



Valley Creek Feasibility Study, Bessemer and Birmingham, Alabama

Draft

Integrated Feasibility Report and Environmental Assessment

May 2020



**US Army Corps
of Engineers** ®
Kansas City District

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EXECUTIVE SUMMARY

This integrated feasibility report and environmental assessment 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 tentatively selected 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 in the greater Birmingham, Alabama metro region. 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. Structural measures identified were off-channel detention, levees, bridge modifications, channel modification, and inline structures (dams). Types of physical non-structural measures considered include structure elevation, relocation, wet and dry proofing, and acquisition. Nonphysical nonstructural measures included an emergency warning system. 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 and Guidelines (U.S. Water Resources Council 1983): 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
Alternative 13	Channel and Bridge Modification plus Residual Risk 2-year floodplain buyout (~79 structures)	1,184
Alternative 3	Three Detention Basins	606
Alternative 1	Channel and Bridge Modification	597
Alternative 7	Channel and Bridge Modification plus Three Detention Basins	390

Alternative 13 is considered the National Economic Development (NED) plan, however, the non-federal sponsors have expressed concern over difficulty with implementing large acquisition plans and as such is considered an unacceptable plan. Local sponsors have expressed their desire to invest in Alternative 3. Alternative 3 provides the next highest mean annual benefits in flood risk reduction and provides those benefits throughout the corridor resulting in a complete, effective, efficient, and acceptable plan. Alternative 3 meets all four planning criteria and meets the planning objectives. Therefore, the tentatively selected plan (TSP) is a locally preferred plan (LPP) represented by Alternative 3.

The TSP components include three 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.

Total fee simple acreage required for the TSP has been estimated at approximately 48.07 +/- acres within 163 parcels and rights-of-way. Placement areas for excavated materials have not been identified and current assumption is the transportation of material to a commercial disposal site. Furthermore, at this

time no other easements required for access and temporary staging have been identified. Fee simple land acquisition with administrative costs of \$2,896,100, estimated relocation assistance of \$62,000, a contingency of \$713,400, relocations of \$200,000 specifically for the radio tower. A total estimated lands and damages cost for the TSP rounded to \$4,000,000.

The estimated cost at a price level date of October 2019 (FY20) is \$45,065,000. The fully funded total project cost is \$49,902,000, which is the estimated cost at the current price level escalated to the third quarter 2023 (FY23). Total project cost includes costs for construction; the LERRD; planning, engineering and design; and construction management, respectively; and a risk derived contingency.

The TSP is anticipated to result in beneficial impacts to hydrology and hydraulics, public health and safety, floodplains, socioeconomics, transportation, and recreation within the study area by reducing flood risk. Construction of the TSP would result in adverse impacts to wetlands and terrestrial habitat requiring compensatory mitigation. A Clean Water Act (CWA) Section 404(b)(1) evaluation has been completed for the TSP. No exceedances of water quality standards would be anticipated. USACE will request a CWA Section 401 water quality certification from the state following completion of the public and agency review period on the draft integrated report. Resulting land cover, land use, and aesthetics would be consistent with the character of the setting of the detention basins. USACE has prepared a Programmatic Agreement to fulfill its National Historic Preservation Act Section 106 compliance responsibilities at this stage of project planning. 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 Draft 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 reduction within the Upper Valley Creek basin, outlines the process used for selecting the recommended alternative, 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 5th Avenue and 7th 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, which has an average fall of 8.4 feet per mile, and a total drainage area of 96 square miles. 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

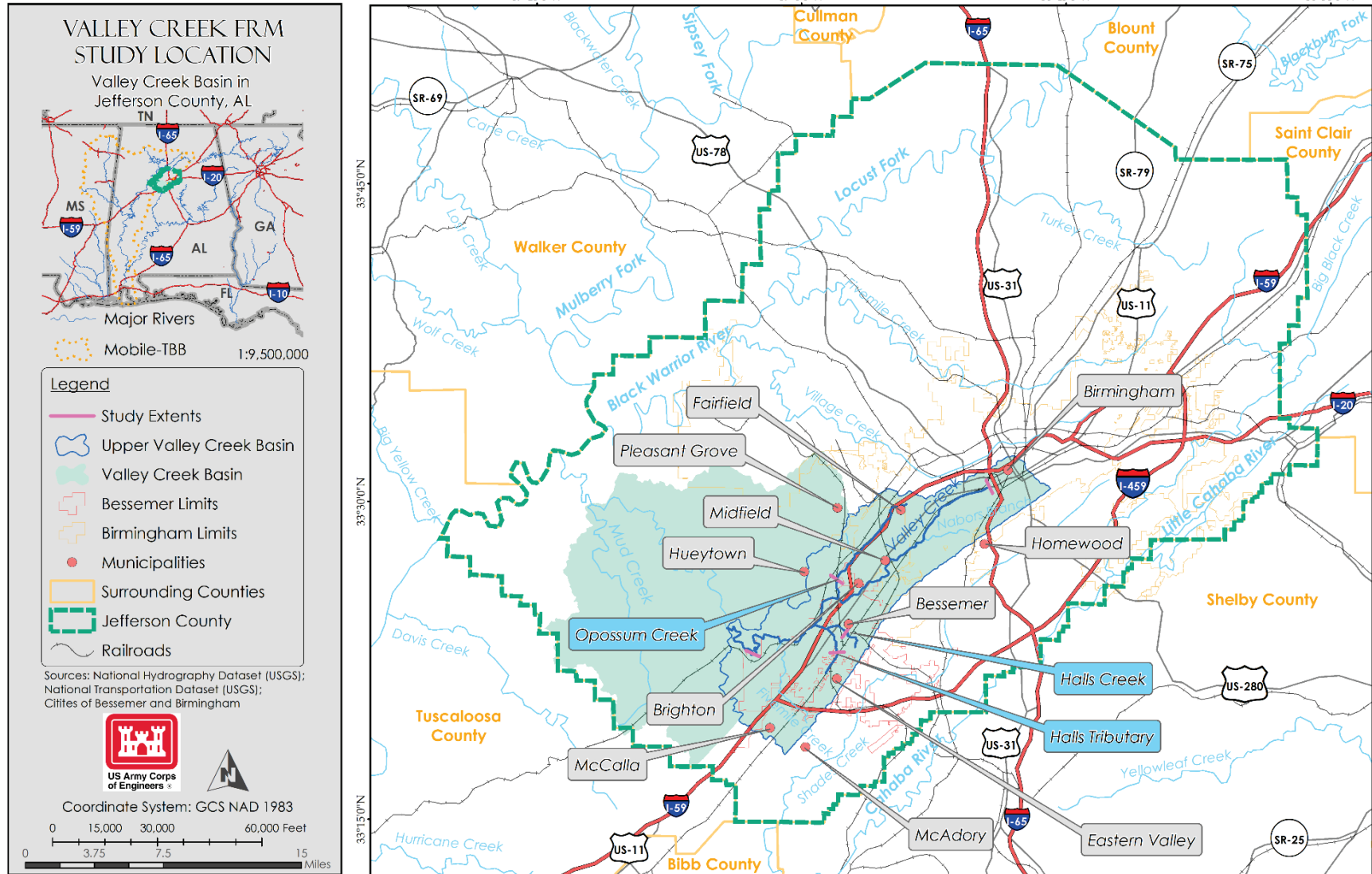


Figure 1-1. Valley Creek Study Area Location

achieving National Economic Development (NED) benefits because funding was provided through the USACE flood risk management business line.

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. The study area contains multiple repetitive-loss areas that translate into costs for the national economy as a result of flood insurance payouts. 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 storm with a 1 in 100 chance of occurring in any given year; sometimes referred to as a "100-year storm".

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. There exists a potential risk for loss of life due to conditions of frequent flash flooding with associated depth and velocity in the Upper Valley Creek watershed.

2. There exists frequent and reoccurring economic damages due to conditions of frequent flash flooding with associated depth in the Upper Valley Creek watershed.

In addressing the identified problems, there are opportunities to achieve the following:

1. Reduce the potential risk for loss of life as measured by reduction of the exposed or vulnerable population, life safety concerns, and flood forecasting.
2. Reduce reoccurring economic damages as measured by the reduction in expected annual damages (EAD).
3. Improve corridor connectivity to local area residents through recreational features that complement existing Jefferson County, and other local, recreation plans to will help serve under privileged communities.
4. Improve the communication of both immediate and long-term risks to local area residents.

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.

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 (500-year). 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 (100-year) event within the study area.

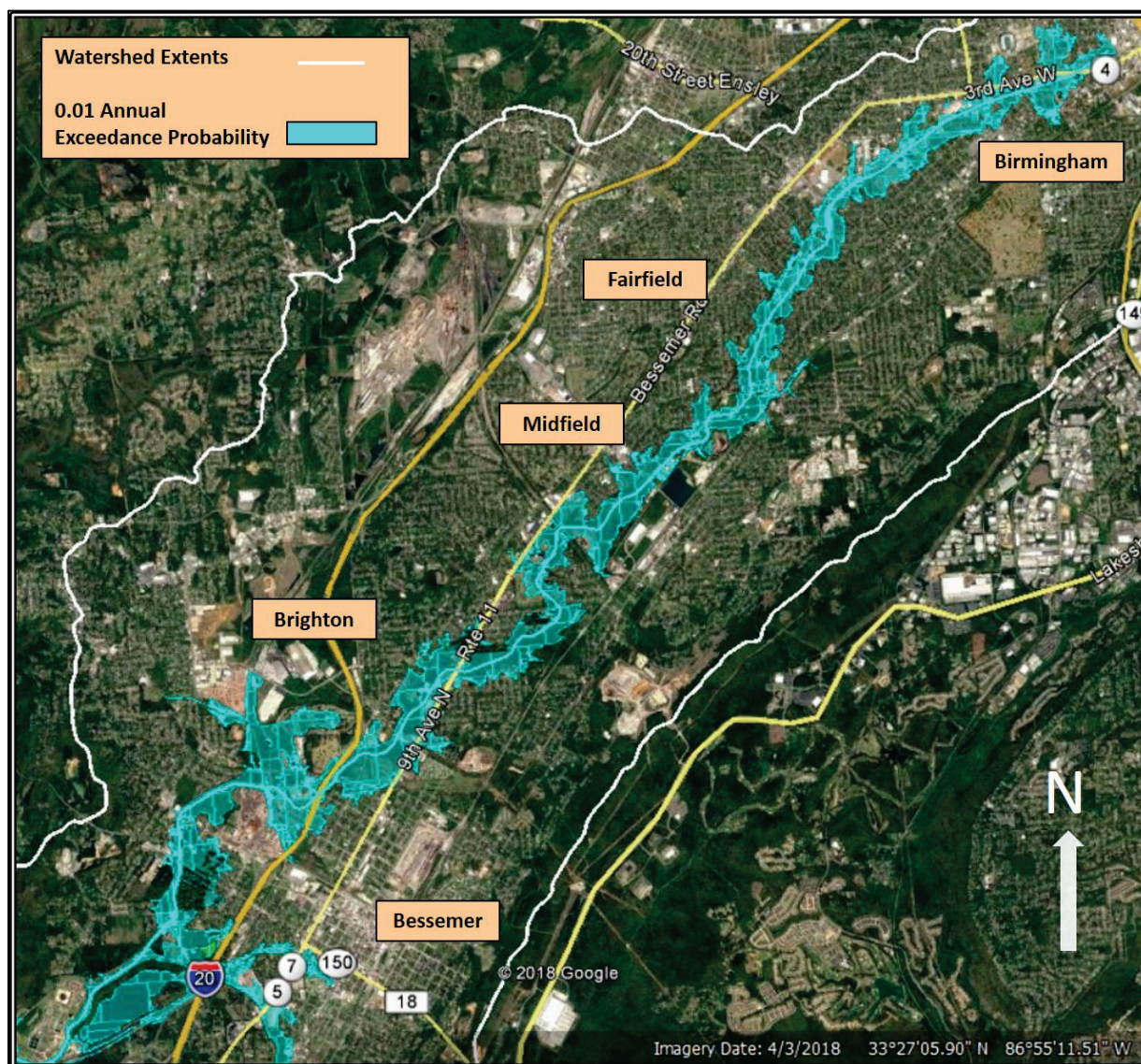


Figure 2-1. Extent of the 0.01 Annual Exceedance Probability Event for Valley Creek.

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.

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 (ft²). As such, drilling and blasting would be necessary to excavate into bedrock.

Twenty-four additional hand-augered 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 (CWA) 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 (*Camptostoma 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 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 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.

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 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.

