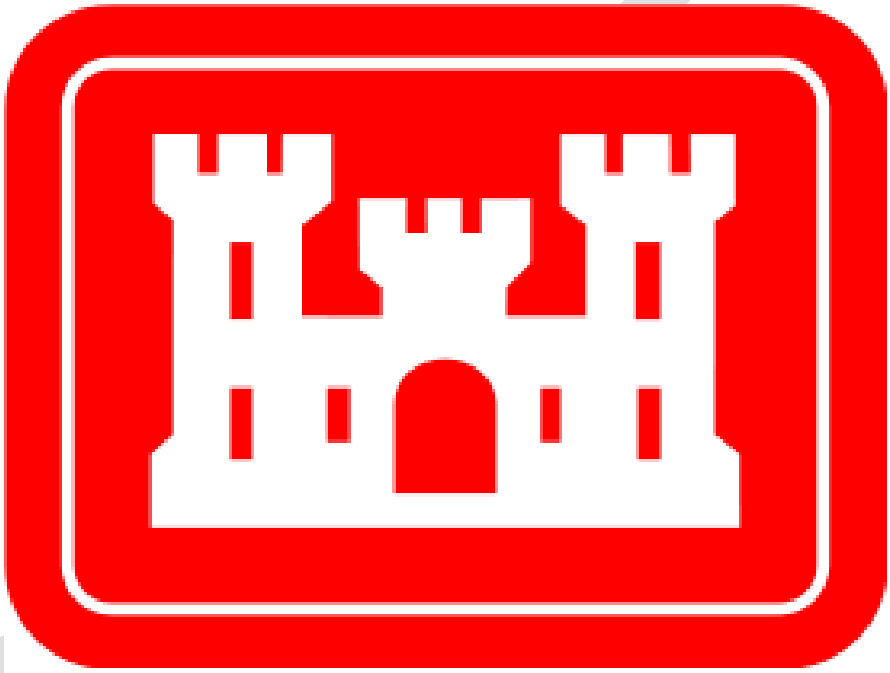
Detailed Project Report
And Integrated Environmental Assessment

Continuing Authorities Program
Town of Boone Ecosystem Restoration – Habitat Restoration Project
Watauga County, North Carolina



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1 INTRODUCTION

1.1 STUDY PURPOSE, NEED AND SCOPE

This Detailed Project Report (DPR) which includes a draft Environmental Assessment (EA) is being prepared by the Huntington District of the U.S. Army Corps of Engineers (USACE) to identify a viable recommended plan for providing ecosystem restoration along Boone Creek on the Appalachian State University (ASU) campus in Boone, North Carolina, while minimizing environmental, economic, and social impacts. The non-Federal sponsors are the Town of Boone, North Carolina and the Appalachian State University. In 2021, the Town of Boone requested Federal assistance in addressing aquatic restoration under the Continuing Authorities Program (CAP) Section 206 authority.

The purpose of the project is ecological restoration, and the need for the project is to reduce the impact of development and human impact that, over time, have reduced the quality and abundance of stream habitat, riparian zone, and wetlands within the New River – Little River watershed, adversely impacted natural floodplain functions, and diminished wildlife habitat. This project would provide ecological restoration and enhancement of the aquatic environment of Boone Creek, a perennial tributary in the New River – Little River watershed, increasing biodiversity and restoring aquatic habitat.

1.2 LOCATION

1.2.1 Study Area

The study area falls within the Headwaters South Fork New River Basin (HUC 050500010201), The New River is one of the nation's American Heritage Rivers, and Boone Creek is a perennial tributary within the watershed. Boone Creek is in the Town of Boone, Watauga County, North Carolina.

1.2.2 Project Area

The project area is in a highly urbanized area in the Town of Boone along the alignment of Boone Creek (Figure 1). The project area runs adjacent to Rivers Street (State Road 1163), which traverses through ASU. Boone Creek's right descending bank borders Rivers Street. The drainage area includes paved streets and parking lots, curbs and gutters, and attendant storm sewers, which convey stormwater runoff to Boone Creek. This project area is roughly four (4) acres in size including the 1,400 linear foot (LF) culverted section of Boone Creek which flows beneath an existing asphalt parking area for ASU. The entire project footprint would fall within ASU property.

This portion of Boone Creek is maintained at the surface as a parking area for those visiting ASU; however, the culvert which conveys the stream beneath has not been well maintained and there are expected failures. Several storm drainage systems direct storm water to this section of Boone Creek, and the culvert is often overwhelmed, leading to frequent flooding in the area.

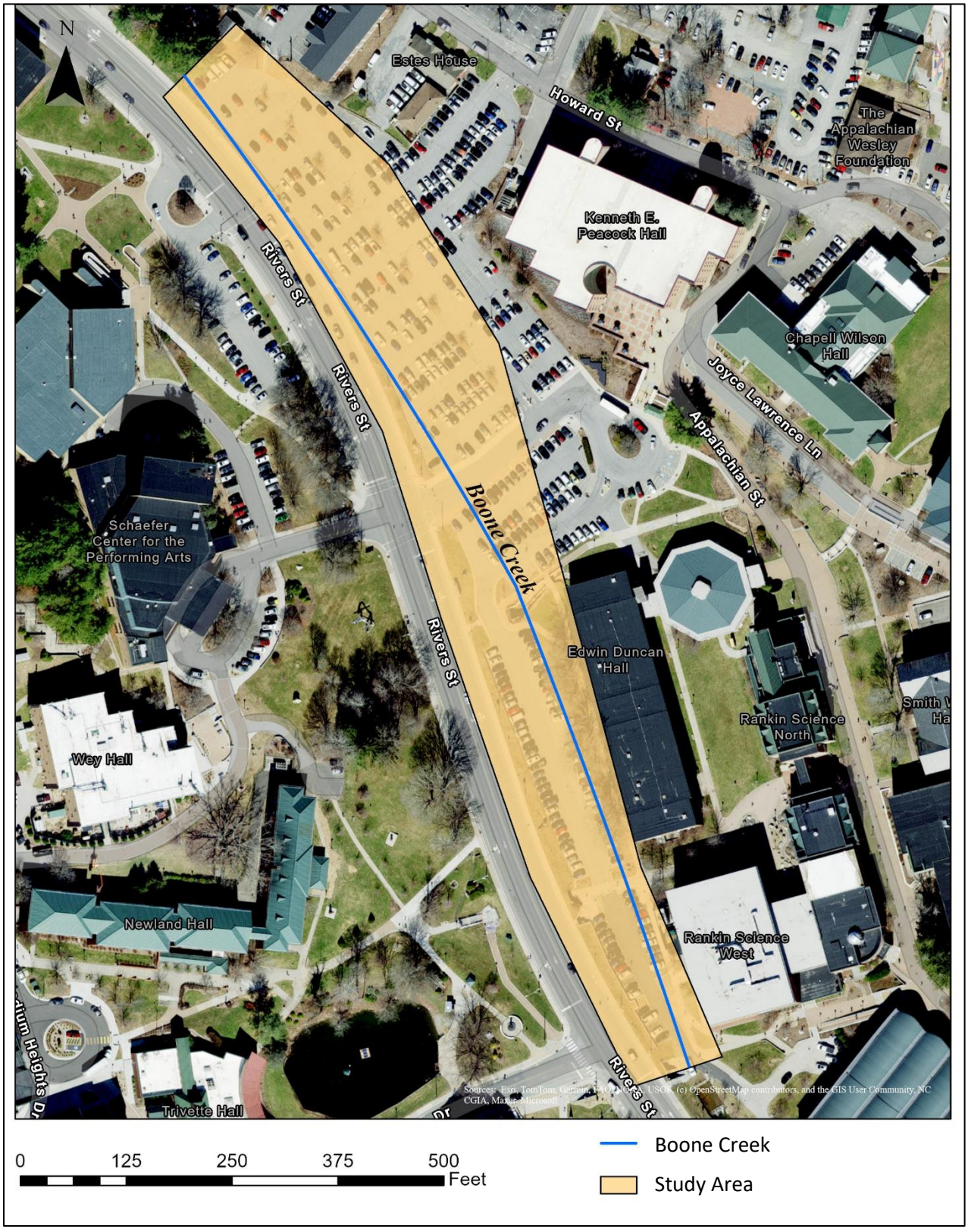

Figure 1: Boone Creek CAP 206 Project Study Area

1.3 STUDY AUTHORITY

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

1.4 RELEVANT PRIOR STUDIES AND REPORTS

1.4.1 Planning and Design Analysis Report and EA; South Fork New River Restoration Project, July 2001

This Planning and Design Analysis (PDA) Report and EA presents the findings of the South Fork New River Restoration Project, an aquatic ecosystem restoration study, and was prepared to document the plan formulation process and potential environmental effects associated with the implementation of restoration alternatives for the proposed site. The study area was located along the South Fork New River in the Town of Boone, Watauga County, North Carolina. The proposed restoration work, a reach of the South Fork New River extending approximately 1,500 feet, is located just north of Elizabeth Drive on the east side of Boone. The EA resulted in a Finding of No Significant Impact (FONSI).

1.4.2 DPR and Final EA; Watauga Section 206 Aquatic Ecosystem Restoration Project, May 2009

This DPR and EA presents the findings of the Watauga Aquatic Restoration Project, an aquatic ecosystem restoration study, and was prepared to document the plan formulation process and potential environmental effects associated with the implementation of restoration alternatives for the proposed site. The study area was located along the South Fork New River in the Town of Boone, Watauga County, North Carolina. The restoration work, a reach of the South Fork New River extending approximately 3,730 feet, is adjacent to the recreational property of ASU near Boone. The EA resulted in a Finding of No Significant Impact (FONSI).

2 AFFECTED ENVIRONMENT - EXISTING CONDITIONS

2.1 CLIMATE

The climate in Boone, Watauga County, North Carolina is typical of the North Temperate Zone. Topographic characteristics considerably modify the climate as marked variations in temperature and precipitation occur between mountain and plateau areas. Frequent and rapid changes in weather occur due to the passage of fronts associated with general low-pressure areas. Seasonal weather patterns consist of hot and humid summers with frequent showers from May to September and mild to moderate winters with snowfall from December to March. Summer is

typically the driest season, while winter is typically wetter. Occasionally, tropical hurricanes moving northward parallel to the Atlantic coast will cross the Appalachian range and deposit enough rain to cause heavy flooding.

The project area is located within the headwaters of the South Fork New River (HUC 050500010201), which is part of the larger Watauga River Basin. The 2020 North Carolina Climate Science Report (NCCSR) is a scientific assessment of historical climate trends and potential future climatic conditions in North Carolina under increased greenhouse gas (GHG) concentrations. The Town of Boone, North Carolina falls within the Western Mountains region, the coolest of the three (3) regions in North Carolina.

Average long-term temperature for the Western Mountains region is 54 degrees Fahrenheit. According to the NCCSR, by the end of the century, the average temperature is expected to increase by two (2) degrees Fahrenheit to six (6) degrees Fahrenheit under the lower scenario, and by five (5) degrees to 10 degrees Fahrenheit under the higher scenario. Based on the NCSSR's findings, it is likely that (1) the number of hot days will eventually increase, (2) the number of cold days and cold nights will eventually decrease, (3) annual hottest temperature will eventually increase, (4) annual precipitation will increase, (5) future droughts in their multiple forms will be more frequent and severe in terms of soil moisture deficits and the impacts on rainfed agriculture and natural vegetation, (6) snow cover lasting more than a few days will increasingly be limited to the highest elevations above 5,000 ft in the coming decades, (7) the number of heavy snowstorms will decrease, and (8) severe thunderstorms in the Western Mountains region of North Carolina will increase in frequency.

In addition, it is very likely that (1) the model-projected increases in the number of warm nights will occur, (2) model-projected increases in annual coldest temperature will occur, (3) heating degree days (degrees that a day's average temperature is below 65 degrees Fahrenheit) will decrease and cooling degree days (number of degrees that the average temperature is above 65 degrees Fahrenheit) will increase in the future, (4) the risk of extreme will increase everywhere in the Western Mountains region, (5) winter storms of even similar intensity will produce heavier precipitation, and (6) total snowfall will decrease. There is low confidence concerning future changes in the number of winter storms as well as future changes in the number of ice storms.

2.2 SOILS AND GEOLOGY

2.2.1 Geology and Physiography

The project area is located entirely in the Blue Ridge province of the Appalachian Mountain and is characterized by high elevations (highest to the south, lower to the north), steep slopes, and many bedrock exposures. The mountains are made of highly deformed metamorphic rocks of largely Precambrian ages. To the west, the Blue Ridge province is structurally divided from the Valley and Ridge province by thrust faults that overlay in part the younger sedimentary rocks of the Valley and Ridge. In the north, the Blue Ridge is as narrow as 13 miles but increases in width and relief to the south reaching 70 miles and peaks above 6,000 ft.

The Blue Ridge province includes several mountain ranges, including the Blue Ridge Range, where the project area is located, and is a drainage divide between the Great Valley to the west and the Atlantic Ocean to the east, the Great Smoky Mountains along the Tennessee-North

Carolina border, the Unaka and Cahutta Mountains, and the Black Mountains.

2.2.2 Soil Associations

The project area is located on the ASU campus, which is highly developed. According to the Natural Resources Conservation Service (NRCS)'s Web Soil Survey (WSS), the entirety of the project area consists of Urban land (Ur) and Urban land, flooded (Ux). Soils in the surrounding area include Porters loam, 15 to 30 percent slopes, stony, and Porters loam, 30 to 50 percent slopes, stony. Urban land is described as streets, parking lots, building, and other structures. Properties and qualities such as slope, drainage class, depth to the water table, and frequency of flooding and ponding are not applicable to Urban land. Ur and Ux are classified as Class 8 under the land capability classification, which are soils and miscellaneous areas that have limitations that preclude commercial plant production and that restrict their use to recreational purposes, wildlife habitat, watershed, or aesthetic purpose.

