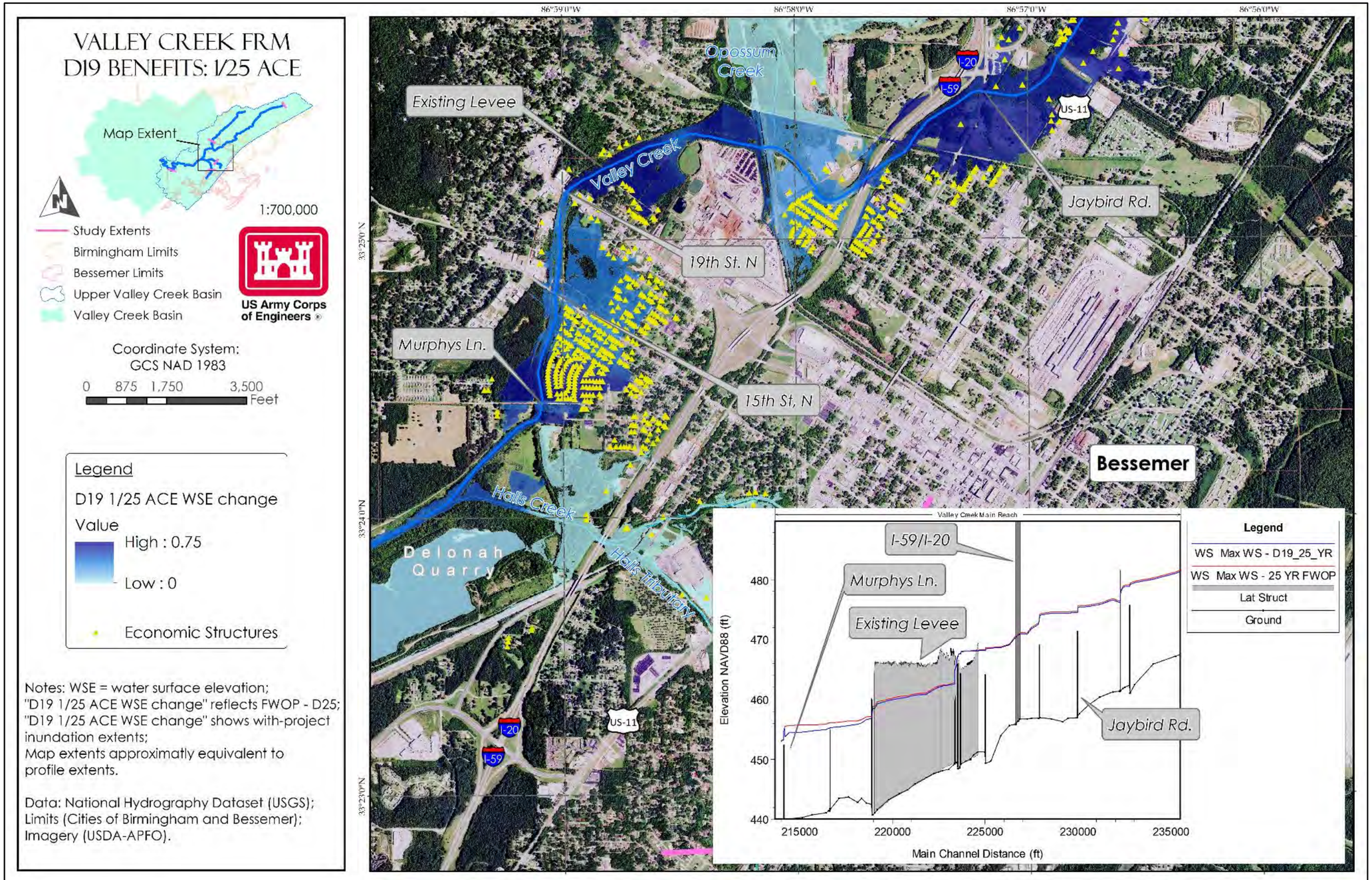


**Figure 7-11. Performance Benefits at the 0.04 AEP in the Lower Extent of the Study Reach..**

## 7.8. Plan Implementation

A standard project partnership agreement (PPA) will be used to partner with the non-Federal sponsor for design and construction of the recommended plan. This section presents the cost sharing requirements between the Federal government and the non-Federal sponsor as well as other responsibilities. These costs are for entering into a PPA and are based on a final cost estimate developed by the PDT and reviewed by the mandatory Center of Expertise for cost.