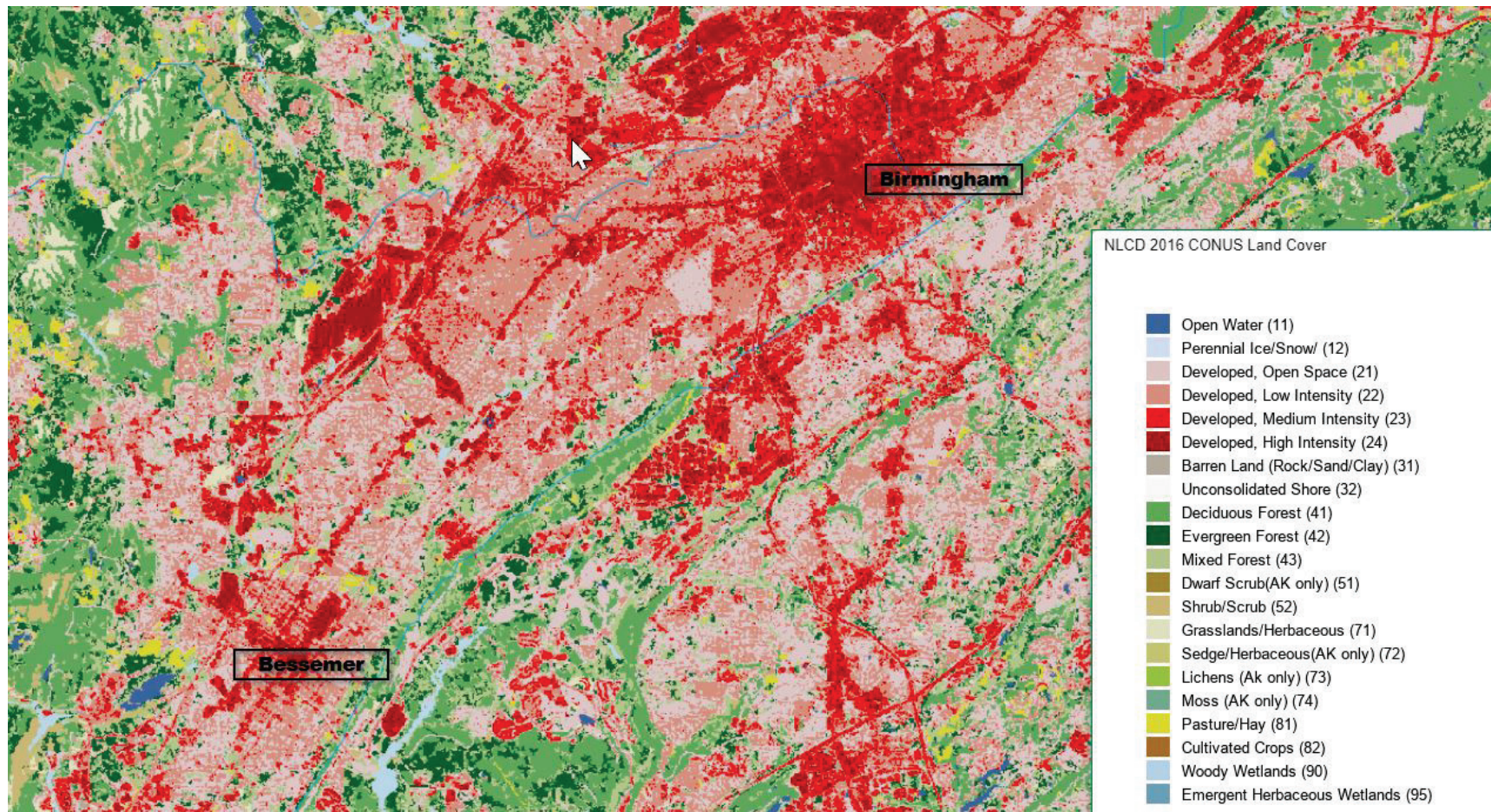


Figure 2-2. Land Use in the Study Area

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

Source: U.S. Census Bureau, 2017 ACS 5-year Estimate

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 USDS-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. None of the measures included in the alternatives overlap with prime farmland soils; therefore, 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 (NHPA) 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 to identify known historic properties within the project's Area of Potential Effects (APE), which aligns with the study area boundaries. Very little of the project's 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 potential APE, including Bessemer Mounds, an excavated Moundville culture, Mississippian period mound site. It is likely that other sites exist in the area. A Programmatic Agreement (PA) among USACE, the Alabama SHPO, and any interested Tribes and the Advisory Council on Historic Preservation (ACHP), if they chose to participate, has been developed to guide the Section 106 process and mitigate any adverse effects to potential historic

properties (Appendix I). Consultation with the Alabama State Historic Preservation Officer (SHPO) and the appropriate Tribes regarding the development of the PA and the effects of the project to historic properties is ongoing.

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 U.S. Water Resources Council’s *Principles and Guidelines* provide the instructions and rules for Federal water resources planning. 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 period of analysis was estimated as 2023 to 2073 because 2023 is the estimated beginning of construction.

3.3. Hydrology

The Future Without Project 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 (ICLUS) 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 future without project 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 revealed that storms in the southeast may be more frequent and severe in the future. However, the Non-Stationarity Assessment Tool showed no trend in increasing streamflow

over the period of record for the gages on Valley Creek. Furthermore, the CHAT ensemble forecast of minimum and maximum streamflow for the Mobile-Tombigbee basin through 2099 showed fairly consistent variability through time, with the mean of these values showing a very small upward trend through 100 years of forecast but not enough to drive a quantitative increase in flows for the FWOP. 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 Corps National Structure Inventory (NSI), within the 500-year floodplain and floodway is an estimated 15,325 individuals. 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 500 FWOP flood extents. Residential buildings, excluding automobiles, make up most of the total investment, valued at \$184,000,000. 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 there will be no new economic development, resulting in a significant increase in the study area potential flood risk damages. Absent any new information, it can be assumed the FWOP structure inventory will parallel the present existing structure inventory.

3.5. Life Safety

A flood in an urban environment with residential, commercial, and industrial areas poses a potential threat to human lives. A computer simulation, LifeSim, was used to simulate flooding scenarios and assess the flooding risk to the safety of the public. LifeSim takes into consideration the magnitude and frequency of a flood, the population at risk with number 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 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 2023 and ending in the year 2073.
- Reduce the risk for loss of life from flooding in the upper Valley Creek watershed for a duration of 50 years beginning in 2023 and ending in the year 2073.

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 taken into account 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. 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 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, 0.05, 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. 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).

A detailed description of the hydrology and hydraulics modeling including calibration and validation results 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 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 a high-level analysis of the study area and engineering judgment. 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). 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 rationale 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
	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
	VD3	22.2 acres on left overbank at Fayette Ave. SW. Previous buyout area with minor roadways and slab foundations.	Screened Out
	VD4	16.4 acres on left overbank at Lincoln Ave.	Retained
	VD5	55.6 acres on left overbank downstream of Alameda Ave. SW.	Screened Out
	VD6	27.9 acres on left overbank at Hartman Industrial Blvd. Site uses existing quarry.	Screened Out
	VD7	38.6 acres at By Williams Sr. Dr. Site uses existing, ponded quarry.	Screened Out
	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
	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
	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
	VD11	39.6 acres on left overbank just upstream of Jaybird Rd. Area is clear of development other than roadways.	Screened Out
	VD11b	Additional 8.5 acres on right overbank added to VD11. Open area.	Screened Out
	VD12	33.4 acres on left overbank just upstream of 19th St. Area is clear of development but may have HTRW issues.	Screened Out
	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
	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
	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
	VL4	Ring levee on left embankment extending from 19th St. N upstream and tying in to I-20 embankment (8740 feet).	Screened Out

Type	Name	Description	Screening Status
Bridge Modification	VB1	3rd Ave. N over Valley Creek.	Screened Out
	VB2	RR DS 3rd Ave. N over Valley Creek.	Screened Out
	VB3	Fayette Ave. SW over Valley Creek.	Screened Out
	VB4	By Williams Sr. Dr. over Valley Creek.	Screened Out
	VB5	RR DS Jaybird Rd. over Valley Creek.	Screened Out
	VB6	RR at Opossum Creek over Valley Creek.	Screened Out
	VB7	2nd RR at Opossum Creek over Valley Creek.	Screened Out
	VB8	Murphys Ln. over Valley Creek	Retained
	VB9	18th Ave. over Valley Creek.	Retained
	HB1	8th Ave. N over Halls Creek.	Screened Out
	HB2	9th Ave. N/Bessemer Hwy. over Halls Creek.	Screened Out
	UB1	5th St. N over Halls Tributary.	Screened Out
	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
	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
	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.

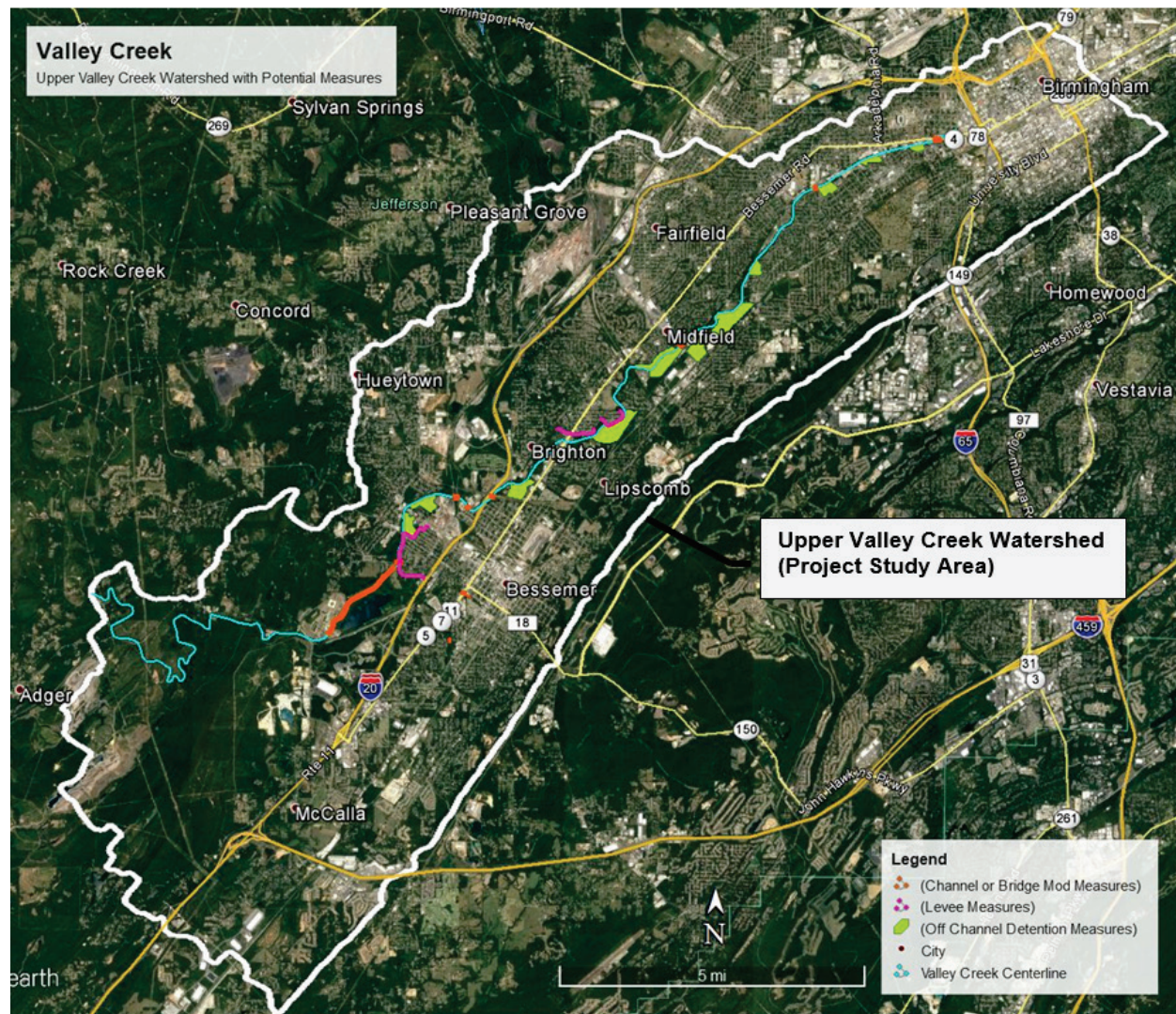


Figure 4-1. Location of Structural Measures within Study Area.