2.2.3 Hydric Soils

As stated above, the project area is located on the ASU campus, which is highly developed. The project area does not contain hydric soils.

2.3 SURFACE WATER AND OTHER AQUATIC RESOURCES

2.3.1 Surface Water

The project area is located along a culverted section of Boone Creek within the Headwaters South Fork New River Basin (HUC 050500010201), which is part of the larger Watauga River Basin. According to the U.S. Environmental Protection Agency's (USEPA) How's My Waterway tool, waterbody data for Boone Creek is not available currently. However, according to Anderson (2014), Boone Creek is classified as a low-order stream, heavily urbanized, and of moderate gradient. In addition, a stream survey in 2005 revealed more than 70 outfall pipes, deeply incised reaches, minimal riparian vegetation, and in some locations, direct drainage from pavement to the stream. The series of culverts that Boone Creek flows through were identified by Anderson as a detrimental feature to the habitat and ultimate health of the stream.

Urbanization of streams such as Boone Creek are often negatively impacted due to greater runoff temperatures from paved surfaces. Specifically, according to Anderson (2011), "rapid increases in stream temperature during storm events in urban landscapes, known as temperature surfaces, have detrimental effects on cold water stream habitats (Wang et. al 2003; Wang and Kanehl, 2003)." In addition, steep slopes in addition to paved surfaces such as parking lots can cause direct runoff of water containing dissolved road salt into Boone Creek. Salt will also gradually seep through cracks in the pavement and eventually recharge the groundwater system which, over time, flows into Boone Creek as well. The primary issues associated with Boone Creek include thermal pollution and salinity

According to the draft 2024 North Carolina Integrated Report, the portion of the Boone Creek that is located within the project area has not been listed as impaired and is not included in the 303(d) list. However, surrounding waters in the Upper New River Basin have been listed as impaired and are included in the 303(d) list (found in Appendix B).

In addition, according to the NCDEQ's Surface Water Classifications, Boone Creek is classified

as a Class C and Trout Waters stream. Class C is classified as waters protected for uses such as aquatic life propagation, survival and maintenance of biological integrity (including fishing and fish), wildlife, secondary contact recreation, and agriculture. Secondary contact recreation means wading, boating, other uses not involving human body contact with water, and activities involving human body contact with water where such activities take place on an infrequent, unorganized, or incidental basis. Trout Waters is classified as supplemental classification intended to protect freshwaters that have conditions that sustain and allow for natural trout propagation and survival and for year-round maintenance of stocked trout. This classification is not the same as the NC Wildlife Resources Commission's Designated Public Mountain Trout Waters designation. Boone Creek is not listed under the Wild and Scenic Rivers Act.

2.3.2 Groundwater

Groundwater occurs in the fractures and openings of bedrock (also referred to as basement rock) and in the pore spaces of the overlying regolith which includes saprolite or weathered basement rock, soils, and alluvium. Urbanization of streams such as Boone Creek are often negatively impacted due to greater runoff temperatures from paved surfaces which affects the groundwater-surface water interaction.

A 2011 study by Anderson investigated Boone Creek's groundwater-surface water interaction by examining the role of temperature surges in the creek with a numerical modeling study of flood waves influenced by temperature-surge events. This study found that flood waves cause a reverse gradient between the stream and riparian groundwater, temporarily changing Boone Creek from a gaining to a losing stream. This reversal in groundwater flow also causes the relatively hot groundwater to exchange heat with the cooler riparian sediments, thereby naturally remediating some of the heat prompted by the temperature surge.

2.3.3 Floodplains

E.O. 11988 requires Federal agencies to consider the potential effects of their proposed actions to floodplains. In order to determine the PAA's potential floodplain impact, the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Maps (FIRM) were reviewed for the proposed project (https://www.fema.gov/floodplain-management/flood-zones). The majority of the project area is located within the 100-year floodplain (Zone A) and regulatory floodway (Zone AE) (Figure 2). These areas are both designated as Special Flood Hazard Areas (SFHA).

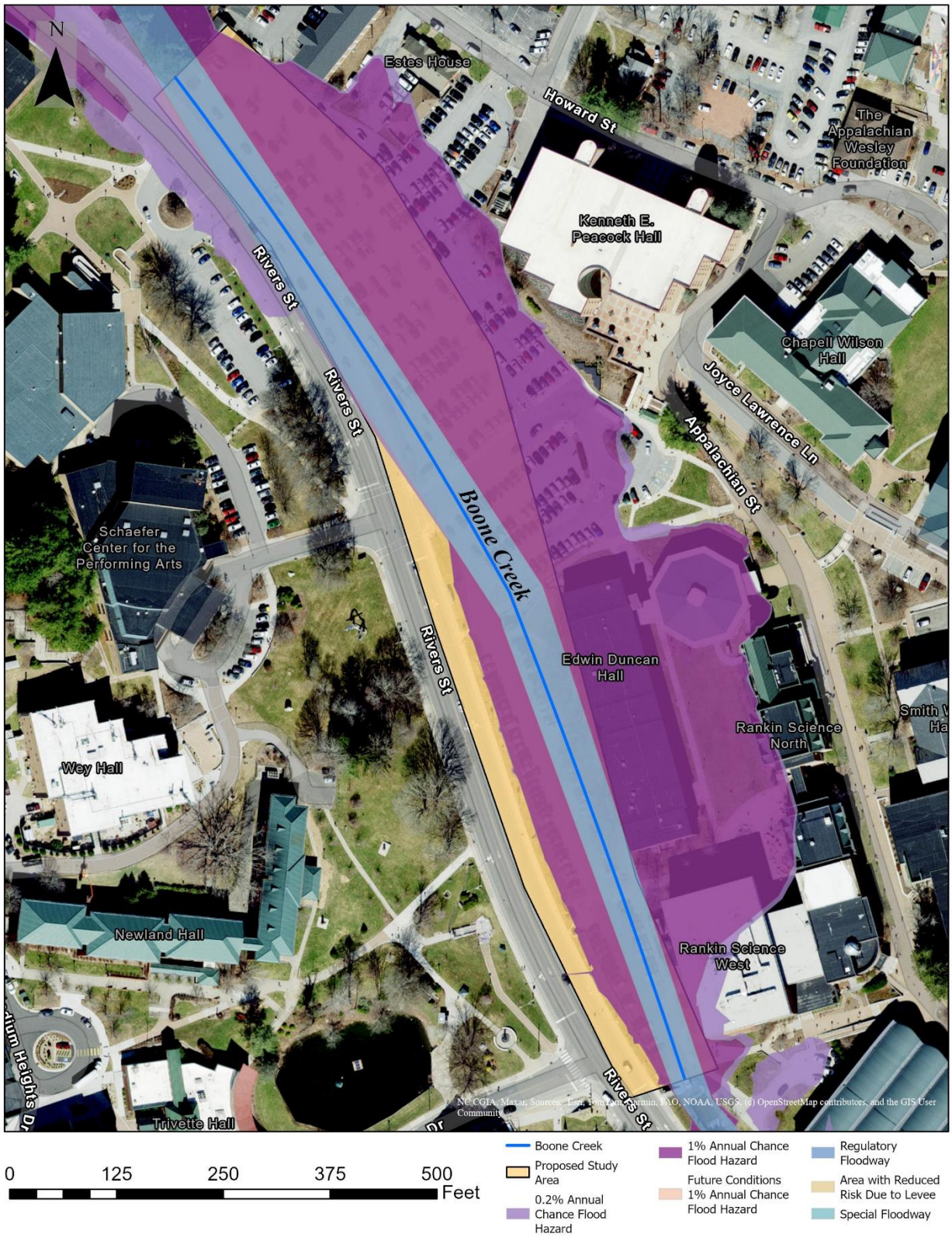

Figure 2: Project Area and FEMA FIRM

2.3.4 Wetlands

E.O. 11990 requires Federal agencies to consider the potential effects of their proposed actions to wetlands. National Wetland Inventory (NWI) Maps were reviewed for the project area and did not identify any wetlands within or near the vicinity of the project area. The project area was thoroughly investigated for wetlands as part of a site visit in the Fall 2023. No wetlands were found within the project area.

2.4 FISH AND WILDLIFE HABITATS

2.4.1 Habitat

The habitat within the project area consists of an asphalt parking lot in the middle of ASU's campus along Rivers Street, one of the main throughfares through the Town of Boone. The stream is completely culverted onsite except for one area near Duncan Hall that offers access to the culvert but is still completely concrete lined. The habitat within the project area is a harsh environment for both vegetation and fauna.

2.4.2 Terrestrial and Aquatic Vegetation

Existing terrestrial vegetation within the project area is very scarce and consists of the majority of sparsely planted landscaping trees within an asphalt parking lot (Figure 3). The aquatic vegetation onsite is non-existent as the portion of Boone Creek within the project area is a completely culverted, urban headwater stream that flows through the ASU campus and downtown Boone, North Carolina. Two (2) issues have been identified within Boone Creek: (1) abnormally high temperatures and (2) abnormally high salinity.

Figure 3 – Above the approximate center of the culvert of Boone Creek looking north.

2.4.3 Fauna

Terrestrial species, including the local bird population, may occasionally travel through the parking area, but it is not suitable habitat for terrestrial species on a long-term basis due to urbanization. As stated above, two (2) issues have been identified within Boone Creek: (1) abnormally high temperatures and (2) abnormally high salinity. These issues have been evaluated in depth by ASU; however, despite these issues, there is aquatic life still present within

the stream. Therefore, aquatic species, such as aquatic snails, may occasionally travel through the culverted section of Boone Creek, but it is not suitable habitat for aquatic species on a long-term basis due to the quality of the stream.

2.5 ENDANGERED AND THREATENED SPECIES

2.5.1 Federal

According to the U.S. Fish and Wildlife Service (USFWS) Information for Planning and Consultation (IPaC) tool (Project Code:2025-0093386, Accessed May 8, 2025), the project area is within the range of the following threatened or endangered species: the gray bat (*Myotis grisescens*), Indiana bat (*Myotis sodalis*), tricolored bat (*Perimyotis subflavus*; proposed endangered), Virginia big-eared bat (*Corynorhinus townsendii*), bog turtle (*Glyptemys muhlenbergii*; similarity of appearance, threatened), eastern hellbender (*Cryptobranchus alleganiensis*; proposed endangered), green floater mussel (*Lasmigona subviridis*; proposed threatened), monarch butterfly (*Danaus plexippus;* proposed threatened), Virginia spiraea (*Spiraea virginiana*), and rock gnome lichen (*Gymnoderma lineare*).

In addition, the bald eagle (*Haliaeetus leucocephalus*), black-billed cuckoo (*Coccyzus erythropthalmus*), bobolink (*Dolichonyx oryxivorus*), Canada warbler (*Cardellina canadensis*), cerulean warbler (*Setophaga cerulea*), chimney swift (*Chaetura pelagica*), eastern whip-poor-will (*Antrostromus vociferus*), golden-winged warbler (*Vermivora chrysoptera*), Kentucky warbler (*Geothlypis formosa*), northern saw-whet owl (*Aegolius acadicus*), prairie warbler (*Setophaga discolor*), red-head woodpecker (*Melanerpes erythrocephalus*), rusty blackbird (*Euphagus carolinus*), and wood thrush (*Hylocichla mustelina*) are migratory birds listed in the project area. These birds have protection as part of the Migratory Bird Treaty Act (MBTA) and the bald eagle under the Bald and Golden Eagle Protection Act (BGEPA).

2.5.2 State

The USACE considers state-listed sensitive species by reviewing proposed actions to assure adverse impacts are avoided when possible. According to the North Carolina Natural Heritage Program (NCNHP) there are no records for rare species, important natural communities, natural areas, or conservation/managed areas withing the proposed project boundary (Appendix B). Table 1 summarizes rare species and natural communities that have been documented within a one-mile radius of the property boundary. The proximity of these records suggests that these natural heritage elements may potentially be present in the project area if suitable habitat exists.

Table 1 – Element Occurrences Documented Within a One-mile Radius of the Project Area

Common Name	Scientific Name	Last Observation Date	State Status
Black-billed Cucukoo	*Coccyzus erythropthalmus*	2002-06-30	Significantly Rare
Red Crossbill	*Loxia curvirostra*	1981-10-31	Special Concern
Golden-winged Warbler	*Vermivora chrysoptera*	2008-06	Special Concern
Black Mantleslug	*Pallifera hemphilli*	2005-07-27	Special Concern

Lamellate Supercoil	*Paravitrea lamellidens*	2005-08-31	Special Concern
Round Supercoil	*Paravitrea reesei*	2005-08-31	Significantly Rare
Bidentate Dome	*Ventridens coelaxis*	2005-08-25	Special Concern
Tricolored Bat	*Perimyotis subflavus*	2021-03-02	Endangered
Lindberg's Maple-moss	*Lindbergia brachyptera*	1990-05-06	Significantly Rare Peripheral
--	Montane Oak--Hickory Forest (Acidic Subtype)	2010	--
Rusty-patched Bumble Bee	*Bombus affinis*	1934-Summer	Significantly Rare
Yellow Ladies'-tresses	*Spiranthes ochroleuca*	2005-09	Threatened
Clingman's Hedge-nettle	*Stachys clingmanii*	1932-07-26	Significantly Rare Throughout
Tower Mustard	*Turritis glabra*	1971-06	Endangered

2.5.3 Critical Habitat

No critical habitat was identified within the project area.

2.6 RECREATIONAL, SCENIC, AND AESTHETIC RESOURCES

2.6.1 Local Resources

The ASU campus includes plazas, gardens, large open spaces, and academic buildings and could be considered a recreational asset by providing access to athletic fields, trails, and recreation. Popular spots on campus for students and visitors include areas such as the Sanford Mall, Durham Park, tailgate parking lot, and Kidd Brewer Stadium. Rivers Street is one of the main thoroughfares through campus, which runs parallel to Boone Creek. Boone Creek is exposed across roughly half of the campus, and these exposed sections of Boone Creek contribute to the campus's existing natural landscape. According to the Duda/Paine Architects' Master Plan 2025 for ASU, the character of ASU's campus is defined by the outdoor public species and natural amenities such as mountains, waterways, and trees. The campus's natural topography allows for preservation of the natural landscape but results in limited buildable space.