### 7.8.1. Division of Plan Responsibilities

#### 7.8.1.1. Cost Sharing

The Federal government is responsible for 65 percent while non-Federal sponsor is responsible for 35 percent of the total project costs during the design and implementation of the project, except costs for recreational features which are cost shared 50-50. Work-in-kind is not anticipated to be performed on the project. A summary of the cost share requirements including cash and estimated creditable LERRD value are shown in Table 7-10. The costs shown are project first costs at FY22 price levels.

**Table 7-9. Summary of Cost Sharing**

| Costs | Federal (65%) | Non-Federal (35%) | Total |
|---|---|---|---|
| Total Project Cost | $17,725 | $9,586 | $27,311 |
| Cash Required | $17,725 | $5,459 | $23,184 |
| LERRD (01 & 02 Accounts) | NA | $4,127 | $4,127 |

Note: The recreational costs were included based on a 50-50 cost share for federal and non-federal entities. Costs are shown in $thousands

#### 7.8.1.2. Federal Responsibilities

Federal responsibility is to provide the Federal cost sharing match, engineering services via either in-house resources or architectural engineering services to produce construction contract documents, award a construction contract, manage construction contract, issue notice of completion to the non-Federal sponsor, and provide an operations and maintenance manual to the non-Federal sponsor.

#### 7.8.1.3. Non-Federal Responsibilities

Non-Federal responsibility is to provide all lands, easements, rights-of-way, relocations, and excavated material disposal areas (LERRDs) for construction, and future operation and maintenance of the project. Non-Federal sponsor is required to provide for operations, maintenance, repair, rehabilitation and replacement (OMRR&R) for the completed project without cost to the USACE, in a manner compatible with the project's authorized purpose and in accordance with applicable Federal and state laws and specific directions prescribed by the USACE in an OMRR&R manual and in accordance with provisions of the Project Partnership Agreement. The non-Federal partners fully understand their financial and other obligations including but not limited to matters of real estate and OMRR&R. These requirements have been discussed and documented in monthly partnering meetings. Additionally, Bessemer, Birmingham and Jefferson County have all provided letters of support.

The non-Federal partner is responsible for the non-Federal cost sharing match in accordance with the Project Partnership Agreement. Work-in-kind is not anticipated on the project. The non-Federal sponsor would be responsible for reviewing, commenting, or providing input to the construction contract documents and operations and maintenance manual at key milestones of the project.

## 7.8.2. Implementation Schedule

**Table 7-10. Project Schedule.**

| Task | Schedule |
|---|---|
| Project Partnership Executed | Jul 2022 |
| Initiate Design (funding dependent) | Aug 2022 |
| 50-Percent Design Complete | May 2023 |
| 100-Percent Design Complete | Feb 2024 |
| Advertise for a Construction Contract | Mar 2024 |
| Award a Construction Contract | Apr 2024 |
| 50-Percent Construction Complete (FY23 Q3) | Apr 2026 |
| 100-Percent Construction Complete | Apr 2028 |
| O&M Manual and Notice of Completion | May 2028 |
| Close Project | Jul 2028 |

## 7.8.3. Environmental Compliance

Environmental compliance requirements have been met to the extent possible as part of the planning process. Several environmental compliance activities would be necessary during plan implementation.