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. 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-foot bottom width was the best alternative for the channel modification template. Results between 120-foot and 140-foot templates were nearly identical, with the 140-foot template requiring additional earthwork. The 100-foot template was less effective at lowering upstream flood elevations than the 120-foot 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-foot and 140-foot 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, but only marginally complete. It was retained for further evaluation understanding it should be combined with another measure during alternative formulation to make it a complete 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
	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
	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

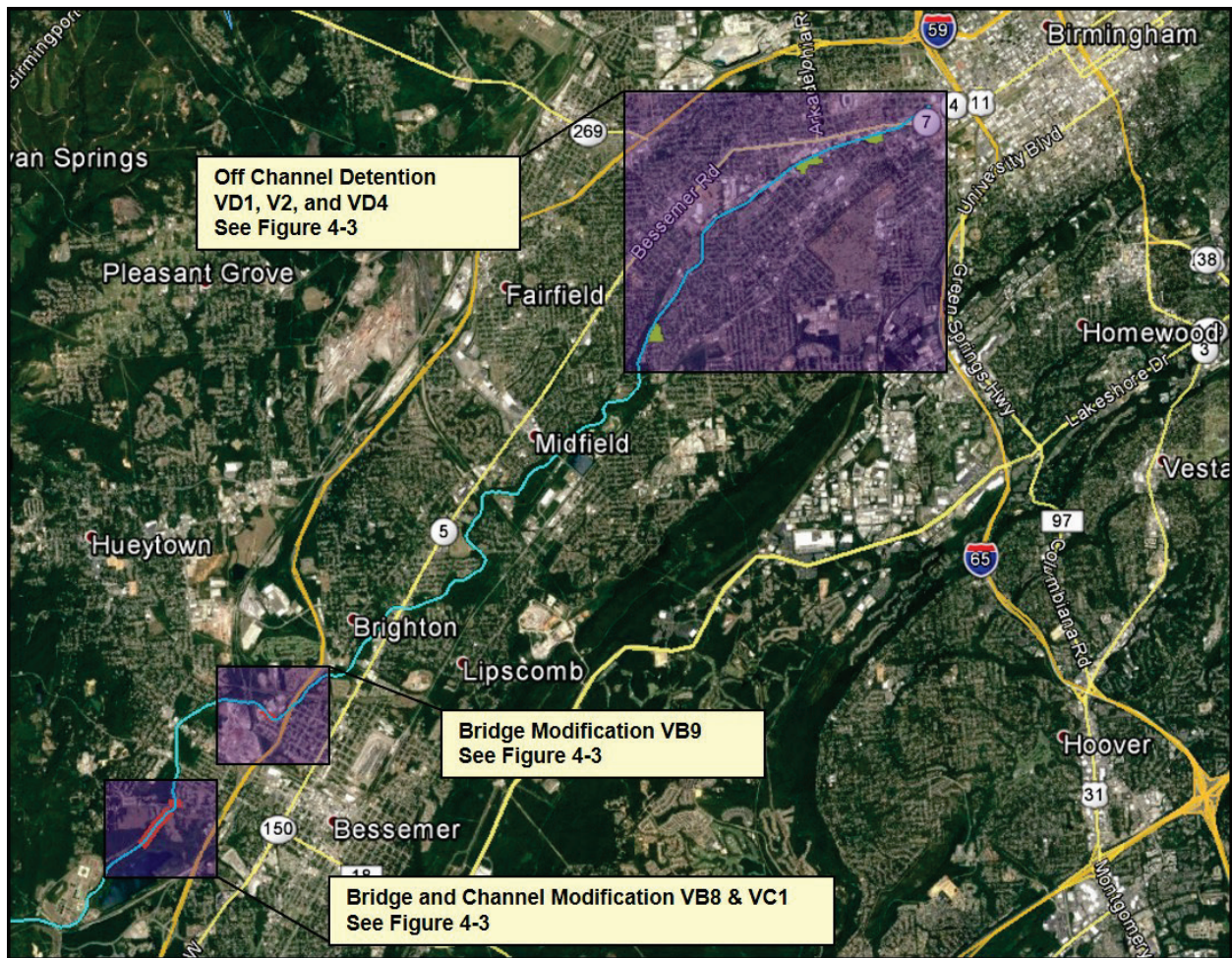


Figure 4-2. Vicinity Location of Final Structural Measures Carried into Alternative Development



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 the 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. 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 4-4).

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.
	VSER (VL3)	Neighborhood on right descending bank generally bound by Sugar Ray Dr, Blocton Ave, and Bessemer Super Highway
	VSER (VL4)	Neighborhood on left descending bank generally bound by 19 th Street N, I-59, and 11 th street N.
	VSER (0.50 AEP)	Frequently damaged structures by the 50% annual chance exceedance probability event along the corridor within the study area.
	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.
	VA (VL3)	Neighborhood on right descending bank generally bound by Sugar Ray Dr, Blocton Ave, and Bessemer Super Highway
	VA (VL4)	Neighborhood on left descending bank generally bound by 19 th Street N, I-59, and 11 th street N.
	VA (0.50 AEP)	Frequently damaged structures by the 50% annual chance exceedance probability event along the corridor within the study area.
	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 Area) Benefits	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 and given fair market value for their property and structure. 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 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. Acquisitions were carried forward for alternatives development.

- **Acquisition within the Levee Areas** –Plan formulation for the three levee areas (L2, L3, and L4 alternatives) were aggregated to the 0.01 AEP. Structures experiencing significant flood damage during model runs were selected for buyouts. Areas 3 and 4 featured several repetitive loss properties. Each levee area was evaluated as an independent measure. Levees, as a measure, were screened out earlier in the process. A measure featuring a buyout behind the levee areas of L2, L3, and L4 was analyzed in place of the levees, as buyouts were considered to have a greater effect on reducing residual risk. Efficiency analysis determined the cost of the measure outweighed the benefits and therefore was screened from further consideration.
- **Acquisition at FEMA Regulatory Floodway** –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.

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. Wet or 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.

The structures identified are frequently damaged structures have crawl spaces and are in fair to poor condition with most in poor condition. Physically altering the structure by relocating or flood proofing is not achievable. Some structures would not accept 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 and large number of homes businesses within the project area, dry

flood proofing 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. Corps 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 USGS 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.

Table 4-5 summarizes the results of the measures screening process. Nonstructural measures carried forward for alternatives development are summarized in Table 4-6.

Table 4-5. 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
	VSER (VL3)	Neighborhood on right descending bank generally bound by Sugar Ray Dr, Blocton Ave, and Bessemer Super Highway	Screened Out – infeasible
	VSER (VL4)	Neighborhood on left descending bank generally bound by 19 th Street N, I-59, and 11 th street N.	Screened Out – infeasible
	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
	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

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

Table 4-6. Valley Creek Nonstructural Measures Carried Forward to Alternative Development.

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.	Final measure
	VA (0.20 AEP)	Frequently damaged structures by the 20% annual chance exceedance probability event along the corridor within the study area.	Final measure

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. 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 a complete 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 complete plan. Nonstructural measures go through the same process of evaluation as structural measures, in that they are formulated to the NED Plan.

Considerations are also given to Environmental Quality, Regional Economic Development, and Other Social Effects. 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 measure. Again, this was to determine if net benefits could be improved by combining the two types of measures.

Table 4-7 summarizes the initial array of alternatives.

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. Re-establishment of vegetation with native trees and grasses would be required as a result of construction activities. 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 Alternative 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.

Table 4-7. 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 18 th 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.

4.6.1.3. 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 is selecting the structural plan with the highest mean net benefits Alternative 3 (D28) 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 is selection of the structural plan (Alternative 1) that produces nearly the same mean net benefits D28 but less costly is Alternative 1 (C1) as the primary action and then identifying residual risk structures 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 Alternative 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 and Guidelines (U.S. Water Resources Council 1983): 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 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).

A 35% contingency was applied to all alternatives and a sensitivity analysis was done to ensure the answer nor the justification changed if the contingencies were adjusted. The final report will be 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
	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
	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
	Clean inlet, outlet & basin of woody debris or trash every 2 years	\$5,000
	Repair minor erosion of berm every 5 years	\$5,000
	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	2,537	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.

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 P&G standard of acceptability. Such plans were considered, however, in an attempt to better understand the costs and benefits, even if such plans were purely hypothetical and would never be implemented.

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. This is considered the NED plan at approximately \$53 million total first cost but not implementable as it is 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				6,374		
STRUCTURAL ALTERNATIVES							
Alternative 1	Chan and Bridge Mod VC1, VB8	8,457	30	356	953	597	2.68
Alternative 2	Chan and Bridge Mod VC1, VB8, VB9	9,940	45	428	981	553	2.29
Alternative 3	Detention Basins VD1, VD2, VD4	50,070	45	1,976	2,582	606	1.31
Alternative 4	Detention Basins VD1, VD2	31,469	30	1,244	1,647	403	1.32
Alternative 5	Alt 1 + Alt 4	39,926	60	1,600	1,921	321	1.20
Alternative 6	Alt 2 + Alt 4	41,409	75	1,672	1,957	285	1.17
Alternative 7	Alt 1 + Alt 3	58,526	75	2,332	2,722	390	1.17
NON-STRUCTURAL ALTERNATIVES							
Alternative 8	Buyout FWOP 2YR Floodplain structures (~100)	53,685	0	2,071	2,772	701	1.34
Alternative 9	Buyout FWOP 5YR Floodplain structures (~300)	92,713	0	3,576	4,106	531	1.15
STRUCTURAL & NON-STRUCTURAL COMBINED							
Alternative 10	NSM: 2YR Floodplain Buyout + Alt 1 + VD1	73,833	45	2,893	3,494	602	1.21
Alternative 11	NSM: 2YR Floodplain Buyout + Alt 1 + Alt 4	93,610	60	3,670	3,830	160	1.04

Alternative 12	Alt 3 + (Residual Risk 2-yr floodplain buyout (~40))	70,761	45	2,774	2,960	186	1.07
Alternative 13	Alt 1 + (Residual Risk 2-yr floodplain buyout (~79))	52,635	30	2,060	3,244	1,184	1.57

The plan with the next highest annual mean net benefit is 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, any plans involving large-scale buyouts fail to meet the P&G standard of acceptability.

Three plans with the next highest annual mean net benefits are Alternatives 3, 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. However, Alternative 10 is unacceptable due to the large-scale buyouts and Alternative 1 is only marginally complete.

Alternative 1 is only marginally complete because it doesn’t fully address the planning objectives. The primary planning objective is to reduce the economic damages and reduce the risk for loss of life along the upper Valley Creek corridor. 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.

Alternative 3 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 3 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.

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, it is highly unlikely for an acquisition plan to be accepted by local residents and therefore alternatives that included acquisition were not considered acceptable. Therefore, any plans involving large-scale buyouts fail to meet the P&G standard of acceptability.

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	953	597	Marginally Complete	Acceptable
Alternative 2	Chan and Bridge Mod VC1, VB8, VB9	981	553	Marginally Complete	Acceptable
Alternative 3	Detention Basins VD1, VD2, VD4	2,582	606	Complete	Acceptable
Alternative 4	Detention Basins VD1, VD2	1,647	403	Complete	Acceptable
Alternative 5	Alt 1 + Alt 4	1,921	321	Complete	Acceptable
Alternative 6	Alt 2 + Alt 4	1,957	285	Complete	Acceptable
Alternative 7	Alt 1 + Alt 3	2,722	390	Complete	Acceptable
Alternative 8	Buyout FWOP 2YR Floodplain structures (~ 100)	2,772	701	Complete	Unacceptable
Alternative 9	Buyout FWOP 5YR Floodplain structures (~ 300)	4,106	531	Complete	Unacceptable
Alternative 10	NSM: 2YR Floodplain Buyout + Alt 1 + VD1	3,494	602	Complete	Unacceptable
Alternative 11	NSM: 2YR Floodplain Buyout + Alt 1 + Alt 4	3,830	160	Complete	Unacceptable
Alternative 12	Alt 3 + (Residual Risk 2-yr floodplain buyout (~ 40))	2,960	186	Complete	Unacceptable
Alternative 13	Alt 1 + (Residual Risk 2-yr floodplain buyout (~79))	3,244	1,184	Complete	Unacceptable

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	883	0	0	505	882	0	0
0.20 AEP	755	1,320	2,231	0	0	1,320	2,228	0	0
0.10 AEP	1,109	1,879	3,100	0	0	1,879	3,096	0	0
0.04 AEP	1,556	2,774	4,168	0	0	2,773	4,166	0	0
0.02 AEP	1,890	3,262	4,910	1	2	3,261	4,910	1	1
0.01 AEP	2,194	3,774	5,669	4	4	3,773	5,666	0	0
0.005 AEP	2,505	4,385	6,555	3	5	4,384	6,551	1	1
0.002 AEP	2,966	5,247	7,573	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. Final Array of Alternatives

Carrying forward selected alternatives from evaluation and comparison to the final array are listed in order of annual mean net benefits from highest to lowest. Alternative 13 is retained for illustrative purposes even though it fails to meet acceptability criteria. Alternative 1 is retained even though its completeness is marginal.