2.6.2 Regional Resources

A Comprehensive Plan Update for Boone, North Carolina was published in 2006 and revised in 2018 and included the existing town limits, areas surrounding the town that was expected to come under the influence of growth over the next 10 to 15 years. The Comprehensive Plan texts are designed primarily to guide the physical development of the town and its environs for the next 15 years. According to the Comprehensive Plan, Boone's recreational needs have been determined by a combination of facility shortfalls, uneven geographical distribution, and unequal access. Regarding passive recreation and open space, greenways have become a favored recreational feature in the community since Boone's topography and multiple streams provides good opportunities for a system of greenways throughout the urban area.

In addition to the Comprehensive Plan Update, the North Carolina State Comprehensive Outdoor

Recreation Plan (SCORP) identified the High Country region (which includes Boone) as having very high demand for outdoor recreation. Popular recreation activities include hiking, mountain biking, paddling, fishing, camping, scenic driving as ranked the most popular in the region. The SCORP also indicates that the region is expanding in population and increased tourism, putting pressure on recreational resources.

Recreational resources within the overall Blue Ridge province include birding and wildlife, hiking, and spectator sports. This province is home to several national parks such as Shenandoah National Park, traversed by the Skyline Drive, which follows the crest of the mountain and offers scenic overlooks. Skyline Drive is continued to the south by the Blue Ridge Parkway, a drive that provides stunning long-range vistas and close-up views of the rugged mountains and pastoral landscapes of the Appalachian Highlands, to Great Smoky Mountain National Park. The Blue Ridge province is also crossed by the Appalachian National Scenic Trail, a 2,190+ mile long public footpath that traverses the scenic, wooded, pastoral, wild, and culturally resonant lands of the Appalachian Mountains. Boone and Watauga County have a well-developed trail system also, including sections of the Mountains-to-Sea Trail. Additional recreational resources in the area include Grandfather Mountain and the Watagua River, and Howard's Knob County Park.

2.7 CULTURAL RESOURCES

Cultural resources include objects and places that are past or present expressions of human culture and history. They include artifacts, archaeological sites, buildings and structures, and places that may be related to specific rituals and cultural transmission. Section 106 of the National Historic Preservation Act (NHPA) (54 U.S.C. 306108) requires federal agencies to consider effects of an undertaking on historic properties. Historic properties – buildings, structures, sites, objects, districts, or landscapes listed in or eligible for listed in the National Register of Historic Places – form a statutorily significant resource. However, cultural resources under NEPA may be more broadly defined and can include places of local importance or may be intertwined with the natural environment.

Per 36 CFR Part 800 (the regulations implementing Section 106 of the NHPA), a historic property is defined as any prehistoric or historic district, site, building, structure, or object included in or eligible for inclusion in the National Register of Historic Places (NRHP).

In 2023, the Huntington District began a preliminary Section 106 review to determine if historic properties could be affected by the undertaking. At that time no resources were located within or adjacent to the undertaking's footprint, however, data will need to be reviewed again to determine if new resources have been located. Currently, the Huntington District does not have access to the North Carolina Department of Natural and Cultural Resources (SHPO) GIS database to review known resources. Once access is regained, the District will re-coordinate with the North Carolina SHPO and will initiate tribal coordination prior to issuance of the FONSI.

2.8 AIR QUALITY

According to the Clean Air Act, 42 U.S.C. 7401 et seq., the USEPA established National Ambient Air Quality Standards (NAAQS) to protect the public from air pollution associated with the following criteria pollutants: ozone, sulfur dioxide, carbon monoxide, lead, nitrogen dioxide,

and particulate matter. Watauga County, North Carolina is considered an attainment area for all criteria pollutants by USEPA. According to the USEPA's 2023 Air Quality Index (AQI) (which is based on a scale of 0-500), Watauga County, North Carolina is considered to have good air quality with a median AQI of 46. An air quality score of 0-50 is considered to be satisfactory, and air pollution poses little or no risk.

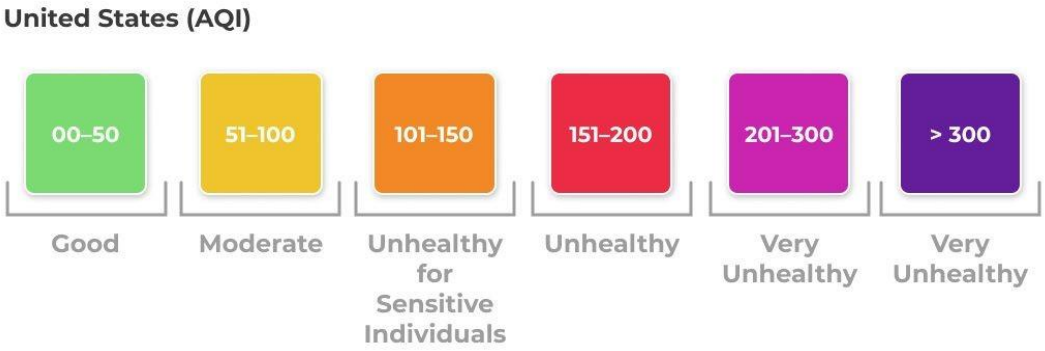

Figure 4 - Air Quality Index basic scale. Source: AirNow.gov

In August 2022, the entire state of North Carolina was designated as meeting all U.S. EPA's health-based National Ambient Air Quality Standards (NAAQS). There is not currently a threshold established by the State of North Carolina for GHG emissions. In addition, the North Carolina Department of Air Quality (DAQ) does not currently require sources to report their GHG emissions directly to DAQ, submittals are voluntary and encouraged. The USEPA Mandatory Reporting Rule of Greenhouse Gases (MRR-GHG) applies to direct greenhouse gas emitters, fossil fuel suppliers, industrial gas suppliers, and facilities that inject carbon dioxide (CO2) underground for sequestration (containment) or other reasons. In general, the threshold for reporting is 25,000 metric tons or more of CO_2 equivalent per year.

2.9 NOISE

Noise is measured as Day Night average noise levels (DNL) in "A-weighted" decibels (dBA) most sensitive to the human ear. There are no Federal standards for allowable noise levels. According to the Department of Housing and Urban Development Guidelines, DNLs below 65 dBA are normally acceptable levels of exterior noise in residential areas. The Federal Aviation Administration (FAA) denotes a DNL above 65 dBA as the level of significant noise impact.

Several other agencies, including the Federal Energy Regulatory Commission, use a DNL criterion of 55 dBA as the threshold for defining noise impacts in suburban and rural residential areas. According to Dr. Paul Schomer in his 2001 Whitepaper, while there are numerous thresholds for acceptable noise in residential areas, research suggests an area's current noise environment, which has experienced noise in the past, may reasonably expect to tolerate a level of noise about 5 dBA higher than the general guidelines. The USACE Safety and Health Requirements Manual provides criteria for temporary permissible noise exposure levels (see Table 2), for consideration of hearing protection or the need to administer sound reduction controls. Ambient noise around the project area is representative of a mixed commercial and residential area.

Table 2 – Permissible Non-Department of Defense Noise Exposure

Duration/day (hours)	Noise level (dBA)
8	90
6	92
4	95
3	97
2	100
1.5	102
1	105

Noise sources within the project area are likely variable and a combination of natural and manmade sounds. Sources of noise may include but are not limited to: traffic from major roadways such as U.S. Route 221 or Rivers Street, athletic events, construction events, roadway repair, wind, animals, and other natural noises. Chapter 82 of Boone, North Carolina's Code of Ordinances discusses noise control. Construction activity noise is prohibited between the hours of 10:00 p.m. and 6:00 a.m. unless constructed by a governmental entity or its contractor and specifically authorized by the Boone Town Council following general notice to the public and a public hearing.

2.10 HAZARDOUS AND TOXIC SUBSTANCES

A Phase I Environmental Site Assessment (ESA) was conducted in June 2023 to identify recognized environmental conditions (RECs) that indicate the possible presence of hazards, toxic, or radioactive waste (HTRW) contamination that may be harmful to workers or may be disturbed and released during the construction and ecosystem restoration of the study area. The Phase I consisted of a site visit, title ownership history, property owner interviews, and regulatory agency record search. No concerns were identified, and no additional Phase I ESA Investigations are required for the study area. The Phase I ESA is included in Appendix B.

2.11 SOCIOECONOMICS

According to the U.S. Census Bureau QuickFacts, the population for Watauga County, North Carolina is 54,997, and it does not contain a significant minority population. The U.S. Census Bureau states that 18.6% of the County resides below the poverty line compared to 12.8% statewide. The U.S. Census Bureau indicates that the County is 94.2% white, and the median household income is $51,367. In addition, 12.1% of individuals residing in Watauga County, North Carolina are under the age of 18 compared to 21.6% statewide.

2.11.1 E.O. 13045 Protection of Children

E.O. 13045, as amended, requires each Federal agency "to identify and assess environmental health risks and safety risks that may disproportionately affect children" and "ensure that its policies, programs, activities, and standards address disproportionate risks to children that result from environmental health risks or safety risks." This E.O. was prompted by the recognition that children, still undergoing physiological growth and development, are more sensitive to adverse environmental health and safety risks than adults. The potential for impacts on the health and safety of children is greater where projects are located near residential areas.

2.12 HEALTH AND SAFETY

The project area is located adjacent to Rivers Street, which traverses through the ASU campus. Rivers Street is considered a main thoroughfare through ASU and the Town of Boone. Peacock Hall, Duncan Hall, AppalCart Bus Loop, and other ASU buildings and amenities are accessible from Rivers Street, and there is heavy foot traffic along and under Rivers Street by ASU students and staff.

2.12.1 Traffic and Transportation

There is heavy traffic presence along Rivers Street throughout the day, and traffic congestion is likely to be at its highest during peak commuting times and when ASU classes are in session during the spring and fall semesters. There are also traffic lights and pedestrian walkways located on Rivers Street.

3 PLAN FORMULATION

Plan formulation is the iterative process resulting in the development, evaluation and comparison of alternative plans to address the identified study problems. To facilitate the plan formulation process, the methodology outlined in the USACE Engineering Circular 1105-2-404, "Planning Civil Work Projects under the Environmental Operating Principles," was used in conjunction with the USACE planning steps outlined in Appendix E of the Planning Guidance Notebook (EC 1105-2-100). The steps in this methodology are summarized below:

1. Identify the study problems, opportunities, objectives, and constraints that relate to the primary project purpose.
2. Formulate management measures to achieve planning objectives and avoid planning constraints, where measures are the building blocks of alternative plans.
3. Formulate, evaluate, and compare an array of alternative plans to achieve the primary NER purpose and identify cost effective plans. This is achieved by evaluating the alternatives through each discipline on the PDT for their engineering feasibility and affects, as well as through the metrics of an alternatives' completeness, effectiveness, efficiency, and acceptability.
4. Perform an effects assessment following Council on Environmental Quality (CEQ) and NEPA guidelines to identify and disclose potential impacts to environmental and cultural resources.
5. Identify and analyze benefits in total and equally across a full array of benefit categories including National Ecosystem Restoration, Regional Economic Development. Environmental Quality, and Other Social Effects.
6. Select the NER plan, which is synonymous with the recommended plan or preferred plan.

3.1 PROBLEMS AND OPPORTUNITIES

3.1.1 Problems

Increased tourism related development and the continued growth and urbanization of ASU has altered the geomorphology, hydrology, hydraulics, sediment transport, groundwater recharge/discharge, soils, temperature regimes, and plant communities historically present within the watershed and floodplain. Alterations to the system have significantly reduced species richness, abundance, and distribution of native plant and animal assemblages, and suppressed

biodiversity. As a result, ecosystem homogeneity and water quality have become a great concern for the watershed. Specific problems relating to the primary project purpose are as follows:

- Degraded ecosystem structure, function, and process from urbanization and lack of natural stream habitat.
- Sub-optimal ecological conditions, such as reduced sunlight, increased temperatures, and flashy stream flow for aquatic and terrestrial wildlife (Anderson, 2010).
- Limited riparian and wetland habitat along Boone Creek due to the extensive culvert running adjacent to Rivers Street (Anderson, 2010).

3.1.2 Opportunities

The impacts of increased urbanization and reduced functional aquatic habitat can be lessened and ultimately reversed via on-the-ground and institutional efforts. Given the problems above, several opportunities have been identified in the studied stretch of Boone Creek that address ecosystem restoration:

- Introduce native species to improve habitat richness.
- Establish and propagate wetland and riparian habitat.
- Increase linear feet of viable and connected stream habitats.
- Stabilize temperature consistency within the watershed.
- Develop flood resilience.
- Enhance opportunities for recreation and education in the community.

3.2 OBJECTIVES AND CONSTRAINTS

3.2.1 Planning Objectives

The planning process for this project seeks to identify opportunities to provide ecological enhancement of the project area by increasing biodiversity, reducing temperature, increasing water quality, establishing riparian zones, and restoring aquatic habitat. Secondary objectives of the project can include flood reduction and recreation benefits. The planning objectives are specified as follows:

- Restore and naturalize the streambed habitat structure in the current culverted reach of Boone Creek.
- Re-establish riparian and wetland habitat along the project focus area of Boone Creek.
- Increase biodiversity of native aquatic and terrestrial species of the focus reach of Boone Creek.
- Enhance water quality of Boone Creek.
- Increase recreational and educational areas for ASU students and Boone citizens.

The study being conducted will recommend the most cost-efficient alternative that also serves to increase ecological function of the site.

3.2.2 Planning Constraints and Considerations

Constraints are factors which limit the planning process or potentially restrict some aspect of project implementation. The planning and project constraints are specified as follows:

- Avoid induced localized flooding along Boone Creek for the campus and the Town.