- **NHPA Section 106 compliance** – Completion of the Section 106 process would be required for the recommended plan. Compliance activities would include site identification efforts and, if present, site evaluation for eligibility for the NRHP. If eligible, treatment or avoidance measures would be developed. Each step would involve consultation with SHPO, Tribes and other interested parties. A PA has been executed for the 106 process and filed with the Advisory Council on Historic Preservation.
- **Endangered Species Act** – It is assumed that tree clearing for implementation of the plan can be restricted to the time period of October 15 to March 31 to avoid any potential impacts to federally listed bat species. Should this not be possible, USACE must further coordinate with USFWS and likely perform surveys for bat presence prior to tree clearing. No tree clearing should occur outside of the specified seasonal window without further coordination with USFWS.
- **Bottomland Hardwood Mitigation** – 5.0 bottomland hardwood credits should be purchased from the Big Sandy Mitigation Bank to offset project impacts from tree clearing. USACE will purchase these credits concurrently with the physical construction that causes the impacts for which mitigation is required. However, where there are technical or cost-efficiencies or by request of the non-Federal sponsor, mitigation bank credits may be purchased prior to the physical construction that causes the impacts for which mitigation is required. Mitigation measures will be scheduled for accomplishment prior to or concurrently with other project features in the most efficient way.
- **Clean Water Act, Section 401** – A 401 water quality certification should be obtained from ADEM prior to construction. Design and construction of the plan should comply with the ADEM water quality certification conditions .
- **Clean Water Act, Section 402** – The construction contractor would be required to obtain a CWA Section 402 National Pollutant Discharge Elimination System (NPDES) stormwater permit from the Alabama Department of Environmental Management because the plan would disturb more than 1 acre. These CWA requirements would need to be met prior to any construction activities.

### 7.8.4. Views of Non-Federal Sponsor

Bessemer, Birmingham, and Jefferson County are in concurrence with the Recommended Plan, Alternative 4.

# 8.0. PUBLIC AND AGENCY INVOLVEMENT

USACE values public and stakeholder involvement. Activities of such are critical for the study's success as they foster trust and credibility between USACE, the community, and all project stakeholders. Furthermore, effective communication increases the collective understanding of issues/problems and improves the quality and execution of decision making. The objectives of USACE public involvement, as defined in ER-1105-2-100 are:

- to provide information about proposed USACE activities to the public
- to make the public's desires, needs, and concerns known to decision makers
- to provide for consultation with the public before decisions are reached
- to consider the public's view in reaching decisions

Throughout the study process to date, several points of engagement were held that gave the opportunity for public and agency input.

- **Planning Charrette (November 6th, 2018) –**In November 2018, the Valley Creek PDT and the City of Bessemer hosted a two-day planning charrette in Bessemer, Alabama. Attendees included the representatives from local municipalities, involved government agencies, and the USACE vertical review team. The charrette lead stakeholders through each step of the USACE planning process, engaging and encouraging feedback. Both a physical and virtual site tour were included, enhancing the understanding of the project area. Overall a collaborative effort was put forth to determine problems within the Valley Creek watershed, set objectives, and briefly explore possible alternatives.
- **Inter-agency Meeting (January 23, 2019) –** An inter-agency meeting was held via webinar and conference call. The intent was to provide background on the study and to highlight the anticipated environmental compliance requirements and timelines with all agencies that may have a review and/or permit-issuing role on the study.
- **Public Scoping Meeting (June 2019) –**USACE and City of Bessemer hosted a public open house to provide information on the Valley Creek Flood Risk Management Study and seek input from the public on June 19, 2019, from 5:00 - 7:00 p.m., at the Bessemer Civic Center, located at 1130 9th Avenue S.W., Bessemer, AL 35022. Comments and input on the scope of the study were accepted through July 19, 2019.
- **Public Review Period for Draft Integrated Report –**In accordance with USACE regulations for implementing NEPA, the draft report was made available for public review and comment for 30 days. The 30-day comment period commenced with the issuance of a notice of availability on June 1, 2020 and publication of the report on USACE website (https://www.sam.usace.army.mil/Missions/Planning-Environmental/Environment-Resources/Inland-Environment/Valley-Creek-Flood-Risk-Management-Study/). Availability of the draft report was announced in a USACE press release and through USACE, City of Bessemer, and the City of Birmingham social media. Due to the Covid-19 situation at the time of the public comment period, no public meetings were held. No public comment was received in response to the public notice. Appendix E includes all public and agency coordination for the project.