Table 5-6. Final Array of Alternatives

Alternative	Description	Annual Mean Net Benefit
Alternative 13	Channel and Bridge Modification plus Residual Risk 2-yr floodplain buyout (~79 structures)	1,184
Alternative 3	Detention Basins VD1, VD2, VD4	606
Alternative 1	Channel and Bridge Modification VC1, VB8	597
Alternative 7	Channel and Bridge Modification plus Detention Basins VD1, VD2, VD4	390

A comparison of the alternatives was conducted based on the range of cost contingencies. Adjusting the cost while holding the annual mean benefits constant can indicate how sensitive the ranking of alternatives is to the costs with the rankings based on annual mean net benefits. Table 5-7 shows each alternative with annual mean net benefit with the corresponding cost contingency. Alternative 3 has the second highest net benefits. Increasing the net benefits of Alternative 3 by decreasing the cost contingency to 25 percent; and comparing against a decrease in net benefits of Alternative 13 (NED) by increasing the cost contingency to 45 percent demonstrates the likelihood of the NED changing to an alternative other than Alternative 13 is unlikely.

The highest performing alternatives of interest by the local sponsors are Alternatives 1, 3, and 7. A contingency of 25 percent applied to Alternatives 1, 3, and 7 did not increase the benefits enough to change the NED plan. A contingency of 45 percent applied to the same alternatives demonstrate positive annual mean net benefits and benefit cost ratio of greater than 1.0. At a 45 percent contingency, Alternative 7 is barely above unity but it is unlikely the contingency will be as high as 45 percent on this alternative. Regardless of the contingency applied, between 25 percent and 45 percent, the NED is still Alternative 13.

Table 5-7. Cost Contingency Sensitivity Analysis Results.

Alternative	Annual Mean Net Benefits	Mean BCR	Annual Mean Net Benefits	Mean BCR	Annual Mean Net Benefits	Mean BCR
	25% Cost Contingency		35% Cost Contingency		45% Cost Contingency	
Alternative 1	621	2.87	597	2.68	573	2.51
Alternative 2	581	2.45	553	2.29	525	2.15
Alternative 3	741	1.40	606	1.31	470	1.22
Alternative 4	488	1.42	403	1.32	318	1.24
Alternative 5	430	1.29	321	1.20	211	1.12
Alternative 6	399	1.26	285	1.17	172	1.10
Alternative 7	550	1.25	390	1.17	230	1.09
Alternative 8	897	1.37	804	1.32	712	1.27
Alternative 9	669	1.19	531	1.15	392	1.11
Alternative 10	718	1.26	602	1.21	485	1.16
Alternative 11	330	1.09	159	1.04	(12)	1.00
Alternative 12	345	1.13	186	1.07	26	1.01
Alternative 13	1,258	1.63	1,184	1.57	1,109	1.52

Each of the Alternatives 1, 3, and 7 as well as the NED plan (Alternative 13) underwent a sensitivity analysis comparing the probability the benefits would be exceeded at the 25%, 50%, and 75% intervals for the range of contingencies. Tables 5-8 through 5-11 summarize the results. Alternative 1 has a range of mean net benefits from 292 to 815 with corresponding BCRs of 1.77 to 3.45. On the low side of the

spectrum, it is expected 75% of the time the project would see 292 mean net benefits with 45% contingency applied to the construction cost. On the high side of the spectrum, it is expected 25% of the time the project would see 815 mean net benefits with 25% contingency applied to the construction cost.

Table 5-8. Alternative 1 Sensitivity Analysis.

Alternative	Mean Net Benefits	Probability Benefits Exceedance Indicated Values			Mean BCR	Probability Benefits Exceedance Indicated Values		
		0.75	0.50	0.25		0.75	0.50	0.25
Alt 1 w/ 25% cost contingency	621	340	514	815	2.87	2.02	2.55	3.45
Alt 1 w/ 35% cost contingency	597	316	490	791	2.68	1.89	2.38	3.22
Alt 1 w/ 45% cost contingency	573	292	466	797	2.51	1.77	2.22	3.02

Alternative 3 has a range of mean net benefits from 50 to 1,157 with corresponding BCRs of 1.02 to 1.63. On the low side of the spectrum, it is expected 75% of the time the project would see 50 mean net benefits with 45% contingency applied to the construction cost. On the high side of the spectrum, it is expected 25% of the time the project would see 1,157 mean net benefits with 25% contingency applied to the construction cost.

Table 5-9. Alternative 3 Sensitivity Analysis.

Alternative	Mean Net Benefits	Probability Benefits Exceedance Indicated Values			Mean BCR	Probability Benefits Exceedance Indicated Values		
		0.75	0.50	0.25		0.75	0.50	0.25
Alt 3 w/ 25% cost contingency	741	322	678	1,157	1.40	1.17	1.37	1.63
Alt 3 w/ 35% cost contingency	606	186	542	1,021	1.31	1.09	1.27	1.52
Alt 3 w/ 45% cost contingency	470	50	406	885	1.22	1.02	1.19	1.42

Alternative 7 has a range of mean net benefits from negative 257 to 1,024 with corresponding BCRs of 0.90 to 1.47. On the low side of the spectrum, it is expected 75% of the time the project would see a negative mean net benefits with 45% contingency applied to the construction cost. On the high side of the spectrum, it is expected 25% of the time the project would see 1,024 mean net benefits with 25% contingency applied to the construction cost.

Table 5-10. Alternative 7 Sensitivity Analysis.

Alternative	Mean Net Benefits	Probability Benefits Exceedance Indicated Values			Mean BCR	Probability Benefits Exceedance Indicated Values		
		0.75	0.50	0.25		0.75	0.50	0.25
Alt 7 w/ 25% cost contingency	550	63	478	1,024	1.25	1.03	1.22	1.47
Alt 7 w/ 35% cost contingency	390	(97)	318	865	1.17	0.96	1.14	1.37
Alt 7 w/ 45% cost contingency	230	(257)	158	705	1.09	0.90	1.06	1.28

Alternative 13 has a range of mean net benefits from negative 446 to 1,796 with corresponding BCRs of 1.22 to 1.90. On the low side of the spectrum, it is expected 75% of the time the project would see a 446 net benefits with 45% contingency applied to the construction cost. On the high side of the spectrum, it is expected 25% of the time the project would see 1,796 mean net benefits with 25% contingency applied to the construction cost.

Table 5-11. Alternative 13 Sensitivity Analysis.

Alternative	Mean Net Benefits	Probability Benefits Exceedance Indicated Values			Mean BCR	Probability Benefits Exceedance Indicated Values		
		0.75	0.50	0.25		0.75	0.50	0.25
Alt 13 w/ 25% cost contingency	1,258	615	1,147	1,796	1.63	1.31	1.58	1.90
Alt 13 w/ 35% cost contingency	1,184	540	1,072	1,721	1.57	1.26	1.52	1.84
Alt 13 w/ 45% cost contingency	1,109	446	997	1,647	1.52	1.22	1.47	1.77

5.2. Four Principles and Guidelines Accounts

The U.S. Water Resources Council Principles 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 13 is the NED alternative, which is the alternative that reasonably maximizes annual mean net benefits. This alternative has a total first cost of \$52.6 million and mean net benefits totaling \$1.19 million. Alternative 13 is a combination alternative, entailing both structural and nonstructural

actions. The structural action involves channel and bridge modifications. The nonstructural action involves the acquisition of 79 structures that incur any flood inundation damages after the implementation of the alternative's structural action.

Regional Economic Development: The project recreational features and amenities could provide regional economic development (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 within or in proximity to the Birmingham CrossPlex, which would support jobs and income and tax revenues in the region. As the Jones Valley Corridor trails are developed in the future, more connectivity of the trails would lead to higher levels of visitation and increases in the regional economic benefits over time.

Environmental Quality (EQ) 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 7 has the largest impact to habitat impacting 12.4 AAHUs (9.6 AAHUs of deciduous forest and 2.8 AAHUs of forested wetland). Alternative 3 impacts 7.1 AAHUs (4.3 AAHUs of deciduous forest and 2.8 AAHUs of forested wetland). Alternatives 1 and 13 impact 5.3 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: The project recreational features and amenities provide other social effects (OSE) for neighborhoods and residents, providing low or no-cost recreational opportunities to local residents, while making communities more attractive places to live. Recreational trail and amenities built within the three 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).

The risk to loss of life compared to the no action is similar. Analysis indicates the most frequent flood events (0.05 AEP through 0.04 AEP) with minimal or ample warning time has a median life loss risk of zero with slight increase at larger events. Implementation does not significantly increase or decrease the risk to loss of life.

5.3. Tentatively Selected Plan

Alternative 13 is considered the NED plan, however, the non-federal sponsors have expressed concern over difficulty with implementing large acquisition plans; would be devastating to their respective communities, and as such is considered an unacceptable plan. The sponsors have experience with

implementing acquisition plans, most notably on an adjacent watershed (Village Creek) through Public 99-662 Section 401. Volunteer acquisition programs are available through the local sponsors but use is minimal. It is highly unlikely for an acquisition plan to be socially acceptable by local communities as strategic acquisition of frequently damaged structures would disrupt neighborhood cohesion and connectivity with other communities along Valley Creek.

An acquisition approach is contrary to what the communities are trying to achieve as evidenced by the Freshwater Land Trust and Jefferson County partnering to develop trails, greenways, rail trails, and other pathways in the greater Birmingham area and in Jefferson County in attempt to bring connectivity back to the communities.

Local sponsors have expressed their desire to invest in Alternative 3. Alternative 3 provides the next highest mean annual benefits in flood risk reduction and provides those benefits throughout the corridor resulting in complete, effective, efficient, and acceptable plan. Alternative 3 meets all four planning criteria and meets the planning objectives. Alternative 3 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. Tentatively Selected Plan plus Recreation

A recreation evaluation was performed on the locally preferred 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 Recreation Appendix.

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 are summarized in Table 5-12.

Table 5-12. 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
Detention Basin 4				
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	39,300	\$225,000
Benefits with Recreation Trails and Amenities (Moderate Estimate)	22	\$5.69	144,000	\$819,000

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 western-most detention basin (VD4) falls within this priority trail segment.

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 \$2.5 million for all three 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 5-13 provides an overview of recreation trail and feature costs by detention basin including the construction costs (including signage and benches), interest during construction, and the total annual cost.

Table 5-13. Recreation Facilities Cost Estimate by Area.

Cost	Detention Basin 1	Detention Basin 2	Detention Basin 4	Total
Construction, Signage, Benches Cost*	\$65,000	\$84,000	\$75,000	\$224,000
IDC (1 yr, 2.75%)	\$1,800	\$2,300	\$2,100	\$6,200
Investment Cost	\$66,800	\$86,300	\$77,100	\$230,200
Annualized Investment Cost (50 years, 2.75%)	\$2,500	\$3,200	\$2,900	\$8,500
Annual OMRR&R**	\$1,000	\$1,000	\$1,000	\$3,000
Total Annual Cost	\$3,500	\$4,200	\$3,900	\$11,500

Table 5-14 provides an overview of the benefit cost ratio by detention basin and in total across all three detention areas. All of the benefit-cost ratios are well over 1, with the lower benefit estimates showing a benefit-cost estimate between 18 and 21, and the higher benefit estimates showing a benefit-cost ratio between 65 and 78.

Table 5-14. Benefit-Cost Comparison

Benefit/Cost	Detention Basin 1	Detention Basin 2	Detention Basin 4	Total
Total Annual Recreation Cost	\$3,500	\$4,200	\$3,900	\$11,500
Annual Recreation Benefits (Low)	\$75,000	\$75,000	\$75,000	\$225,000
Annual Recreation Benefits (High)	\$273,000	\$273,000	\$273,000	\$819,000
Benefit-Cost Ratio (Low)	21	18	19	20
Benefit-Cost Ratio (High)	78	65	70	71

5.3.2. Tentatively Selected Plan and Compatibility

Alternative 3 is also compatible with other flood risk reduction 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 measures in the future and would only complement Alternative 3. 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.

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 future with project 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. 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 7 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 hydrology and hydraulics analysis and its results can be found in Appendix A. The channel and bridge modifications included in Alternatives 1, 7, and 13 also reduces water surface elevations; however, those benefits are more localized as the benefits of the channel modification do not extend further upstream than the 19th 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. Very few 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.