- Maintain required emergency access across Boone Creek toward Duncan Hall on the downstream reach.
- Preserve the underground concrete pedestrian tunnel near Duncan Hall on the downstream section due to both difficulty of removal and the importance of access for ASU students.

Considerations are factors which should be taken into account during plan formulation, evaluation and comparison of alternatives. The planning and project considerations are specified as follows:

- Consider the importance of the existing function of the study area to ASU students. The study area is a main thoroughfare for students and parking for the ASU campus, so recommendations will consider potential impacts to the current function of the area as well as effects during construction.
- Understand the location of the steam tunnel near the downstream reach creates a level of uncertainty and constrains space due to difficulty of relocation.

3.3 MOST PROBABLE FUTURE WITHOUT PROJECT CONDITIONS

A prediction of the future conditions (50-year time horizon) of the study area in the absence of the project forms the basis for comparing alternative plans discussed in this study. Information describing the existing conditions in the area, ongoing projects, and any information on future activities in the area were used to predict future conditions that relate to the project goals and objectives. This prediction describes the future that the project area will face if no action is taken. The National Environmental Policy Act (NEPA) requires that one of the alternatives evaluated for each project be a “no action” alternative. This essentially sets a baseline against which action alternatives may be evaluated and helps ensure that any action taken is in the public interest. The description of the area in the absence of the project is directly analogous to the No Action Alternative.

Boone Creek is currently maintained within the study area as an asphalt-paved parking lot for students of ASU. In addition, the storm corrugated metal pipe (CMP), which conveys the stream beneath the parking area, has not been well maintained, and there are expected failures along this alignment. Several additional storm drainage systems direct storm water to this section of Boone Creek. Currently the storm CMP at the upstream end becomes overwhelmed, causing the study area to flood on a routine basis. This flooding causes significant impact to university buildings and surrounding areas. Future without project conditions indicate further degradation of the CMP and continued flooding of campus buildings.

Additionally, planning studies that require an assessment of future without project (FWOP) conditions must include an assessment of current trends and future climatic conditions, per Engineering and Construction Bulletin (ECB) 2018-14. As stated in the Engineering Appendix A for this study, generally, predictions of future conditions indicate a warmer and wetter climate for the project area. Due to increasing temperatures, the future without project conditions includes a consistent decline in water quality and aquatic habitat. The stream currently

experiences severe thermal variations in the summer as a result of the area's urbanization and reduced riparian corridor, which would continue to worsen with projected increased temperatures (Anderson, 2010). Furthermore, the predicted increased precipitation may increase the frequency and severity of flood events along Boone Creek.

3.4 MEASURES TO ACHIEVE PLANNING OBJECTIVES

3.4.1 Preliminary Measures

Management measures are features or activities that can be implemented at a specific geographic location to address all or a portion of the identified study problems. Measures can directly address a problem, eliminate or reduce the consequences of a problem, or adapt the way a problem behaves. A brief description of measures to solve problems and achieve the planning objectives follows:

- **Stream Daylighting**

Daylighting the stream would excavate the soil, deconstruct the pavement, and remove the culvert currently channeling Boone Creek. Daylighting would restore the stream to its more natural state, providing "numerous benefits, including increased hydraulic capacity for flood control, slowing water velocity to reduce downstream erosion, removal of water from combined sewer systems resulting in fewer sewer overflows, community and ecological revitalization, as well as water quality improvements" (American Rivers, 2016).

Removing the culverted portion of the stream would provide ecological uplift via increased nutrient retention and decreased thermal variation (American Rivers, 2016; Anderson, 2010). As it stands, culverts create short-term pulses in water flow that result in a flashy system that does not allow the stream to store and transform nutrients or to cool heated water flowing from the urban setting. The naturalized stream would store water for longer periods of time than a culvert, which allows the system to transform pollutants to nutrients as well as balance temperature spikes.

- **Floodplain Terracing and Riparian Development**

Floodplain terraces are steps or benches adjacent to a stream that hold overbank flow in flood events. Riparian corridors are linear strips of vegetation on the terraces adjacent to streams and rivers (Figure 555). A riparian buffer would serve to increase habitat suitability for a variety of aquatic and terrestrial animals. Flying animals, including a variety of birds and bats, would benefit from native shrub and tree plantings through increased shelter and forage opportunities. Terrestrial animals, including mice, turtles, snakes, and fox would also find shelter and foraging opportunities within a newly constructed riparian buffer. The planting of trees and shrubs may potentially decrease water temperatures by providing shade within the tributaries, which would serve to increase habitat suitability of many fish and other aquatic wildlife. Furthermore, streamside riparian buffers provide many other benefits including removing pollutants during periods of overbank flow, filtering pollutants from overland flows, providing leaves and woody debris - the basic source of energy for the stream ecosystem - and reducing streambank erosion through the durability of tree roots. Extending the tree canopy vegetation and creating new

riparian buffers can restore many of these benefits in degraded stream corridors.

Source: EcoVision (https://ecovision2025.ca/riparianzone/)

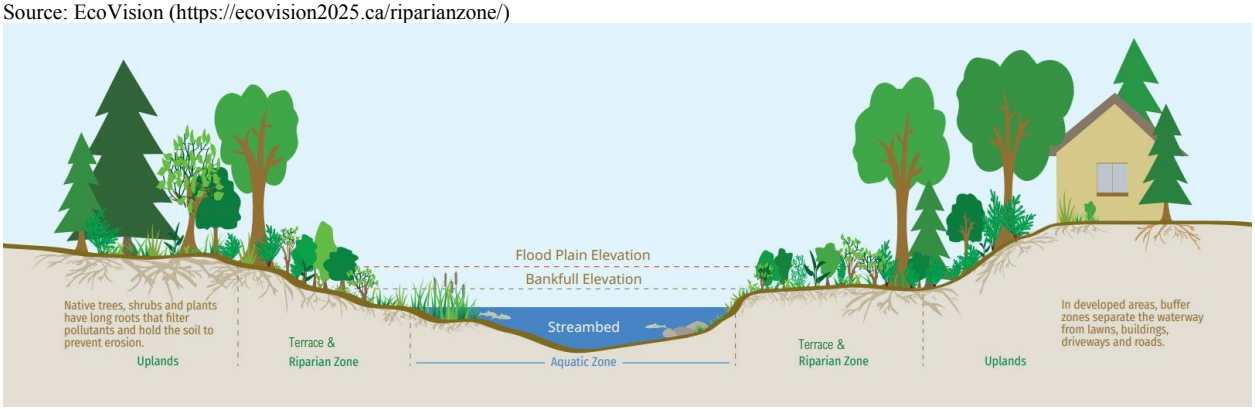

Figure 55: Riparian Ecosystem Cross Section

- **Wetland Development**

The creation of wetland areas within the project areas would increase habitat diversity and help filter polluted runoff and improve water quality within the Boone Creek watershed. Wetlands provide essential habitat for amphibians, waterfowl, and other aquatic life.
Floodplain wetlands along the riparian corridor of the streambank could be created by excavating down to an appropriate elevation that would allow for overbank flooding on a semi-regular basis. The floodplain topography would be designed to be variable and would include depressional wetlands that would collect and temporarily store flood waters and storm runoff. Depressional wetlands would serve as ephemeral pools for amphibians and other aquatic life. Native plantings would be included to enhance the riparian habitat of the floodplain.

- **Native Species Plantings and Seeding**

This strategy would address the absence of native plant species and thus the native community type that was historically present. This would mitigate the land use change that has occurred, which has driven the natural plant community out and allowed an exotic community to establish. Specific methods include:

- Seeding
- Live plugs
- Shrubs and trees

- **Streambed and Streambank Stabilization**

Potential structural bank stabilization measures include retaining walls or stream cross-vanes. Each of these measures would be designed to redirect flows, reduce bank erosion, or both.

Retaining walls could be placed at the tops of channels to minimize erosion where there are spatial constraints that limit ability to create floodplain terraces. The walls can vary in height and use stones to stabilize the streambanks.

Cross-vanes are specific types of in-stream structures that can provide bank stabilization, grade

control in a channel, as well as affect the channel alignment. These in-stream structures normally extend across the entire channel to tie into both banks as they cross through areas with the highest velocities. Figure 666 below provides an example of these types of structures.

Source: Natural Resources Conservation Service National Engineering Handbook, Part 654

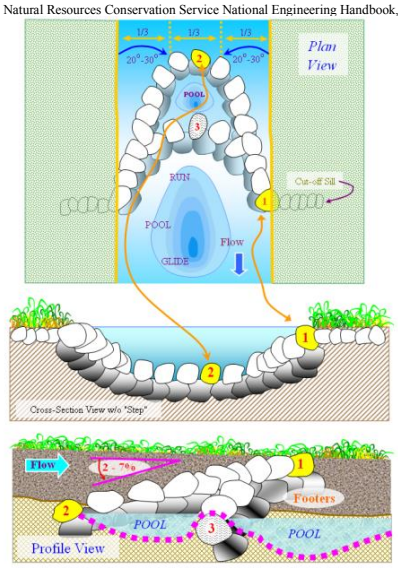

Figure 66: Typical Cross-Vane Structure

3.4.2 Evaluation of Measures

Table 3 - Evaluation Criteria for Measures to Meet Project Objectives

Potential Restoration Measure	Objective					
	Restore streambed structure	Re-establish riparian habitat	Re-establish wetland habitat	Increase biodiversity	Enhance water quality	Increase recreation & education areas
Stream Daylighting	✓	✓	X	✓	✓	✓
Floodplain Terraces/ Riparian Development	X	✓✓	✓✓	✓✓	✓✓	✓✓
Wetland Development	X	✓✓	✓✓	✓✓	✓✓	✓✓
Native Species	X	✓✓	✓✓	✓✓	✓✓	✓✓
Streambed & Streambank Stabilization	✓	X	X	X	X	X

Prior to developing alternative plans, the PDT evaluated the measures against their ability to meet project objectives (Table 3). A green background indicates the measure meets the objective while a "x" with a red background indicates it does not. Stream Daylighting, Floodplain Terraces/Riparian Development, Wetland Development, and Native Species met all but one objective and remained for alternative development consideration. Although Streambed and Streambank Stabilization only met one objective, restoring streambed structure is a significant objective of the project area and is foundational to the other objectives (i.e., if the streambed

structure is not restored, no other objective could be achieved). Therefore, Streambed and Streambank Stabilization was carried forward for alternative development.

3.5 FORMULATION AND COMPARISON OF ALTERNATIVE SOLUTION SETS

The planning process ensures the project team formulates, evaluates, and compares an array of alternative plans to achieve the primary purpose of ecosystem restoration and identify cost effective plans. The first part of this step is to formulate alternative plans by combining measures developed earlier in the process.

The purpose of ecosystem restoration measures is to restore the aquatic and riparian resources of an impacted section of stream. The project team combined the restoration measures to produce three alternatives that restore Boone Creek's ecosystem based on USACE Project Delivery Team (PDT) and Non-Federal Sponsors (ASU and Town of Boone) input, as well as University campus plans for future infrastructure development that incorporated one or more measures outlined in Section 3.4 – Measure to Achieve Planning ObjectivesMEASURES TO ACHIEVE PLANNING OBJECTIVES.

Most measures do not inherently have benefits associated with them, so they must be combined with other measures to achieve habitat outputs. Additionally, implementing a combination of measures improves connectivity of habitats with the system. It allows stream reaches to be better connected to other reaches and tributaries, and better connected to floodplains, which is important for both stream health and riparian health and resilience. Apart from the No Action Alternative, each alternative includes measures that daylight the culvert, increase floodplain and riparian habitat, and create an ecosystem more suited for aquatic and terrestrial species diversity. Measures are fully explained in 3.4.1 - Preliminary Measures.

3.5.1 Alternative Plan Descriptions

For this study, the stream was divided into two reaches with different lateral constraints. The upstream section (Reach 1) extends from the northernmost end of the parking lot at Peacock Hall to the parking lot entrance near Duncan Hall; the downstream section (Reach 2) extends from the parking lot entrance along Duncan Hall and terminates at an existing six-by-eight-foot concrete box culvert between Duncan Hall and the Rankin Science Building (Figure 7Figure 7 7- Map of Boone Creek Reaches as Analyzed in Study). The remaining reach of culverted stream, which extends from the existing six-by-eight-foot box culvert to the existing concrete weir, was not considered in this study due to constraints, discussed in Section 3.2.2 - Planning Constraints, including but not limited to location of the steam tunnel, pedestrian tunnel, and maintaining the emergency access road to Rankin Science Building area.