# 9.0. DISTRICT ENGINEER'S RECOMMENDATION

Based on the conclusions of this study, after having given consideration to all significant aspects in the overall public interest, including environmental, social, and economic effects; and engineering feasibility; I recommend the implementation of the Recommended Plan. The Recommended Plan is the National Economic Development Plan, which is Alternative 4. The plan includes flood risk management features including but not limited to two off-channel detention basins each with an inlet weir, containment berm, and outlet structure. Recreation features include trails around the perimeter of each basin and are included in the plan. The total estimated first cost of the Recommended Plan based on 2022 price levels is $27.311 million with the Federal and nonFederal shares of the total first cost estimated at $17.725 million and $9.586 million, respectively. The flood risk management features have an estimated first cost of $27.130 million with the Federal and nonFederal shares estimated at $17.635 million and $9.496 million, respectively. The recreation features have an estimated first cost of $181 thousand, with the Federal and nonFederal shares estimated at $90.5 thousand and $90.5 thousand, respectively. The annual operation, maintenance, repair, replacement and rehabilitation costs are $52 thousand. The Recommended Plan has an overall benefit-cost ratio of 2.3 (flood risk management features only) and 2.7 (with recreation included) and would provide flood risk reduction for the Birmingham / Bessemer area. I recommend this plan with such modifications thereof as in the discretion of the Commander, HQUSACE, may be advisable.

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.

Date: 22 OCT 2021

Travis J. Rayfield
Colonel, Corps of Engineers
District Commander

# 10.0. LIST OF PREPARERS

This chapter identifies the USACE team members who prepared this FR/EA and its appendices.

**Valley Creek Integrated Feasibility Study and Environmental Assessment Preparers.**

| Name | Education | Years of Experience/ Area of Expertise | Responsibilities |
|---|---|---|---|
| George Baker | B.S. Civil Engineering | 3 years/Cost Engineering | Lead cost engineer and primary author of cost estimate appendix |
| John Bass, P.E. | B.S. Civil Engineering | | |
| Holly Bender | Ph.D., Natural Resource Economics<br>B.A. Political Science and Economics | 20 years/NEPA compliance and natural resources planning | Lead on EA sections for socioeconomics, environmental justice, and recreation |
| Katherine Carter | B.A. Economics | 4 years/Economics Analysis of Flood Risk Management and Ecosystem Restoration | Lead economist and primary author of Economics appendix |
| Ryan B. Crane, P.E. | B.S. Civil Engineering | 11 years/Hydrologic and Hydraulic modeling | Hydrologic modeler and Engineering Technical Lead |
| Cassidy Garden, P.E. | B.S Agricultural Engineering Water Resources<br>M.S. Civil Engineering Water Resources | 18 years/Civil Engineering Water Resources | Project Manager/Planner |
| John Grothaus | B.S. Civil Enineering<br>M.S. Water Resources Planning | 27 years/Civil Engineering Water Resources | Senior & Lead Planner Chief Plan Formulation Section |
| Diane Hassaballa | B.S.B.A. Business Ethics, Marketing, and Management | 3 years/NEPA compliance and natural resources planning | Contributor to EA sections on socioeconomics, environmental justice, and recreation |
| Marshall Hayden, P.E. | B.S. Civil Engineering<br>M.S. Civil Engineering: Coastal/Water Resources | 6 years/water resources (hydraulic/hydrologic) engineering, geospatial analysis, and cartography | H&H Engineer/Primary EN Appendix Author |
| Steven Highland | PhD., Geography, MS Anthropology, BS Anthropology and English | 22 years as Archaeologist | Primary author and responsible for Section 106 compliance. |
| Ronald Jansen, P.E. | B.S. Civil Engineering | 24 years general civil engineering; 7 years planning / project management | Project Manager / Planner |
| Timothy Meade | M.A. Anthropology. B.A. Anthropology | 30 years as Archaeologist | Cultural Resource compliance co-Author |
| John Lunn | M.U.P– Land Use/ Environmental B.S. Accounting | 2 years USACE experience in Plan Formulation | Non-structural analysis. Contributor to Recreation analysis |
| Michael Snyder | B.A. Biology<br>M.S. Biological Sciences | 20 years/NEPA compliance and natural resources planning | Primary author of EA, compilation of main report, and 404(b)(1) evaluation. |
| Paul Speckin | B.S Civil Engineering | 4 years Civil/Geotechnical design + 30 years Civil/Geotechnical design/remediation of HTRW sites | Primary author of HTRW Appendix F |
| John Tetreau | M.A. Management/Public Administration B.A. History | 5 years/Real Estate Planning | Real Estate Plan |

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