6.2.2. Final Array Alternatives

Climate was assessed for this NEPA evaluation in two ways: 1) would the proposed action contribute emissions that would have the potential to contribute to climate change and 2) how might projected climate change in the study area influence the impacts to resources described in this chapter. None of the final array alternatives would introduce a permanent source of emissions to the study area; therefore, no effect to climate is anticipated from any of the final array alternatives.

The most likely possibility of climate change having an influence on the effects of final array alternatives would be for the hydrology resource. This was evaluated as part of a climate change assessment and is documented in Appendix A. The detention basins were optimized to reduce floods of magnitude less than 0.01 AEP (specifically, 0.04 AEP). Changes 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 would still produce benefits across the range of analyzed frequencies; 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.

Additionally, due to increased volume, pond berms could overtop more frequently than the expected AEPs. Additionally, berm-influenced backflows could occur more frequently. This could result in additional incremental risk associated with the alternatives, as impacts were shown to increase as the magnitude of analyzed events increased. However, it is considered highly unlikely that these increases to frequency would be realized based on the results of the 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 slight downward trend in peak streamflow in the local area over the last several decades.

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 that include detention basins have a relatively small potential to impact geology if excavation were to go deeper than bedrock. This would be unlikely, because excavating through bedrock would become cost prohibitive. Therefore, there is a greater potential that no effects to geology would be experienced under any alternative. Channel and bridge modification is likewise 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 7 result in the excavation and disposal of soils. Likewise, the channel and bridge modification included in Alternatives 1, 7, and 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 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 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 has been completed (Appendix G). Following the public review period on the draft report, USACE will apply for a CWA Section 401 Water Quality Certification from the ADEM. Prior to construction, a National Pollutant Discharge Elimination System (NPDES) stormwater permit would be obtained. All construction activities would incorporate BMPs to minimize and contain runoff.

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

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 will be performed to confirm the presence of forested wetland at VD4 as part of refinement of the TSP and prior to completion of the final report. Should the presence of forested wetland be confirmed, a wetland delineation will be completed. The updated information will be used to refine acreage impacts and required compensatory mitigation. A final compensatory mitigation plan including necessary monitoring and adaptive management will be included in the final report. 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 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). 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.

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 6-1. Mitigation for tree clearance was assumed to be achieved through tree plantings elsewhere in the study area. The compensatory mitigation plan to include the location and manner of tree plantings, as well as monitoring and adaptive management requirements will be documented in the final report. 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. Channel modification would also result in similar impacts to bottomland forest and was evaluated in habitat modeling (Table 6-1). Bridge modifications would result in negligible disturbance to terrestrial habitats.

Table 6-1. Summary of Habitat Evaluation and Mitigation.

Alternative	Description	AAHUs Impacted (Deciduous Forest/Forested Wetland)	Mitigation (Acres of Tree Plantings)
Alternative 1	Channel and Bridge Modification (VC1, VB8)	5.3/0.0	13.5
Alternative 3 (TSP)	Detention Basins (VD1, VD2, VD4)	4.3/2.8	18.5
Alternative 7	VC1, VB8, VD1, VD2, VD4	9.6/2.8	32.0
Alternative 13	VC1, VB8, Residual Risk 2-yr floodplain buyout (~79)	5.3/0.0	13.5

6.7. Fish and Wildlife

6.7.1. No Action Alternative

No impacts to fish and wildlife would occur under the No Action alternative.

6.7.2. Final Array Alternatives

Wildlife would experience a loss of habitat as a result of alternatives that include 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.

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.

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 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. Other facilities located in proximity to VD1 present no or low risks of contamination. Known risks associated with VD2 are considered low as well. No HTRW issues or contamination risks were identified for VD4. The only potential issue for the channel modification 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 Alternative 3 (Table 6-2). 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.

Table 6-2. Summary of LifeSim Results of Alternative 3.

Scenario	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	99	156	276	0	0	156	275	0	0
0.20 AEP	428	729	1243	0	0	729	1241	0	0
0.10 AEP	778	1346	2271	0	0	1346	2268	0	0
0.04 AEP	1272	2085	3449	0	0	2085	3445	0	0
0.02 AEP	1650	2912	4384	0	0	2912	4384	0	0
0.01 AEP	1998	3520	5187	3	4	3519	5185	0	0
0.005 AEP	2362	4360	6110	6	8	4359	6108	1	1
0.002 AEP	2856	5051	7297	17	23	5050	7294	3	4

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

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 was performed to determine the number of structures that would be removed from the 0.04 AEP floodplain (Table 6-3). Area used to implement flood risk management alternatives would not be developed in the future to maintain forecasted benefits.

Table 6-3. Detention Basin Performance Details.

Measure	Total Cost (millions)	Structures Removed (0.04 AEP floodplain)	Value Removed (0.04 AEP floodplain)	Value-to-Cost Ratio
VD1	\$11.70	339	14.46	1.24
VD2	\$19.80	378	15.10	0.76
VD4	\$18.50	303	12.83	0.69

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.

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 that include detention basins or the channel and bridge modification would convert undeveloped or recent buyout areas to stormwater management features. The areas comprising VD1, VD2, and VD4, the three detention areas included in the TSP, are already predominantly zoned for open space/passive recreation, which would be consistent with stormwater detention areas. Alternatives that include acquisition 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

No impacts to transportation would occur under the No Action alternative. Continued flooding within the study area 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

USACE has prepared a Programmatic Agreement to fulfill its Section 106 compliance responsibilities at this stage of project planning. 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.

6.17.2. Final Array Alternatives

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) 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 reduction project purposes.

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

Aesthetics in the detention basin areas 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 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 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 reasonably foreseeable future actions. 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 impacts to a resource, by definition there is no cumulative impact and that resource should not be 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 reasonably foreseeable future actions 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. 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 reasonably foreseeable future actions (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 6-4 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 6-4. 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) Channel widening Freshwater Land Trust land management	Freshwater Land Trust land management Local floodplain ordinances	Freshwater Land Trust land management Local floodplain ordinances
Wetlands	Study Area	Urban development (industrial, commercial, and residential) Channel widening Freshwater Land Trust land management	Freshwater Land Trust land management Local floodplain ordinances	Freshwater Land Trust land management Local floodplain ordinances
Terrestrial Habitat	Study Area	Urban development (industrial, commercial, and residential) Channel widening Freshwater Land Trust land management	Freshwater Land Trust land management Local floodplain ordinances	Freshwater Land Trust land management Local floodplain ordinances
Fish and Wildlife	Study Area	Urban development (industrial, commercial, and residential) Channel widening Corrective actions for past contamination Freshwater Land Trust land management	Freshwater Land Trust land management Local floodplain ordinances	Freshwater Land Trust land management 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 6-5 summarizes the status of environmental compliance for the TSP to date.

Table 6-5. 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.	On-going
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.	On-going
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.	On-going
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.	On-going
National Historic Preservation Act of 1966, as amended, 16 U.S.C. 470a, et seq.	On-going
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
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 statute

Noncompliance – Violation of a requirement of the statute

7.0. Tentatively Selected Plan

Alternative 3 is the tentatively selected plan (TSP), which is a locally preferred plan (LPP). The plan consists of three overbank (off-channel) detention basins (VD1, VD2, and VD4). The plan meets all four of the planning criteria of effectiveness, efficiency, completeness, and acceptability. It is effective as it produces \$2.6 million of benefits. It is efficient as it produces \$606 thousand in annual net benefits. It is a complete plan as it produces benefits throughout the upper Valley Creek watershed. It is an acceptable plan as it compatible with local planning objectives. This plan meets the primary objective and to the extent practical the secondary objective. Alternative 3 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 three detention basins.



Figure 7-1. Location of the Three Detention Basins

7.1. Plan Components

The plan components include three 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 10.0 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 13.6 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. VD4 comprises 16.4 acres on left overbank at Lincoln Ave. Figures 7-6 and 7-7 display a general grading plan and associated profile and section, respectively.

Table 7-1 summarizes detention basin details for the recommended 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	200
VD2	19.0	184	534.5	550.5	544.0	200
VD4	16.0	230	508.0	527.0	516.0	200

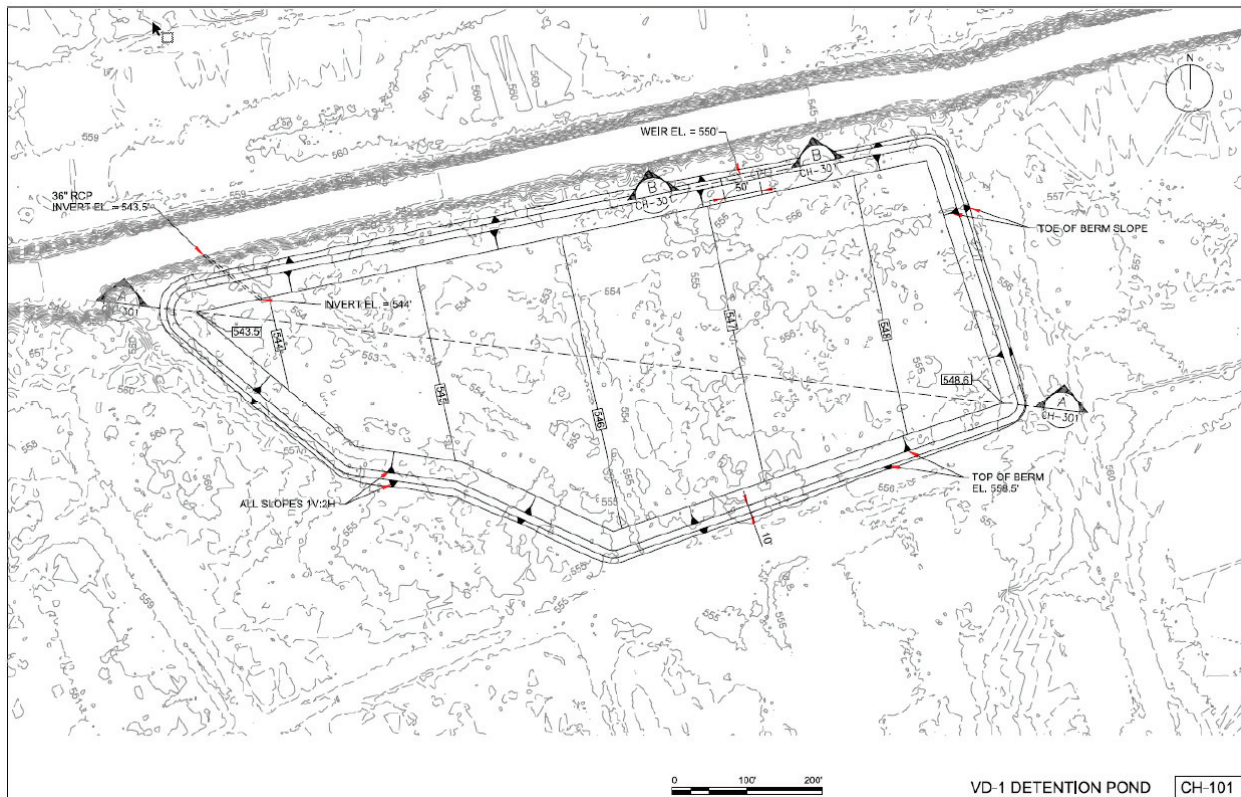


Figure 7-2. Conceptual plan of Overbank Detention Basin VD1.