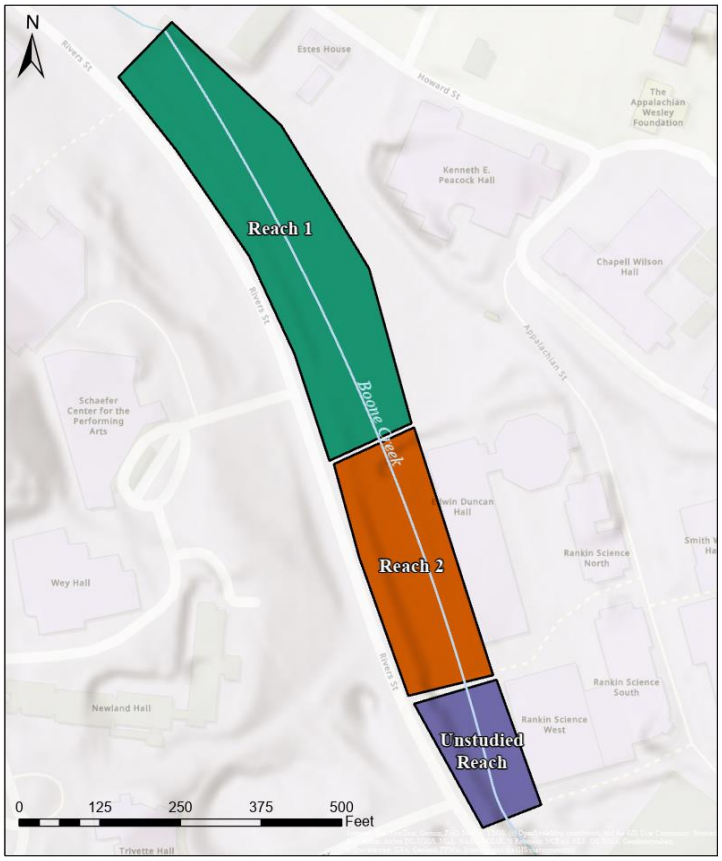

Figure 7 7- Map of Boone Creek Reaches as Analyzed in Study

No Action Alternative

The No Action Alternative (NAA) is defined as the "Without Project Conditions". Under the NAA, the aquatic ecosystem of Boone Creek would continue to degrade as it would remain encapsulated in a culvert under an ASU parking lot. As a result, Boone Creek would likely continue to be subject to limited fragmented riparian habitat, sediment deposition, out of bank flooding on campus, streambank erosion, debris accumulation, temperature fluctuations, and degraded water quality. While the Town of Boone could potentially continue to implement measures to restore the local waters, implementation of these actions would likely be fragmented due to financial constraints, limited technical capability, and available resources. Therefore, the NAA is included in the alternatives analysis as previously defined to establish a baseline condition for existing human and natural environmental conditions, to allow comparison between future without and with project actions, and to determine potential environmental effects of proposed with project alternatives.

Alternative A: Stream Daylighting + Floodplain Terraces + Riparian Development + Stabilization

This restoration alternative daylights Reaches 1 and 2 to create a naturalized stream channel. Reach 1 consists of a low-flow, ten-foot-wide stream channel with meanders and sinuosity. The streambank slopes will be 3H:1V with floodplain terraces of widths varying between ten and twenty feet extending along both sides of the stream channel for storing and dissipating overbank

flows. Native riparian vegetation will be planted within the riparian corridor to optimize ecological conditions.

Reach 2 continues the ten-foot-wide stream channel but shifts to 2.5H:1V embankment slopes. A six- to eight-foot retaining wall would be placed at the top of the channel along both the right and left descending embankments. This stream alternative maintains access from Rivers Street to Duncan Hall between Reaches 1 and 2 via a three-sided bottomless concrete arch culvert, which accommodates the ASU proposed parking deck, proposed Peacock Hall expansion, potential surface parking by Duncan Hall, and vehicle/bus access from Rivers Street. Constructed cross vanes and rock toe protection will be used to build, control grade, and stabilize the new channel.

Alternative B: Stream Daylighting + Floodplain Terraces + Riparian Development + Wetlands + Stabilization

This restoration alternative daylights Reaches 1 and 2 to create a naturalized stream channel. Reach 1 consists of a low-flow, ten-foot-wide stream channel with 3H:1V embankment slopes, a 15-ft. wide benched floodplain area extending along the right descending side of the stream channel (Rivers Street side), and a series of variously sized depressed wetland areas extending along the left descending embankments of the stream channel (Peacock Hall side). Native riparian vegetation will be planted within the riparian corridor to optimize ecological conditions.

Reach 2 continues the ten-foot-wide stream channel but shifts to 2.5H:1V. Instead of two retaining walls on both sides of the stream like Alternative A, Alternative B - Reach 2 will include embankment slopes that extend along the right descending embankment (Rivers Street side), and a vertical slope, achieved by means of a ten- to twelve-foot-tall retaining wall, will extend along the left descending side of the stream channel (Duncan Hall side). This stream alternative maintains access from Rivers Street to Duncan Hall between Reaches 1 and 2 via a three-sided bottomless concrete arch culvert, which accommodates the ASU proposed parking deck, proposed Peacock Hall expansion, potential surface parking by Duncan Hall, and vehicle/bus access from Rivers Street. Constructed cross vanes and rock toe protection will be used to build, control grade, and stabilize the new channel.

Alternative C: Stream Daylighting + Riparian Development + Stabilization

This restoration alternative daylights Reaches 1 and 2 to create a naturalized stream channel. Reach 1 consists of a low-flow ten-foot-wide stream channel with 2.5H:1V embankment slopes extending along both the left and right descending embankments of the stream channel to existing grade. Native riparian vegetation will be planted within the riparian corridor of the embankment slopes to optimize ecological conditions. No floodplain benched areas or wetland development were considered for this alternative to accommodate ASU and the Town's request for maintaining the parking of the area.

Reach 2 continues the ten-foot-wide bottom stream channel with vertical slopes, achieved by ten- to twelve-foot retaining walls, extending along both the right and left descending side of the stream channel. This stream alternative accommodates the ASU proposed parking deck, potential surface parking by Peacock Hall, proposed Peacock Hall expansion, and vehicle/bus access from Rivers Street by utilizing a three-sided bottomless concrete arch culvert, while minimizing the

impacts to the existing site conditions. Constructed cross vanes and rock toe protection will be used to build, control grade, and stabilize the new channel.

3.5.2 Comparison of Alternative Plans

Per Engineering Regulation (ER) 1105-2-103 "Policy for Conducting Civil Works Planning Studies", "[t]he objective of ecosystem restoration is to restore degraded ecosystem structure, function, and dynamic processes to a less degraded, more natural condition" and the benefits of the project are "based on a combination of monetary and non-monetary benefits and costs." Therefore, the PDT evaluated alternatives based on internally established objectives and the required planning evaluation criteria of acceptability, completeness, effectiveness, and efficiency. The PDT compared the benefits of each alternative using cost effectiveness and incremental cost analysis (CE/ICA), along with the four P&G accounts, described in detail in the following sections. In combination, these screening tools and analyses ensure the Recommend Plan is the most cost effective and beneficial for the achieved environmental uplift.

3.5.2.1 Initial Screening of Alternatives

The PDT evaluated each alternative against its ability to meet the project objectives (Table 4). At this point, the team decided to separate alternatives into Reach 1 and Reach 2 to ensure robust analysis during formulation. This would also allow the separation and possible recombination of alternatives should a reach of one alternative better meet objectives than the full alternative. The table classifies each alternative reach by its ability to meet the stated project objectives as either high, medium, or low. No alternatives were screen based on these objectives due to similar rankings of each Reach 2.

Table 4 - Matrix for Evaluating Alternatives against Project Objectives

Alternative	Objective					
	Restore streambed structure	Re-establish riparian habitat	Re-establish wetland habitat	Increase biodiversity	Enhance water quality	Increase recreation & education areas
Alternative A - Reach 1	High	High	Low	Medium	High	Medium
Alternative A - Reach 2	High	Medium	Low	Medium	Medium	Low
Alternative B - Reach 1	High	High	High	High	High	High
Alternative B - Reach 2	High	Low	Low	Low	Medium	Low
Alternative C - Reach 1	High	Low	Low	Low	Medium	Low
Alternative C - Reach 2	Medium	Low	Low	Low	Medium	Low

3.5.2.2 Four Account Alternative Comparison

Due to the small project footprint, similarity of each alternative, limited nature of the authority and minimal effects of any alternative, a comparison of alternatives against the four P&G accounts is difficult. Per EP 1105-2-79, Planning Aquatic Ecosystem Restoration Civil Works Mission and Evaluation Procedures, "Alternative plans that qualify for further consideration will be compared against each other to identify the recommended plan." Due to the reasons above and to expedite project delivery through risk-informed decision making, a qualitative analysis of

each alternative and the without-project condition is presented below. A quantitative analysis would require significant cost to perform and provide vanishingly small differences between each alternative.

National Economic Development (NED)

NED is the estimated change in nationwide economic output that occur as a result of project alternatives as opposed to the same output without a plan. The three alternatives in the final array are similar in nature. Each would remove the culvert and overlying asphalt parking lot above Boone Creek in the project area and open the stream to daylight, thereby restoring the riparian environment to a more natural above-ground state. Due to the small size of the project area (less than 4 acres) the alternatives are a mixture of daylighting, creation of wetlands, planting and floodplain terracing. A more differentiated alternative could not be formulated given the strict constraints in the project area. A NED analysis comparing the three alternatives would not show any measurable difference between the three. A comparison of any of the three final array against the without-project condition would likely show an infinitesimally small increase in NED due to the incidental benefits in reducing flood risks. Given that Alternative B reach 1 would have slightly a better ability to retain flood waters due to the incorporation of wetlands adjacent to the stream, the NED plan is qualitatively identified as Alternative B, reach 1.

Environmental Quality (EQ)

EQ evaluation is used to identify significant beneficial and adverse effects of alternative plans on significant EQ resources. All the three alternatives in the final array create significant EQ benefits over the without-project condition due to the daylighting of Boone Creek and the incorporation of native plants and streambed restoration. However, Alternative B, reach 1 produces slightly higher EQ benefits as it incorporates a wetland into the project alignment. As discussed throughout the rest of Chapter 3, the wetland was the driving factor in the increased CE/ICA score of Alternative B. Because the environmental benefits are the driving factor for Section 206 projects, the discussion and comparison of environmental quality factors is found throughout Chapter 3 of this report. The EQ plan is identified as Alternative B, reach 1.

Regional Economic Development (RED)

RED is the changes in the distribution of regional economic activity that results from each alternative plan and the without-project condition. RED benefits from the three final alternatives are so similar that an economic analysis through the Regional Economic System (RECONS) is not warranted. Any of the three final alternatives would be expected to create a minor amount regional economic output in jobs, earnings, and infrastructure spending. The without-project condition currently provides parking for ASU. The loss of these parking spaces may cause some slight temporary loss in RED benefits. However, ASU plans to construct a larger parking garage adjacent to the project area. Both the Non-Federal Sponsors have conceded that there will be a loss of parking at Appalachian State University due to the project but are in agreement that the environmental benefits outweigh the temporary loss of parking in the area. As in the NED and EQ accounts, the formulated changes in regional economic activity are so minimal between the alternatives and the without-project conditions, a qualitative analysis of RED is not warranted.

Other Social Effects (OSE)

OSE benefits any of the formulated alternatives are significantly greater than the without-project condition. The addition of recreational and viewing opportunities along the newly created stream bank are significant to the Non-Federal Sponsors. They also are anticipating the ability to instruct biology and ecology courses in the restored waterway. Due to the incorporation of a wetland in Alternative B, reach 1 would allow additional recreational viewing and instructing opportunities to the Non-Federal Sponsors, Alternative B, reach 1 is qualitatively selected as OSE plan.

3.5.2.3 Final Screening of Alternatives

Cost Effective/Incremental Cost Analysis

Cost effectiveness and incremental cost analysis (CE/ICA) are two distinct analyses that must be conducted to evaluate the effects of alternative plans according to USACE policy. First, it must be shown through cost effectiveness analysis that a restoration plan's output cannot be produced more cost effectively by another alternative. Cost effective means that, for a given level of non-monetary output, no other plan costs less and no other plan yields more output at a lower cost. Subsequently, through incremental cost analysis, a variety of alternatives and various-sized alternatives are evaluated to arrive at a "best" level of output within the limits of both the sponsors' and the USACE's capabilities.

The North Carolina Stream Assessment Method (NC SAM) Version 2.1 was utilized in order to assess the present stream conditions and to model conditions under the alternatives. A site visit occurred in the Fall 2023 for the collection of the baseline data used for the model. The NC SAM Stream Quality Assessment Sheet (SQAM) was used to calculate predicted change in habitat quality in order to quantitatively weigh the habitat units by acre. The SQAM evaluated the following characteristics: physical, stability, habitat, and biology, and an individual score was assigned for each sub-characteristic. Habitat units for each alternative were then calculated using amount of habitat created in acres and the SQAM scores as shown in Table 5, and average annual habitat units were calculated over a 50-year period as shown in

Site Name	**Acres (All Habitat)**	**Habitat Units (HU)**	**Average Annual Habitat Units (AAHU)**

		HU w/o Project (Combined)	HU w/ Project (Combined)	NET HU W/ Project (Combined)	AAHU Existing	AAHU With Project	Δ AAHU
Alt A-1	1.3	0.1430	0.60	0.46	0.14	0.60	0.46
Alt A-2	0.32	0.04	0.10	0.07	0.04	0.10	0.07
Alt B-1	1.75	0.19	1.02	0.82	0.19	1.02	0.82
Alt B-2	0.36	0.04	0.14	0.10	0.04	0.14	0.10
Alt C-1	0.9	0.10	0.34	0.24	0.10	0.34	0.24
Alt C-2	0.25	0.028	0.06	0.04	0.03	0.06	0.03

Table 72. In addition, the average annualized costs of each alternative were calculated over a 50-year period as shown in Table 7.

Table 5 – Habitat Units for Each Alternative

Site Name	Acres (Cover type = EM Wetland and Riparian)	SQAM W/O Project	SQAM with Project	SQAM W/O Project Normalized	SQAM With-Project Normalized	Habitat Units W/O Project	Habitat Units with Project
Alt A-1	1.3	11	46	0.11	0.46	0.14	0.60
Alt A-2	0.32	11	32	0.11	0.32	0.04	0.10
Alt B-1	1.75	11	58	0.11	0.58	0.19	1.02
Alt B-2	0.36	11	40	0.11	0.4	0.04	0.14
Alt C-1	0.9	11	38	0.11	0.38	0.10	0.34
Alt C-2	0.25	11	25	0.11	0.25	0.03	0.06

Table 6 – Average Annual Habitat Units for Each Alternative

Site Name	Acres (All Habitat)	Habitat Units (HU)			Average Annual Habitat Units (AAHU)		
		HU w/o Project (Combined)	HU w/ Project (Combined)	NET HU W/ Project (Combined)	AAHU Existing	AAHU With Project	Δ AAHU
Alt A-1	1.3	0.1430	0.60	0.46	0.14	0.60	0.46
Alt A-2	0.32	0.04	0.10	0.07	0.04	0.10	0.07
Alt B-1	1.75	0.19	1.02	0.82	0.19	1.02	0.82
Alt B-2	0.36	0.04	0.14	0.10	0.04	0.14	0.10
Alt C-1	0.9	0.10	0.34	0.24	0.10	0.34	0.24
Alt C-2	0.25	0.028	0.06	0.04	0.03	0.06	0.03

Table 72 – Cost per Average Annual Habitat Unit

Site Name	Acres	Net AAHUs	AAC	$/AAHU	$/Acre
Alt A-1	1.3	0.46	$231,502	$508,796	$178,078
Alt A-2	0.32	0.07	$193,767	$2,883,438	$605,522
Alt B-1	1.75	0.82	$315,021	$383,004	$180,012
Alt B-2	0.36	0.10	$176,431	$1,757,281	$490,086
Alt C-1	0.9	0.24	$273,900	$1,136,515	$304,333
Alt C-2	0.25	0.03	$201,736	$6,207,262	$806,944

The subset of cost-effective plans is examined sequentially (by increasing scale and increment of output) to ascertain which plans are most efficient in the production of environmental benefits. Those most efficient plans are called “best buys.” As a group of measures, they provide the greatest increase in output for the least increases in cost. They have the lowest incremental costs per unit of output. In most analyses, there will be a series of best buy plans, in which the relationship between the quantity of outputs and the unit cost is evident. As the scale of best buy plans increases (in terms of output produced), average costs per unit of output and incremental

costs per unit of output will increase as well. The incremental analysis by itself will not point to the selection of any single plan. The results of the incremental analysis must be synthesized with other decision-making criteria (i.e., significance of outputs, acceptability, completeness, effectiveness, risk and uncertainty, reasonableness of costs) to help the study team select and recommend a plan.

Four (4) alternative reaches for Reach 1 and four (4) alternative reaches for Reach 2, including the No Action Alternative (NAA), were input into the Institute for Water Resources (IWR) Planning Suite II to perform a cost effectiveness and incremental cost analysis using the average annual habitat units and average annual cost (highlighted in green above). The software identified Alternative A – Reach 1 and Alternative B – Reach 2 as being cost effective (Table 83). The NAA is always considered a best buy; however, Alternative B - Reach 1 was also identified as a "best buy" (Table 8Figure 8).

Table 83 – CE/ICA Output Table

Plan	Plan Description	Cost (Thousands)	Output	Cost Effective
No Action	Default No Action Plan	$0.00	0	Best Buy
Alt A-1	Upstream, No Wetlands	$232.00	0.46	Cost Effective
Alt A-2	Downstream, Two Short Walls	$194.00	0.06	Non-Cost Effective
Alt B-1	Upstream, Wetlands	$315.00	0.82	Best Buy
Alt B-2	Downstream, One Tall Wall and Bank	$176.00	0.1	Cost Effective
Alt C-1	Upstream, No Wetlands or Benches	$274.00	0.24	Non-Cost Effective
Alt C-2	Downstream, Two Tall Walls	$202.00	0.03	Non-Cost Effective

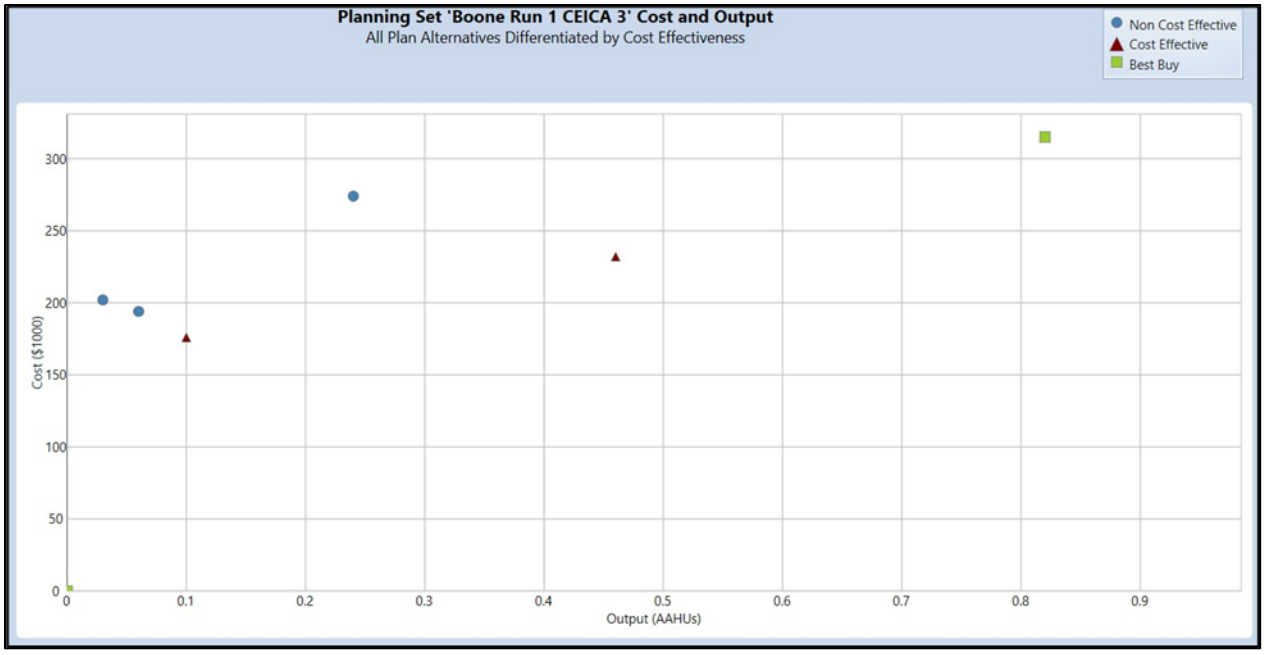

Figure 88 – CE/ICA Output Graph

Planning Evaluation Criteria

Each Alternative Reach was evaluated against the four planning evaluation criteria of acceptability, completeness, effectiveness, and efficiency, as defined below. Alternatives considered in any planning study, not just aquatic ecosystem restoration studies, should meet minimum subjective standards of these criteria to qualify for further consideration and comparison with other plans. Each criterion was rated Low, Medium, or High based on what level the alternative met the criteria (Table 94).

Acceptability

An aquatic ecosystem restoration plan should be acceptable to state and federal resource agencies and local governments. There should be evidence of broad-based public consensus and support for the plan. A recommended plan must be acceptable to the non-federal cost-sharing partner. However, this does not mean that the recommended plan must be the locally preferred plan.

Completeness

A plan must provide and account for all necessary investments or other actions needed to ensure the realization of the planned restoration outputs. This may require relating the plan to other types of public or private plans if these plans are crucial to the outcome of the restoration objective. Alternatives that provided both strong riverine and riparian connectivity with higher habitat output scored higher in comparison to other alternatives.

Efficiency

An aquatic ecosystem restoration plan must represent a cost-effective means of addressing the restoration problem or opportunity. It must be determined that the plan's restoration outputs cannot be produced more cost effectively by another agency or institution. The cost effectiveness

of the array of alternatives was analyzed using IWR-Plan software. This metric assessed how much effort would be involved with subsequent operations and maintenance of each alternative once complete. The PDT discussed adaptive management, operations and maintenance, and compared the average annual cost to rate each alternative.

Effectiveness

An aquatic ecosystem restoration plan must make a significant contribution to addressing the specified restoration problems or opportunities (i.e., restore important ecosystem structure or function to some meaningful degree). Effectiveness was rated by reviewing the cost per unit output and where the amount was higher in comparison, the alternative received a lower rating.

4Table 5 – Matrix for Evaluating Alternatives against Planning Criteria

Alternative	Objective			
	Acceptable	Complete	Efficient	Effective
Alternative A - Reach 1	Medium	Medium	Medium	Medium
Alternative A - Reach 2	Medium	Medium	Low	Medium
Alternative B - Reach 1	High	High	High	High
Alternative B - Reach 2	Medium	Medium	Medium	Medium
Alternative C - Reach 1	Medium	Medium	Low	Low
Alternative C - Reach 2	Medium	Medium	Low	Low

Each alternative was similarly acceptable and complete. According to the CE/ICA analysis, Alternative B – Reach 1 is the Best Buy plan due to the additional wetlands, therefore ranking "High" for efficiency and effectiveness. Alternative A – Reach 1 and Alternative B – Reach 2 are both Cost Effective plans; however, Alternative A – Reach 1 was screened since Alternative B – Reach 1 is the Best Buy plan. All other alternatives were not efficient and were therefore screened. As such, the Recommended Plan is Alternative B (Stream Daylighting + Floodplain Terraces + Riparian Development + Wetlands + Stabilization).

3.5.3 Risk and Uncertainty

A risk and uncertainty analysis have been completed to identify the degree of risk and uncertainty associated with this project. As part of this analysis, a risk register was completed which integrates the uncertainty from the hydrology, hydraulics, economics, and other aspects of the project into the plan formulation process. Feasibility study team members selected their best estimates for project management, planning, environmental, real estate, hydrologic, hydraulic, cost engineering, and economic parameters used in the analysis to determine their related uncertainty. The risks are outlined in detail in Appendix H – Risk Register. An abbreviated cost engineering risk analysis (CSRA) assessment is provided in the Cost Engineering Report in Appendix D. A discussion of project risks and uncertainties is summarized below.

<u>Hydrology & Hydraulics</u>

The inundation duration for wetlands is a critical factor in success of plant communities selected for implementation. For the inundation duration maps, which were developed using USGS data paired with hydraulic modeling, can be found in Appendix A. Despite models, climatic weather

shifts can increase the uncertainty of duration and extent of inundation for the implemented wetlands.

A complete qualitative assessment of changing climatic conditions is included in Engineering Appendix A, and these impacts are summarized in Section 3.3 - MOST PROBABLE FUTURE WITHOUT PROJECT CONDITIONS of this DPR. This climate analysis indicates the Town of Boone Ecosystem Restoration – Habitat Restoration Project should expect warmer temperatures going into the future and there is a possibility of increasing rainfall and stream flow as well. These potential changes in future climate and hydrology highlight the importance of the project's ability to be resilient to future conditions.

Structures should be selected, designed, and placed to accommodate future conditions where streamflow could have more erosive power. The future conditions also highlight the need for additional habitat creation to offset the amplified stresses the environment is anticipated to experience. Higher temperatures and more sporadic and unpredictable rainfall make habitats such as wetlands all the more valuable. These wetlands will be designed appropriately, with adequate water supply and groundwater considerations, to be resilient to a variable and difficult future condition. The same can be said for in-stream measures, which must be able to accommodate both increased high-flows, and potentially prolonged low-flow drought periods simultaneously.

Native Plantings

Native plantings have an associated risk of not establishing due to a variety of unforeseen events. Predation from herbivorous animals and insects is a possibility and can be reasonably estimated based on baseline surveys of the existing flora and fauna. Weather also plays a large role in the establishment success of new plantings where periods of drought or early frost may alter the survival percentage of plantings. Although historical records can help to predict the best possible location and timing of new plantings, a single unforeseen event may lead to failure. To mitigate these risks, planting over several years, overplanting, and/or adaptive management and monitoring may be incorporated into the overall plan. Uncertainties of planting native plants can be reduced by considering the following:

- Use local plant genetics.
- Use soil amendments.
- Plant tougher species first, then add in more sensitive ones once the first are establish.
- Ensure the planting contract is a five-year contract.
- Establish plants through temporary watering (deep and infrequent).
- Introduce temporary predator control (e.g., geese, deer).
- Select species based on hydrologic and geomorphic position.
- Develop a clear and concise maintenance protocol.

3.6 RECOMMENDED PLAN

The recommended plan consists of a combination of Alternative B – Reach 1 and Alternative B – Reach 2. Alternative B provides the best buy alternative while minimizing constraints and maximizing objective considerations and output of CE/ICA model, as discussed in Section

3.5.2.3 - Final Screening of Alternatives. Due to the "non-cost effective" status of Alternative A-Reach 2, C-Reach 1, and C-Reach 2, the complete Alternative A and Alternative C have been considered to be non-cost effective and will not be further evaluated for environmental effects in Section 4. Technical drawings and cross sections can be found in the Engineering Appendix.

3.6.1 Recommended Plan Description

To be more specific, the Recommended Plan will daylight both reaches of Boone Creek into a ten-foot-wide trapezoidal stream channel with terraced floodplains and riparian areas (Figure 10910, Figure 111011). Reach 1 will include depressed wetlands on the Peacock Hall side with native plantings to create a more natural riparian corridor and increase recreational and educational opportunities for students and community members of ASU and the Town. Reach 2 will include a ten- to twelve-foot retaining wall on the Duncan Hall side of Boone Creek instead of terraced floodplains to stabilize the banks. Furthermore, the Project requires removal of the existing access road and culvert. As for a replacement for the access, if it is determined to be eligible for public facility/utility relocations, then the Non-Federal Sponsors (NFS) would be responsible for the cost as part of LERRDs but would be eligible to receive LERRD credit toward the NFS's cost share requirements. If it is determined not eligible for public facility/utility relocations, then the NFS could choose to: 1) not have a replacement, 2) build a replacement after USACE project is complete, or 3) request that USACE include the replacement structures as additional work to be done under the agreement at the NFS's cost.