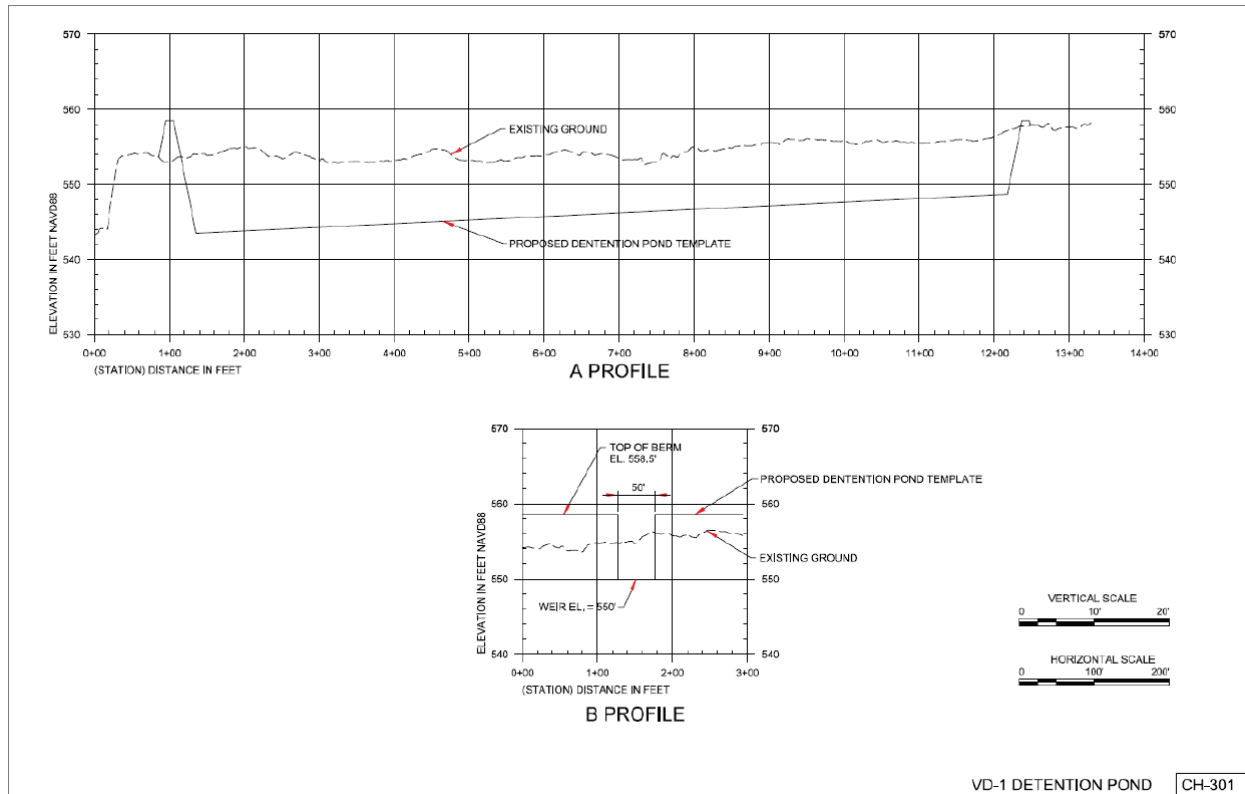


Figure 7-3. Conceptual Profile and Section Detail of Basin and Lateral Inflow Weir at VD1.

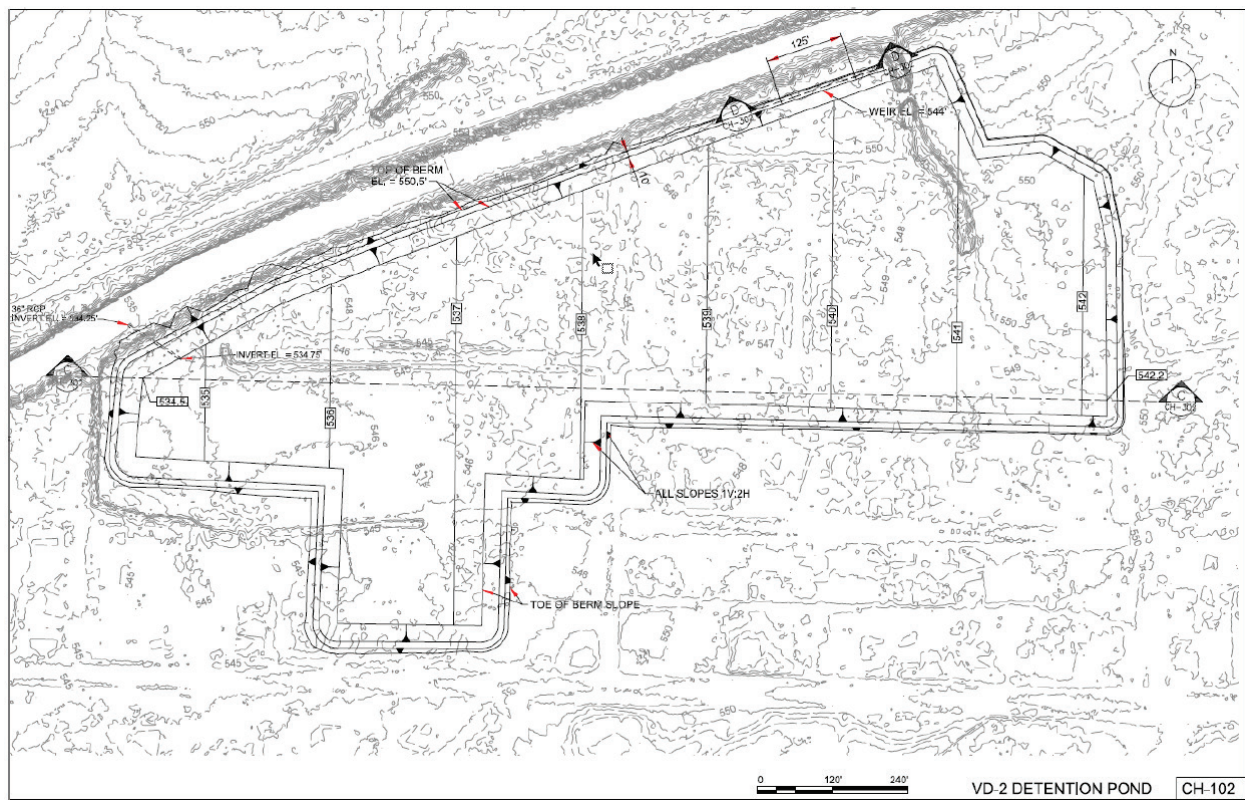


Figure 7-4. Conceptual plan of Overbank Detention Basin VD2.

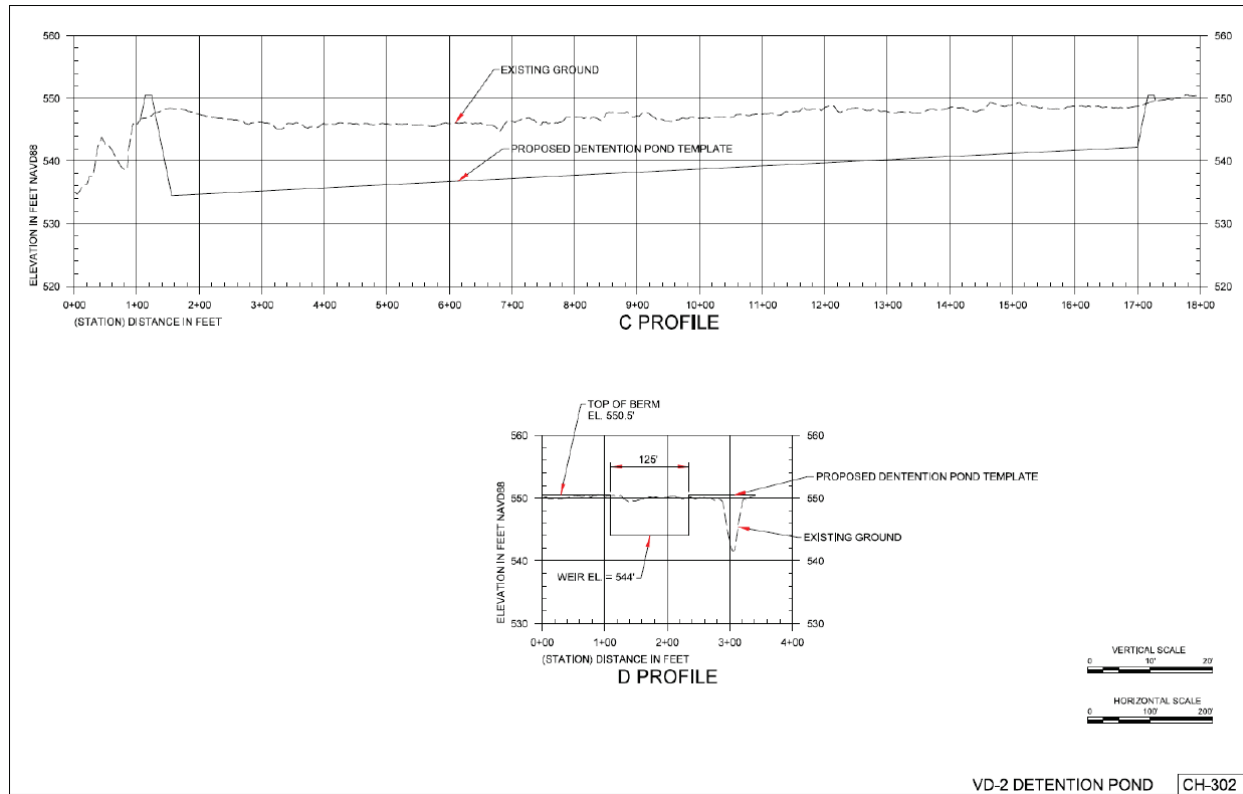


Figure 7-5. Conceptual Profile and Section Detail of Basin and Lateral Inflow Weir at VD2.

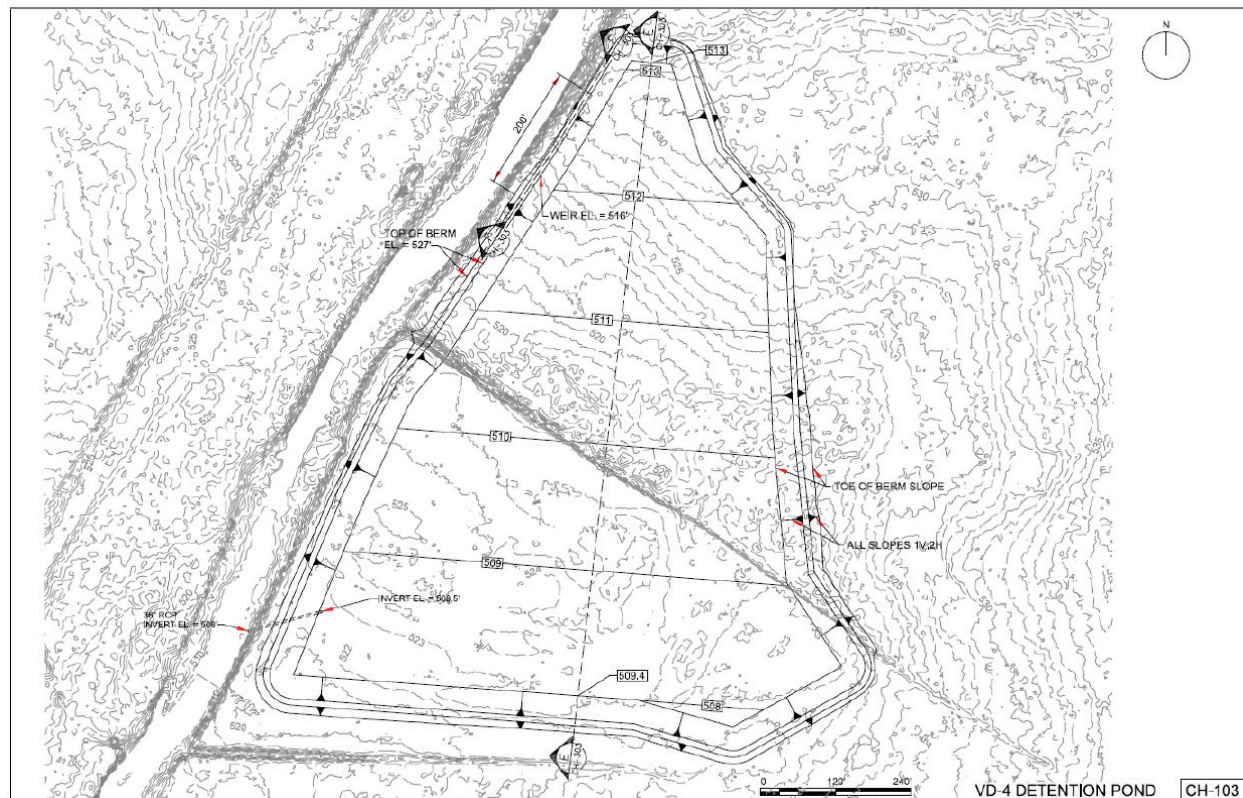


Figure 7-6. Conceptual plan of Overbank Detention Basin VD4.

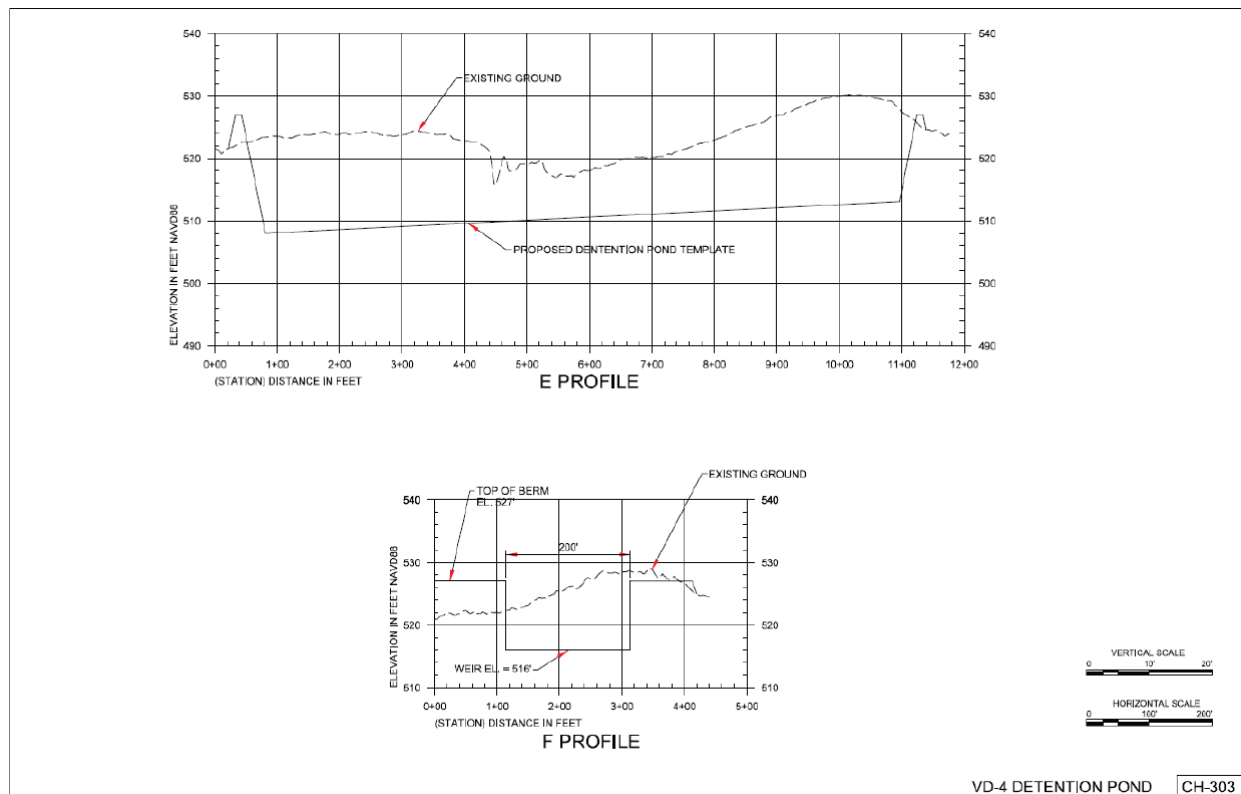


Figure 7-7. Conceptual Profile and Section Detail of Basin and Lateral Inflow Weir at VD4.

7.1.1. Detention Basins and Containment Berms

The basins will be excavated, and soil hauled to the containment berm locations for placement and compaction or hauled to the designated disposal location. 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.

It is anticipated all excavation can be achieved prior to encountering bedrock. It is assumed there is sufficient quantity of suitable material for building the containment berm on site based on the overwhelming volume of material excavated compared to the volume of material required for the containment berm. Additional geotechnical exploration and testing should confirm these assumptions.

The containment berm essentially follows the perimeter of the basin and ranges in height 2-feet to 6-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 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. With these side slopes, the sites will need armoring for erosion protection on both channel and detention sides of their embankments. Armoring is based on the surface area of the embankments (or berms) for each and listed under “Armor Area” of Table 7-3. “Detention Basin and Containment Berm Armoring Summary.” The armoring suggested is of the articulated concrete block (ACB) or articulated concrete mat (ACM) type. Some manufacturers include FLexamat® (Ohio), Waskey (Louisiana), and Contech® (national with plant locations in Alabama). Though the berms will be armored, some grass will grow in the interstitial of the ACB/ACM. 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 (yd³)	Total Fill (yd³)
VD1	99,000	6200
VD2	227,000	7400
VD4	268,000	11,200

Table 7-3. Detention Basin and Containment Berm Armoring Summary.

Detention Basin	Armor Area (ft²)	Class V Toe (yd³)	Class II Choke Stone (yd³)	Toe Filter (yd³)	Spillway Length (feet)
VD1	119,000	297	75	75	200
VD2	198,000	297	75	75	200
VD4	193,000	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. For simplification in modeling, only reinforced concrete pipe (RCP) culverts have been utilized and serve as the basis for the estimate; however, other types could certainly be employed if needed based on site constraints. 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
VD4		RCP – 36 inch	240	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 New Georgia Landfill. Opportunities should be explored during PED to reuse chipped material. 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
VD4	15.9	4.0	11.9

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 as well as one radio tower. 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 TSP has been estimated at approximately 48.07 +/- acres within 163 parcels and rights-of-way. Placement areas for excavated materials have not been identified and current assumption is the transportation of material to a commercial disposal site. Two potential sites have been identified, the New Georgia Landfill or Vulcan Materials. One or both sites will need further coordination in the next phase of the feasibility study.

Furthermore, at this time no other easements required for access and temporary staging have been identified. A rough order of magnitude cost estimate was developed. It estimates fee simple land acquisition with administrative costs of \$2,896,100, estimated relocation assistance of \$62,000, a contingency of \$713,400, relocations of \$200,000 specifically for the radio tower. A total estimated lands and damages cost for the TSP rounded to \$4,000,000. Appendix C, Real Estate Plan, contains further details.

7.4. Operations and Maintenance

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).

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
	Clean inlet, outlet & basin of woody debris or trash every 2 years	\$5,000
	Minor repairs to ACB/ACM & minor berm erosion every 5 years	\$5,000
	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 2019 (FY20) is \$45,065,000. The fully funded total project cost is \$49,902,000, which is the estimated cost at the current price level escalated to the third quarter 2023 (FY23). 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.

CWBS	Project Cost Component	Brief Definition		For PPA
			Project First Cost	Total Project Cost
			Effective Price Level 01 Oct 2019	Fully Funded Estimate
01,02	Lands, Easements, Right of Way, Relocations, and Dredged material Disposal Areas (LERRD)	Estimated value/costs of LERRD for the project (to include breakout of related Federal administrative costs)	\$5,664,000	\$6,162,000
06	Fish & Wildlife Facilities	Physical Construction	\$44,000	\$49,000
14	Recreation Facilities	Physical Construction	\$224,000	\$248,000
15	Floodway Control & Diversion Structures	Physical Construction	\$34,556,000	\$38,360,000
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 project.	\$3,662,000	\$4,040,000
31	Construction Management	Estimated costs for construction management	\$915,000	\$1,044,000
	Inflation through midpoint of construction	Estimate of inflation using Civil Works Construction Cost Index System (CWCCIS) factors applied to the Total Project Cost	NA	\$4,837
	Project Cost Totals		\$45,065,000	\$49,902,000

7.5.2 Recreation Cost

The federal share of the recreation cost is estimated to be 50 percent of \$248,000 or \$124,000. The total construction cost of the TSP is estimated to be \$49.9 million, of which 65 percent or \$32.4 million is estimated to be the federal portion of the costs. The Federal cost share of \$124,000 for the recreation facilities would account for less than 0.4 percent of the Federal cost share of the fully funded cost.

7.6. Risk and Uncertainty

Initially, a baseline design contingency of 35 percent was added 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 a risk to 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. Following the CSRA, a contingency of 21.5 percent was derived and implemented in the cost estimate.

7.7. Plan Benefits

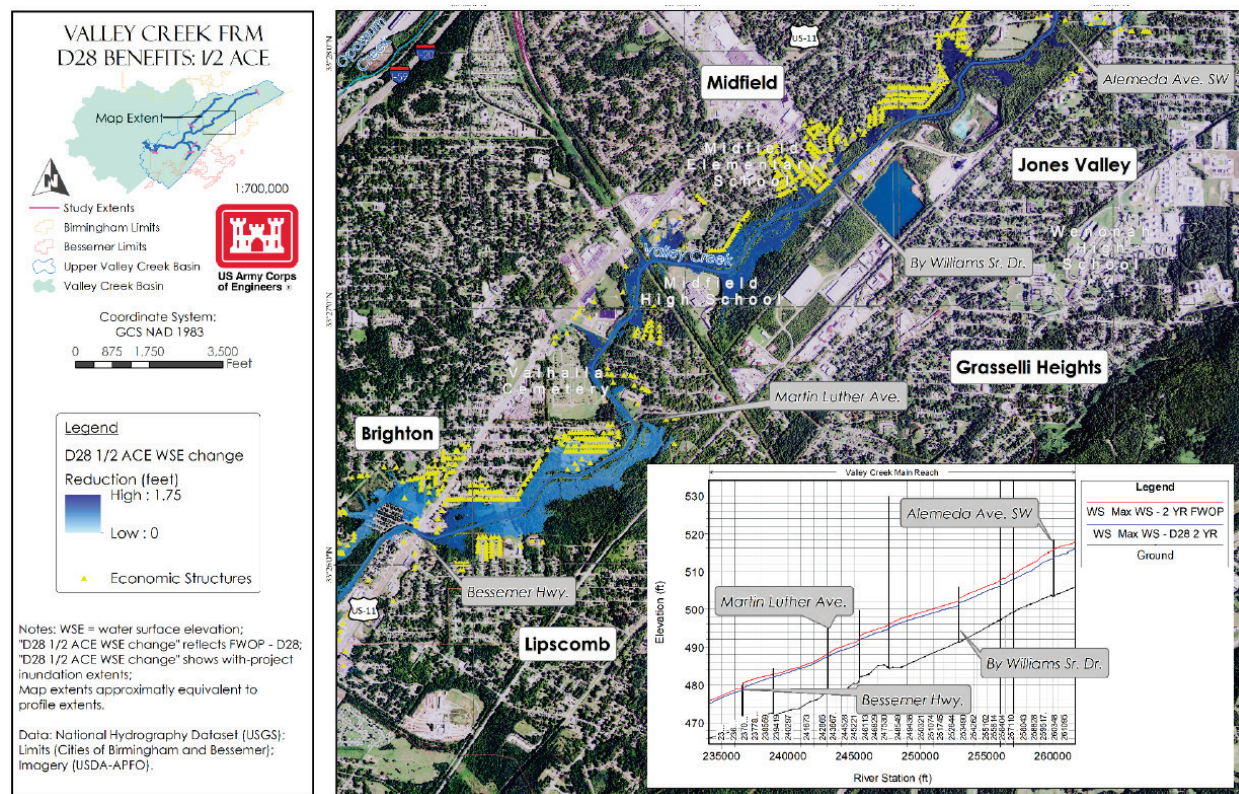
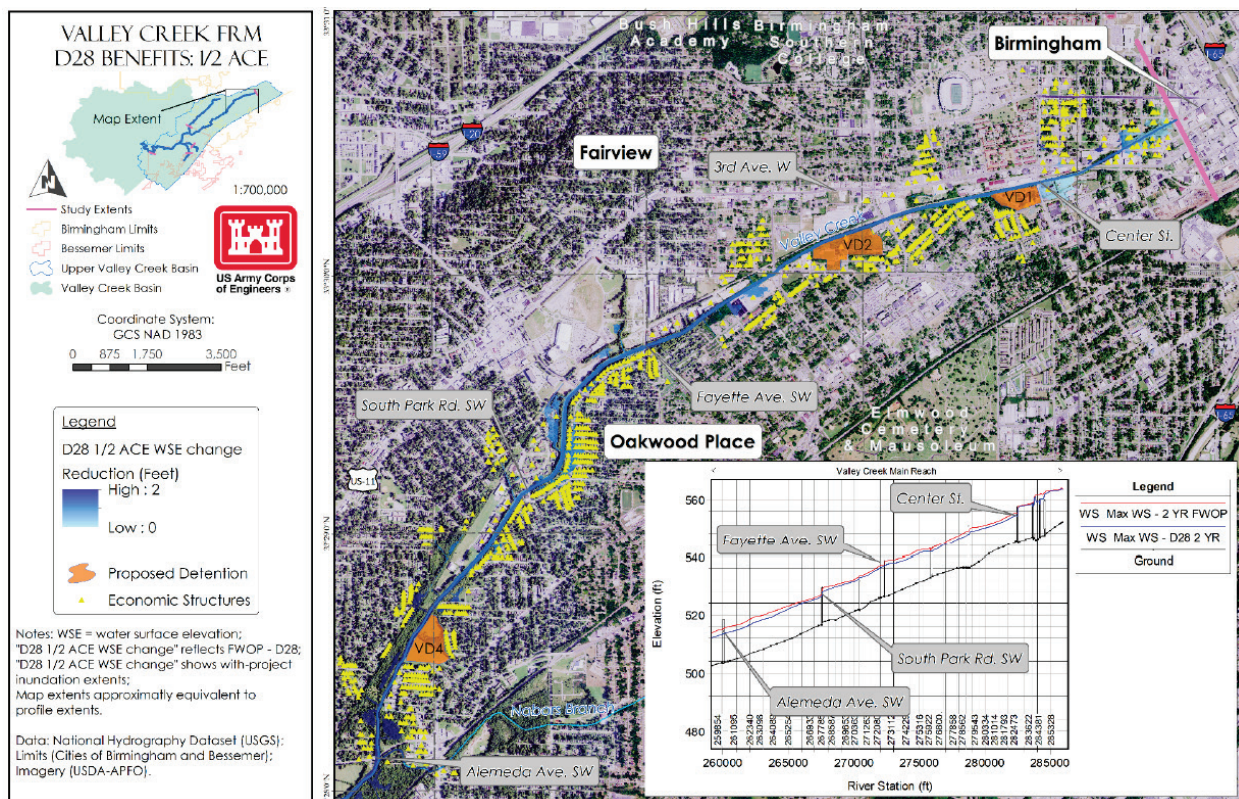
The expected annual damages to the study area in the future without project condition is estimated at \$6,374,000. The expected annual damages to the study area with Alternative 3 implemented is estimated at \$3,792,000 producing an annual benefit of approximately \$2,582,000. This is approximately a 32 percent reduction in damages. The mean annual cost is approximately \$1,671,000. This is based on the project first cost of \$45,065,000 annualized over a 50-year period of analysis, at an interest rate of 2.75 percent. The annual mean net benefit of Alternative 3 is approximately \$911,000 and a resulting BCR of 1.5. Figures 7-8 through 7-10, demonstrate performance of the system. Though the figures show performance of the 0.5 AEP, the project provides similar reductions in profiles for a wide range of events.