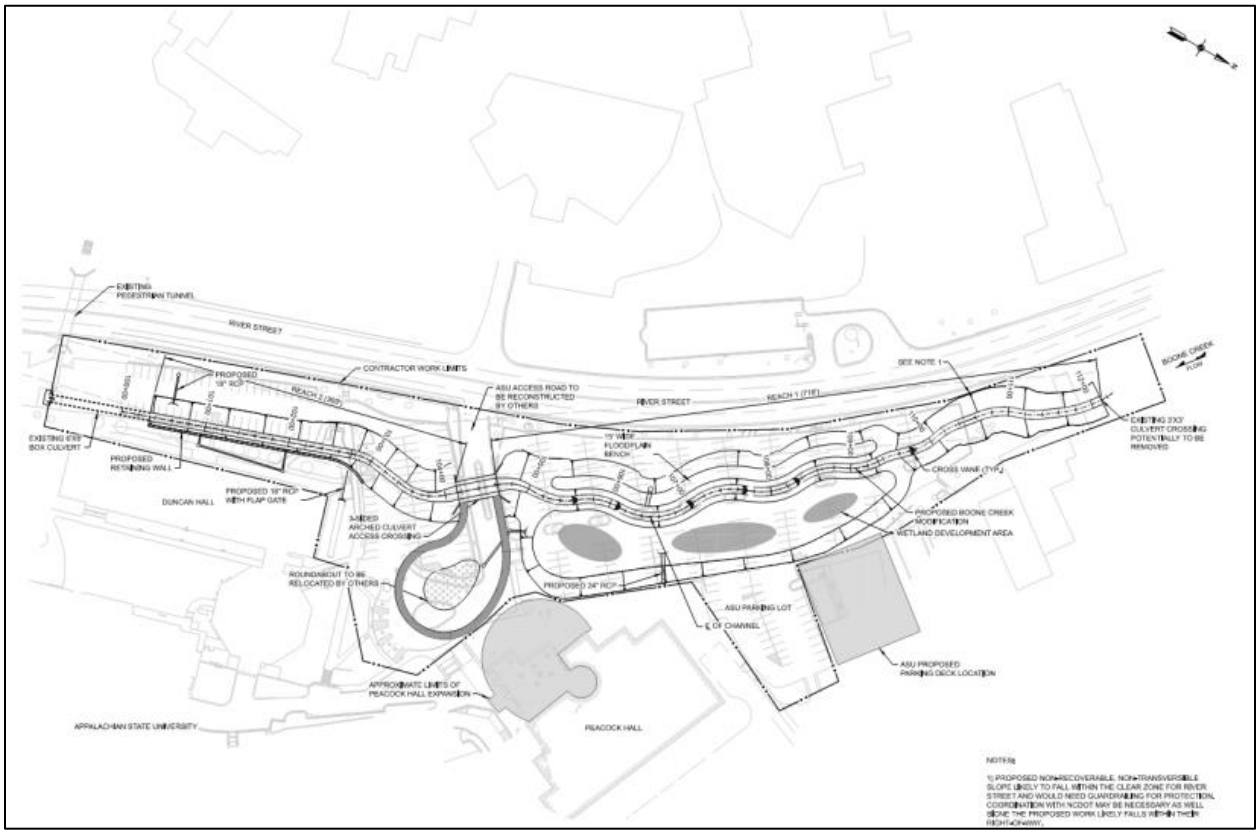

Figure 109 – Recommended Plan Engineering Plans

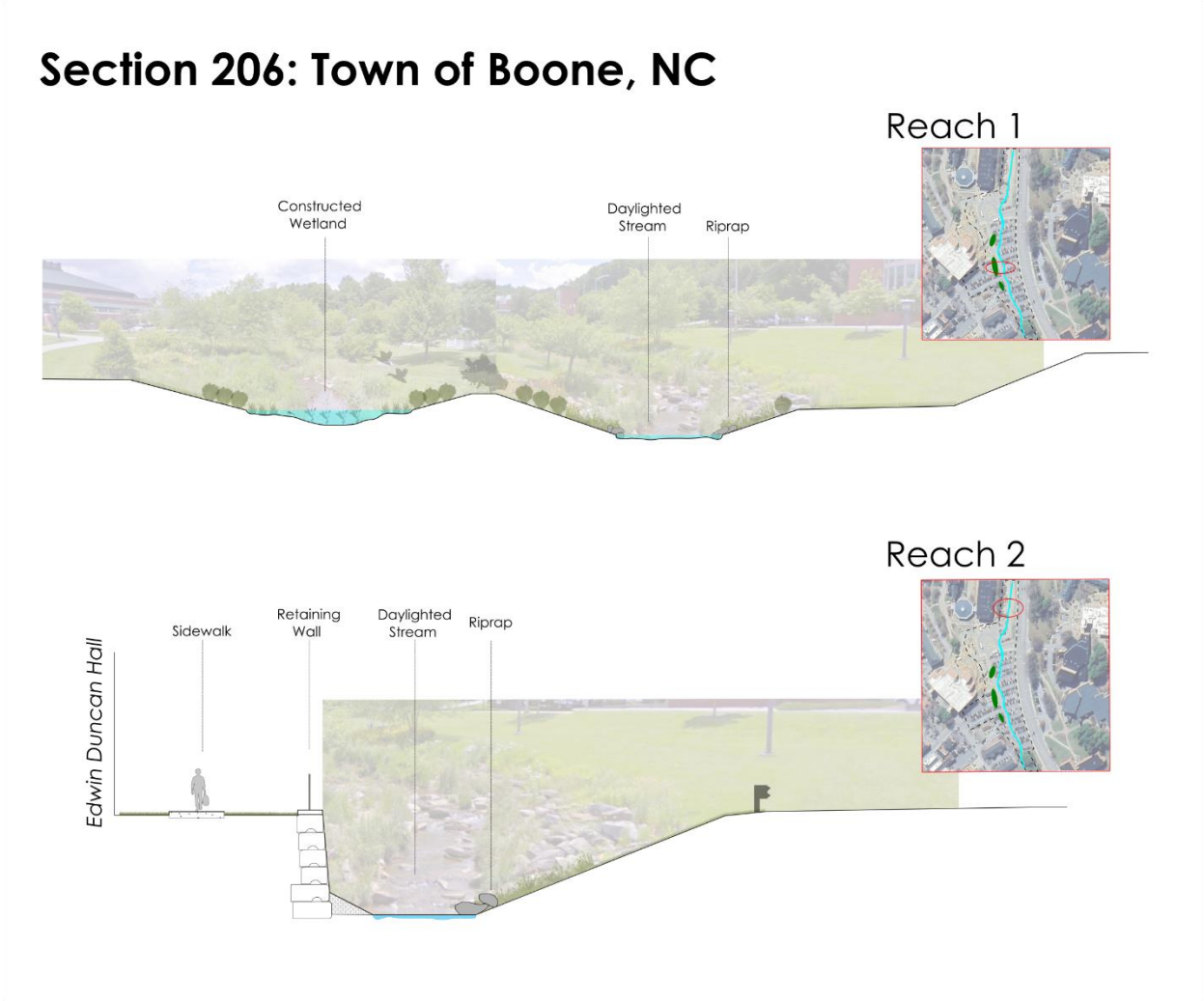

Figure 1110 - Diagram of Recommended Plan

3.6.2 Estimated Project Costs and Schedule

The estimated project cost and apportionment is displayed in Table 10 below. The estimation was developed with PDT forecasting of potential courses of action. The estimated costs for the remainder of the Feasibility Phase were developed from the current project schedule and budget. Following the Feasibility Phase, it was assumed that the Design and Implementation Phase would follow on immediately. The PDT has not yet developed the budget for the Design and Implementation Phase due to the high uncertainty of obtaining funding and the uncertainty of the non-Federal Sponsors' agreement to continue into design following the feasibility phase. The Design and Implementation estimation was developed from the Total Project Cost estimate with contingency and escalation. See the Cost Appendix for Alternative B estimated costs. Construction and LERRDs is not scheduled until 2029 or later and is not included in Table 10 below.

Table 6 10 – Estimated Project Costs and Apportionment

	FY2025	FY2026	FY2027	FY2028
Feasibility Study Costs*				
FED share	$ 184,514	$ 104,138	$ 1,799	
non-FED	$ 84,514	$ 104,138	$ 1,798	
Design & Implementation Costs				
Design Analyses, Plans & Specs			$ 501,000	$ 1,503,000
Construction				
LERRDs				
FED share			$ 325,650	$ 976,950
non-FED			$ 175,350	$ 526,050
non-FED cash/WIK				
non-FED LERRD				
Total Project Cost				
FED share			$ 328,449	$ 926,950
non-FED			$ 177,148	$ 526,050

*Up to first $100,000 is 100% federal responsibility. All costs after FCSA execution are shared 50/50.

Table 117 – Implementation Schedule

Milestone	Scheduled	Actual
Initiate Feasibility Phase	6-Dec-2021	6-Dec-2021
Submit Federal Interest Determination Report	15-Feb-2022	2-Mar-2022
MSC Approved FID Report	15-Feb-2022	4-Mar-2022
Execute Feasibility Cost Share Agreement	1-Dec-2022	14-Apr-2023
Submit MDM Draft DPR	7-Jan-2026	
MSC Approved MDM Draft DPR	11-Feb-2026	
Submit draft Final DPR	3-Mar-2026	
MSC Approved Decision Document	13-Apr-2026	
Project Approval – Initiate D&I Phase	13-Apr-2026	
Fully Executed PPA	21-Aug-2026	
RE Certification	28-Apr-2027	
ATR Certified Construction Plans and Specs	8-Jul-2027	
Construction Contract Award	21-Jan-2028	
Construction Complete	28-Mar-2029	
Project Closeout	18-Jan-2030	

3.6.3 Non-Federal Sponsor Responsibilities

For all aquatic habitat restoration projects funded by the USACE, project costs must be shared between the local sponsors and the USACE. This study was authorized by Section 206 of the

Water Resources Development Act of 1996, Public Law 104-303, as amended, and by Section 210 of WRDA 1999, which modifies portions of the earlier law.

As the non-Federal sponsors, the Town of Boone and Appalachian State University are required to provide 35% of total project costs relating to ecosystem restoration. Total project costs include the costs of the DPR and EA, plans and specifications, and construction. The state is also responsible for 100% of operation and maintenance of constructed feature costs during the 50-year life of the project. Adaptive management and monitoring costs associated with the ecosystem restoration are summarized in Appendix D. The non-Federal sponsors' 35% cost share obligation can be in the form of a cash contribution, in-kind services, or credit for lands, easements, rights-of-way, relocations, and disposal areas (LERRDs). The non-Federal sponsors are responsible for acquiring all LERRDs prior to any construction activity. Before signing the PPA, the non-Federal sponsors must have secured funds to complete the non-Federal cost-sharing portion.

All alternatives have additional work items refer to certain identified project features, namely continued access from Rivers Street to ASU facilities (within the Study Area) by means of a 3-sided arched concrete culvert and all necessary features to provide and construct this access, which are being evaluated in order to determine whether they are able to be part of a public facility/utility relocation. The Project requires removal of the existing access road. As for a replacement for the access, if it is determined to be eligible for public facility/utility relocations, then the Non-Federal Sponsors (NFS) would be responsible for the cost as part of LERRDs but would be eligible to receive LERRD credit toward the NFS's cost share requirements. If it is determined not eligible for public facility/utility relocations, then the NFS could choose to: 1) not have a replacement, 2) build a replacement after USACE project is complete, or 3) request that USACE include the replacement structures as additional work to be done under the agreement at the NFS's cost.

4 ENVIRONMENTAL EFFECTS OF RECOMMENDED PLAN

This section discusses the potential environmental impacts associated with the NAA as well as with implementation of the Recommended Plan. The USACE took context and intensity into consideration in determining potential impact significance. The intensity of a potential impact is the impact's severity and includes consideration of beneficial and adverse effects, the level of controversy associated with a project's impacts on human health, whether the action establishes a precedent for future actions with significant effects, the level of uncertainty about project impacts and whether the action threatens to violate federal, state, or local laws established for the protection of the human and natural environment. The severity of an environmental impact is characterized as none/negligible, minor, moderate, significant, or beneficial. The impact may also be direct, indirect, short-term or long-term in nature.

- None/negligible – No measurable impacts are expected to occur.

- Minor – A measurable and adverse effect to a resource. A slight impact that may not be readily obvious and is within accepted levels for permitting, continued resource sustainability, or human use. Impacts should be avoided and minimized, if possible, but

should not result in a mitigation requirement.

- Significant – A measurable and adverse effect to a resource. A major impact that is readily obvious and is not within accepted levels for permitting, continued resource sustainability, or human use. Impacts likely result in the need for mitigation.

- Beneficial – A measurable and positive effect to a resource. May be minor to major, resulting in improved conditions, sustainability, or viability of the resource.

- Direct – Caused by the action and occur at the same time and place.

- Indirect – Caused by the action and are later in time or farther removed in distance but are still reasonably foreseeable.

- Short-Term – Temporary in nature and does not result in a permanent long-term beneficial or adverse effect to a resource. For example, temporary construction-related effects (such as, an increase in dust, noise, traffic congestion) that no longer occur once construction is complete. May be minor, significant, adverse or beneficial in nature.

- Long-Term – Permanent (or for most of the project life) beneficial or adverse effects to a resource. For example, permanent conversion of a wetland to a parking lot. May be minor, significant, adverse or beneficial in nature.

The USACE used quantitative and qualitative analyses, as appropriate, to determine the level of potential impact from proposed alternatives. Based on the results of the analyses, this section identifies whether a particular potential impact would be adverse or beneficial, and to what extent. NEPA also requires that the reasonably foreseeable future/cumulative effects of the proposed project are addressed. Cumulative impacts are discussed in Section 4.13.

4.1 CLIMATE

Recommended Plan

The Recommended Plan would not involve any activities that could significantly affect the environment regarding climate. Only minor discharges of carbon-based pollutants would occur for a short duration during construction activities that could contribute to increased greenhouse gases. The region is not projected to experience severe drought conditions and is instead expected to experience more precipitation in the future, as referenced in Section 2.1.

The Recommended Plan would result in long-term beneficial impacts by providing some reduction in flooding on the ASU campus during high flow events. In addition, the Recommended Plan would establish riparian and wetland habitat along Boone Creek which would sequester a small amount of carbon from the atmosphere once established. Therefore, activities under the Recommended Plan would not be negative contributing factors to climate and the project as designed would be robust to withstand projected climate events. No significant adverse effects to climate are anticipated as a result of the Recommended Plan.

No Action

Under the NAA, there would be no direct or indirect impacts to climate.