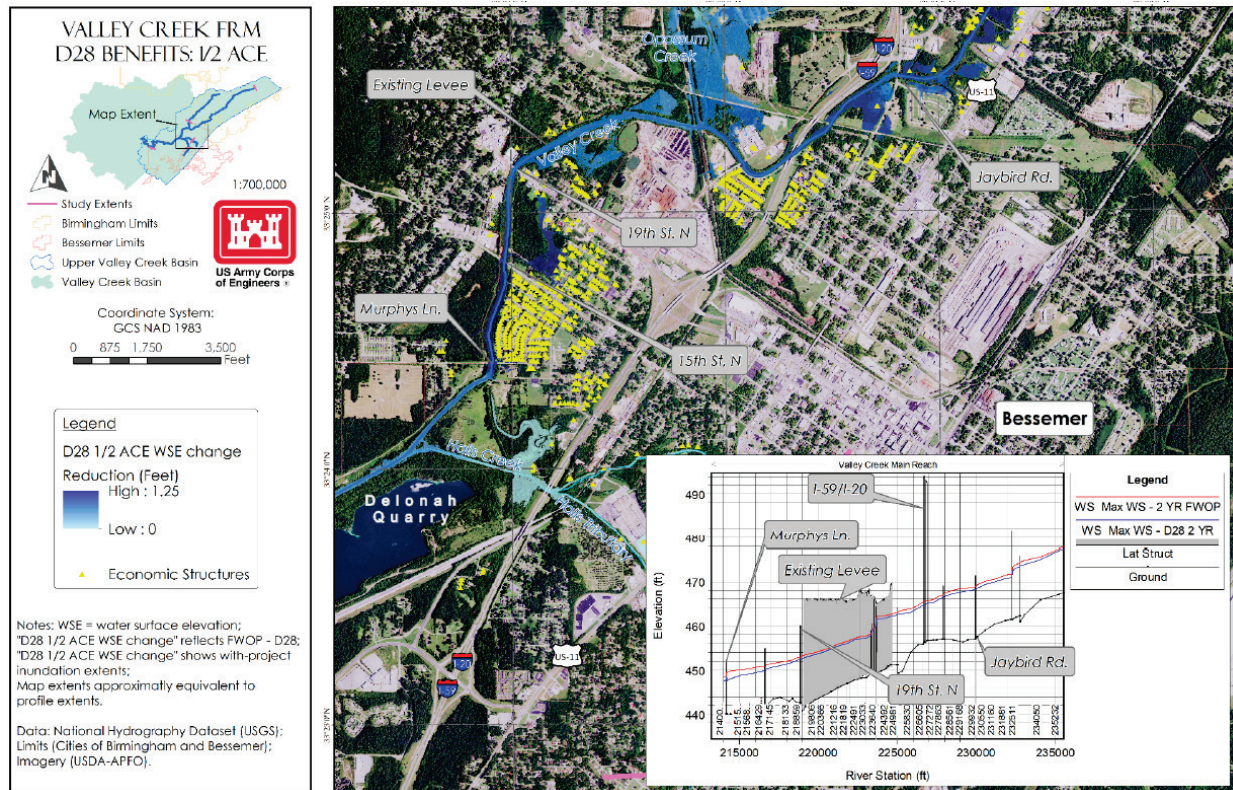
The recreation evaluation involves an analysis of the National Economic Development (NED) benefits from recreation opportunities created from the proposed recreation facilities. Benefits are compared to costs to inform decision-makers on the feasibility of the recreation facilities.

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.

Table 7-8. Benefits Summary.

Total Project First Cost	\$45,065,000
Annual Benefits	\$2,582,000
Annual Costs	\$1,671,000
Benefit-Cost Ratio	1.54
Net Benefits	\$911,000
October 2019 FY(20) price level, Interest Rate 2.75 percent	





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. Recreational features are cost shared 50-50. The total project cost is \$49,902,000; the Federal share of the total project cost is estimated to be \$32,399,100 and the non-Federal share is estimated to be \$17,502,900. The non-Federal costs include the value of LERRD estimated to be \$6,162,000. Work-in-kind is not anticipated to be performed on the project and therefore the non-Federal cash requirement is \$11,340,900. A summary of the cost share requirements including cash and estimated creditable LERRD value are shown in Table 7-9.

Table 7-9. Summary of Cost Sharing.

Costs	Federal (65%)	Non-Federal (35%) ^a	Total
Total Project Cost	\$32,399,100	\$17,502,900	\$49,902,000
Cash Required	\$32,436,300	\$11,340,900	\$43,740,000
LERRD (01 & 02 Accounts)	NA	\$6,162,000	\$6,162,000

Note: ^a The recreational costs were included based on a 50-50 cost share for federal and non-federal entities.

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, turn over the project 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 Corps, 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 Corps in an OMRR&R manual and in accordance with provisions of the Project Partnership Agreement.

Non-Federal 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	31 Nov 2021
Initiate Design (funding dependent)	01 Dec 2022
50-Percent Design Complete (FY22 Q3)	01 May 2022
100-Percent Design Complete	01 Nov 2022
Advertise for a Construction Contract	15 Nov 2022
Award a Construction Contract	31 Dec 2022
50-Percent Construction Complete (FY23 Q3)	31 Jun 2023
100-Percent Construction Complete	31 Dec 2023
O&M manual and Project Turnover	31 Jan 2024
Close Project	31 Mar 2024

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** – The footprints of each detention basin would require review, survey, and coordination in accordance with the PA developed as part of the feasibility phase. The PA outlines how USACE intends to comply with Section 106 prior to initiation of construction.
- **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.

- **Clean Water Act, Section 401** – Design and construction of the plan should comply with the Alabama Department of Environmental Management water quality certification conditions associated with Nationwide Permit 43.
- **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 locally preferred plan, Alternative 3.

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 engagement, as defined in ER-02-100 are:

- Provide stakeholders with clear, concise, and timely information about proposed USACE activities
- Learn from stakeholders with diverse perspectives and incorporate the scientific, technical, and social information they can provide into the planning process
- Make the stakeholders' desires, needs, and concerns known to decision-maker and respond to their concerns
- Manage conflict by discussing and resolving differences as they arise, thereby reducing study and implementation risks
- Consider the stakeholder'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, this draft report will be made available for public review and comment for a minimum of 30 days. The 30-day comment period will commence with the issuance of a notice of availability and publication of the report on USACE website (insert web address). Availability of the draft report will be announced in a USACE press release and through USACE, City of Bessemer, and the City of Birmingham social media. Two public meetings or webinars will be held to present the findings of the draft report and solicit comments from the public. The webinar option would be taken should the evolving situation with COVID-19 prevent the ability to hold in-person meetings. All substantive comments received will be considered, and USACE will include responses to comments with the final report.

9.0. List of Preparers

This chapter identifies the USACE team members responsible for preparation of the 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			
Holly Bender	Ph.D., Natural Resource Economics 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	B.A Civil Engineering	11 years/Hydrologic and Hydraulic modeling	Hydrologic modeler and Engineering Technical Lead
Cassidy Garden, P.E.	B.S Agricultural Engineering Water Resources M.S. Civil Engineering Water Resources	18 years/Civil Engineering Water Resources	Project Manager/Planner
John Grothaus			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 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.
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 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

10.0. References

- ADEM. 2001. Use Attainability Analysis: Valley Creek. https://www.epa.gov/sites/production/files/2014-11/documents/support_valley_creek.pdf
- ADEM. 2007. 2007 Monitoring Summary. Rivers and Streams Monitoring Program.
- Caceres, C. M. and R. M. R. Barclay. 2000. *Myotis septentrionalis*. Mammalian Species, American Society of Mammalogists. No. 634, pp. 1-4.
- Center for Watershed Protection. 2004. Unified Stream Assessment: A User's Manual, Ellicott City, MD: Chapter 3.
- City of Birmingham. 2014. City of Birmingham Comprehensive Plan.
- EPA. 1998. Final Guidance for Incorporating Environmental Justice Concerns in EPA's NEPA Compliance Analyses. April. Accessed online, August 25, 2011. Available: https://www.epa.gov/sites/production/files/2015-02/documents/ej_guidance_nepa_epa0498.pdf.
- Freshwater Land Trust. 2019. Email communication between Carolyn Buck, Red Rock Executive Director and Holly Bender, Economist at the USACE regarding survey data on trail use in 2017. July 25, 2020.
- Freshwater Land Trust. 2020. Personal communications between Carolyn Buck, Red Rock Executive Director and Holly Bender, Economist at the USACE regarding trail use. March 5, 2020.
- Jefferson County Health Department. 2019. Air Quality Monitoring. Accessed at: <https://jcdh.org/SitePages/Programs-Services/EnvironmentalHealth/Air-RadiationProtectionDivision/AirQualMonitoring.aspx>.
- Missouri Department of Conservation. 2019. Online Field Guide. Gray Myotis (Gray Bat) *Myotis grisescens*. <https://nature.mdc.mo.gov/discover-nature/field-guide/gray-myotis-gray-bat>
- NOAA. 2013. Atlas 14: Precipitation-Frequency Atlas of the United States. Vol. 9 Version 2.0: Southeastern States. National Oceanic and Atmospheric Administration.
- USACE. 1986. Warrior River and Tributaries Interim Reconnaissance Report, Valley Creek, Jefferson Co., AL. U.S. Army Corps of Engineers, Mobile District. January.
- USGS. 2002. Investigation of water quality and aquatic-community structure in Village and Valley Creeks, City of Birmingham, Jefferson County, Alabama, 2000-01. U.S. Geological Survey Water Resources Investigations Report 02-4182.
- USFWS. 1985. Resource Inventory, Valley Creek, Birmingham, Alabama. Report submitted to U.S. Army Corps of Engineers Mobile District.
- USFWS. 1993. Recovery Plan: watercress darter (*Etheostoma nuchale*).
- USFW. 2006. Gray bat (*Myotis grisescens*) 5 year review: summary and evaluation. Midwest region, Columbia, Missouri. https://ecos.fws.gov/docs/five_year_review/doc2625.pdf.
- USFWS. 2007. Indiana bat (*Myotis sodalist*) draft recovery plan: first revision. April 2007. Fort Snelling, Minnesota. 258 pp.
- USFWS 2018. Watercress darter (*Etheostoma nuchale*) 5-year review: summary and evaluation.
- USFW. 2019a. Gray bat (*Myotis grisescens*) fact sheet. https://www.fws.gov/midwest/endangered/mammals/grbat_fc.html
- USFWS 2019b. Northern long-eared bat (*Myotis septentrionalis*) fact sheet. <http://www.fws.gov/midwest/endangered/mammals/nleb/nlebFactSheet.html>

USFWS. 2019c. Indiana bat (*Myotis sodalis*) fact sheet.

<https://www.fws.gov/midwest/Endangered/mammals/inba/inbafctsht.html>

U.S. Water Resources Council. 1983. Economic and environmental principles and guidelines for water and related land resources implementation studies.