4.2 SOILS AND GEOLOGY

Recommended Plan

There would be no impact to geology of the project area under the Recommended Plan. The features outlined in the Recommended Plan are too minimal to have any effect on local geology.

There would be long-term beneficial impacts to soils under the Recommended Plan. Through reestablishing natural flow regimes and restoring hydrology and native plant communities, soils within the project area would be restored by natural nutrient and water cycles being re-established, and further diversification of native plant and animal assemblages in the soil would occur. Impacts to soils during construction activities for excavation of the channel and removal of unsuitable soil would be temporary and/or minor in nature. Therefore, no significant adverse effects to soils are anticipated as a result of the Recommended Plan.

As there is no prime or other important farmland within the project area, the Huntington District has determined that the Recommended Plan does not impact prime or other important farmland and is therefore not subject to the Farmland Protection Policy Act (FPPA). Coordination with the NRCS is ongoing and will be completed prior to issuance of the FONSI.

No Action

Under the NAA, no ground disturbing activities would occur. Therefore, there would be no direct or indirect impacts to soils, geology, or prime and unique farmland.

4.3 SURFACE WATERS AND OTHER AQUATIC RESOURCES

4.3.1 Surface Water

Recommended Plan

There would be long-term, beneficial effects to Boone Creek under the Recommended Plan. Daylighting of Boone Creek would restore the natural hydraulics of the stream to promote a healthier and more diverse ecosystem. In addition, the proposed wetlands along Boone Creek would help restore the natural hydrology of the project area by slowing and retaining water on the site during high flow events. Implementation of the Recommended Plan would not result in new discharge of pollutants and is expected to have a positive effect on the aquatic habitat and water quality within the project area by reducing pollutant discharge into surrounding waters. Impacts to surface water during construction for in-stream work would be temporary and/or minor in nature and would be minimized by implementing Best Management Practices (BMPs). It is anticipated that the Recommended Plan would fall under Nationwide Permit 27 for Aquatic Habitat Restoration, Enhancement, and Establishment Activities, and a 401 Water Quality Certification would be required. In addition, a National Pollutant Discharge Elimination System (NPDES) permit would be obtained prior to construction, and BMPs would be implemented to minimize any direct or indirect impacts.

Coordination with the NCDEQ is ongoing and will be completed prior to issuance of the FONSI. A Letter of Confirmation will be obtained from the NCDEQ prior to issuance of the FONSI. No significant adverse effects to surface water are anticipated as a result of the Recommended Plan.

No Action
Under the NAA, Boone Creek would remain culverted, and no improvements would occur. Therefore, there would continue to be direct, long-term negative impacts to surface water due to thermal pollution and salinity.

4.3.2 Groundwater

Recommended Plan
There would be long-term, beneficial effects to groundwater-surface water interactions along Boone Creek under the Recommended Plan. Removing the culvert would reduce stream temperatures and restore groundwater-surface water interactions. In addition, establishment of plant communities and wetlands would collect excess nutrients and toxins in the water before it is able to infiltrate local groundwater resources. As stated above, BMPs would be implemented to minimize any direct or indirect impacts such as stormwater runoff during construction. No significant adverse effects to groundwater are anticipated as a result of the Recommended Plan.

No Action
Under the NAA, Boone Creek would remain culverted, and no improvements would occur. Therefore, there would continue to be direct, long-term negative impacts to groundwater due to thermal pollution.

4.3.3 Floodplains

Recommended Plan
There would be long-term, beneficial effects to floodplains and the regulatory floodway under the Recommended Plan. The floodplain and regulatory floodway along the project reach of Boone Creek is currently restricted due to the presence of the culvert. Under the Recommended Plan, the banks along Boone Creek would be graded to allow the stream to more easily connect to the floodplain, and establishment of plant communities and wetlands adjacent to the stream would help restore the hydrology of the floodplain. Therefore, daylighting Boone Creek as well as removal of the parking lot would promote re-establishment of the floodplain. On 13 May 2025, the Town of Boone floodplain administrator determined that a permit would not be required as they do not have developmental regulation over ASU. No significant adverse effects to floodplains or the regulatory floodway are anticipated as a result of the Recommended Plan. As the project moves into the design and implementation phase, coordination with FEMA will occur on the need for Condition Letter of Map Revision and Letter of Map Revision (CLOMR/LOMR) for the project.

The eight steps associated with the decision-making process in E.O. 11988 were considered in the evaluation of the Recommended Plan. See Table 12812 below for more detail on how each step was considered. Based on the findings and determination discussed in this report, the Recommended Plan is in compliance with E.O. 11988.

Table 128 – Eight Step Decision Making Process

Determine if a proposed action is in the base floodplain.	Yes, portions of the proposed alternatives are within the regulatory floodplain and Special Flood Hazard Area.

Conduct early public review, including public notice.	Coordination with the local floodplain manager will occur and additionally, a 30-day public review period will be conducted for this Integrated DPR and EA.
Identify and evaluate practicable alternatives to locating in the base floodplain, including alternative sites outside of the floodplain.	The purpose of the proposed project is to daylight and restore Boone Creek. No acceptable alternatives were identified outside of the floodplain.
Identify impacts of the proposed action.	Based on the current effective FEMA model, a portion of the project is located within the floodplain and regulatory floodway. The Recommended Plan is designed in a manner that will help restore the floodplain and regulatory floodway. HEC-RAS H&H modelling has been completed.
If impacts cannot be avoided, develop measures to minimize the impacts and restore and preserve the floodplain, as appropriate.	The project as designed would restore the hydrology of the floodplain and no adverse impacts are anticipated.
Reevaluate alternatives.	Alternatives were developed during formulation of the DPR and all environmental impacts were considered and the impacts are considered minimal in the Integrated DPR and EA.
Present the findings and a public explanation.	The findings will be presented during the 30-day public review.
Implement the action.	Implementation is dependent upon execution of the Project Partnership Agreement and allocation of funding.

No Action

Under the NAA, no changes to the floodplain would occur. Therefore, there would be no direct or indirect impacts to floodplains.

4.3.4 Wetlands

Recommended Plan

There would be long-term beneficial effects to wetlands under the Recommended Plan. A total of approximately 0.5 acres of wetland habitat would be created adjacent to Boone Creek. These wetlands would create habitat heterogeneity and increase diversity and ecological function of the project reach. No significant adverse effects to wetlands are anticipated as a result of the Recommended Plan.

No Action

Under the NAA, there would be no direct or indirect impacts to wetlands.

4.4 FISH AND WILDLIFE HABITATS

4.4.1 Terrestrial and Aquatic Vegetation

Recommended Plan

There would be long-term beneficial effects to terrestrial and aquatic vegetation under the Recommended Plan. Removal of the parking lot would allow for establishment of native plant communities along Boone Creek within the riparian zone and wetlands, and daylighting of the stream would improve aquatic habitat within Boone Creek through restoration of natural stream flow and conditions. Less than one (1) acre of decorative trees would be cleared; however, trees would be preserved where possible. In addition, under the Recommended Plan, native tree species and other woody vegetation would be planted along Boone Creek, and it is anticipated plant communities would be fully established within 10 years after project implementation. Therefore, impacts to terrestrial and aquatic vegetation would be minor and/or temporary in nature, and no significant adverse effects to terrestrial and aquatic habitat are anticipated as a result of the Recommended Plan.

No Action

Under the NAA, no changes to terrestrial and aquatic vegetation would occur. Therefore, there would be no direct or indirect impacts to terrestrial and aquatic habitat.

4.4.2 Fauna

Recommended Plan

There would be long-term beneficial effects to terrestrial and aquatic fauna such as fish, macroinvertebrates, mammals, reptiles, amphibians, and resident and migratory birds under the Recommended Plan. Restoration of Boone Creek and the creation of wetlands and floodplain terracing would improve water quality conditions and help address thermal pollution and salinity issues within the stream. In addition, re-establishment of native plant communities would serve as a food and shelter source for local fauna. Impacts to local fauna from construction activities would be minor and/or temporary in nature, and short-term displacement of some wildlife could occur. However, no significant adverse effects to terrestrial and aquatic habitat are anticipated as a result of the Recommended Plan

No Action

Under the NAA, there would be no direct or indirect impacts to local fauna.

4.5 ENDANGERED AND THREATENED SPECIES

Recommended Plan

There would be long-term beneficial effects to threatened and endangered species under the Recommended Plan as habitat within the project area would be restored to more natural conditions. Direct impacts to threatened and endangered species from construction activities would be minor and/or temporary in nature, and BMPs would be implemented to minimize any indirect impacts.

The Recommended Plan would involve removal of less than one (1) acre of trees. Trees within the project area are decorative and not preferred habitat for the gray bat, Indiana bat, tricolored bat, or Virginia big-eared bat. However, bats may be displaced during construction activities, and short-term and/or minor impacts to foraging, roosting, and transient habitat for bats may occur.

Native tree species would be planted along Boone Creek and would provide suitable habitat once established. Therefore, the Huntington District has determined that the Recommend Plan may affect, but is not likely to adversely affect, the gray bat, Indiana bat, tricolored bat, or Virginia big-eared bat.

The Recommended Plan would involve in-stream work in a culverted section of Boone Creek. This section of Boone Creek is heavily urbanized and does not provide suitable habitat for the other aforementioned state or Federally listed species. Therefore, the Huntington District has determined that the Recommended Plan would have no effect on the bog turtle, eastern hellbender, green floater, monarch butterfly, Virginia spiraea, and rock gnome lichen.

On 3 June 2025, the USFWS Asheville Field Office concurred with the Huntington District's determinations. Consultation under the Fish and Wildlife Coordination Act with the USFWS Asheville Field Office is ongoing and will be completed prior to issuance of the FONSI.

No Action
Under the NAA, there would be no direct or indirect impacts to endangered and threatened species.

4.6 RECREATIONAL, SCENIC, AND AESTHETIC RESOURCES

Recommended Plan
The Recommended Plan would have long-term beneficial effects to recreational, scenic, and aesthetic resources. Native plant communities would be restored along the highly trafficked ASU campus, which would allow for more scenic views and more opportunities to view wildlife. In addition, water quality and fish communities would be improved and could therefore provide additional educational opportunities for ASU staff and students. The proposed retaining wall would be constructed in a manner that it would not obstruct the viewshed. No significant adverse effects to recreational, scenic, and aesthetic resources are anticipated as a result of the Recommended Plan.

No Action
Under the NAA, there would be no changes to Boone Creek. Therefore, there would be no direct or indirect impacts to recreational, scenic, and aesthetic resources.

4.7 CULTURAL RESOURCES

Recommended Plan
In 2023 the USACE provided preliminary notification to North Carolina resource agencies with interest in the proposed project. The North Carolina Department of Natural and Cultural Resources (SHPO) was included in this notification, and they responded on 30 January 2023 with the following comments:

1. "We have conducted a review of the project and are aware of no historic resources which would be affected by the project. Therefore, we have no comment on the project as proposed."

This preliminary notification was not intended as official Section 106 coordination, and an effects determination was not made by the USACE. To fulfill the USACE's statutory

requirements, the USACE will re-coordinate with the North Carolina SHPO and will initiate tribal coordination prior to issuance of the FONSI. The USACE anticipates that the Recommended Plan will constitute a *no adverse effect* determination.

No Action
Under the NAA, there would be no direct or indirect impacts to cultural resources.

4.8 AIR QUALITY

Recommended Plan
The Recommended Plan would have short-term minor effects to air quality and generate a variety of GHG emissions throughout its life cycle, spanning from construction to O&M of the project. GHGs such as carbon dioxide (CO_2), methane (CH_4), and nitrous oxides (NO_x) are considered pollutants to air quality. Impacts would be temporary and localized and primarily occur during construction activities, and the Contractor would be required to operate all equipment and machinery in accordance with local, state, and Federal regulations. In addition, BMPs such as implementing dust control measures throughout the construction site would be utilized to the extent practicable. Therefore, estimated emissions from construction equipment would not be expected to exceed *de minimis* levels, direct emissions of a criteria pollutant, or its precursors. No significant adverse effects to air quality are anticipated as a result of the Recommended Plan.

No Action
Under the NAA, there would be no direct or indirect impacts to air quality.

4.9 NOISE

Recommended Plan
The Recommended Plan would have short-term minor effects to noise. Noise associated with the Recommended Plan would be limited to that generated during construction, and the Contractor would be required to abide by the local noise ordinance. It is anticipated that construction noise would be similar to that of farm equipment and other small machinery.

An excavator, dump truck, grader, and backhoe are examples of equipment that are likely to be used during construction. Each emits noise levels around 85 dBA at 45 feet. Peak outdoor noise levels ranging from 78-90 dBA would occur during the time in which equipment is directly in front of or in proximity to buildings (within 25-100 feet). A maximum noise exposure of approximately 98 dBA, for one (1) hour, could occur if equipment were within 10 feet of buildings. Sensitive noise receptors within the project area include Duncan Hall and Peacock Hall as well as students and staff walking on campus.

The noise projections do not account for screening objects, such as trees, outbuildings or other objects that muffle and reduce the noise being emitted, or existing noise conditions that individuals already experience in the project area. The outdoor construction noise would be further muffled while individuals are inside a building. While the construction noise generated would be considered unacceptable according to HUD and FAA standards, these limited exposures and time intervals are still within allowable USACE safety levels. Further, they are similar to typical local noise levels generated by equipment such as traffic or gas powered lawnmowers, which could range from 90-95 dBA at three feet and 70-75 dBA at 100 feet.

Individuals being exposed to these noise levels would occur if and/or when individuals are walking within close distance of the construction site or when equipment is operating in close proximity to campus buildings. To the extent practicable, the majority of the ground disturbing activities could occur during the summer months when fewer students are on campus to limit the exposure and disruption on campus.

Due to daytime construction and the short and limited duration of elevated noise levels associated with the Recommended Plan, there would be no significant adverse impacts to noise.

No Action
Under the NAA, there would be no direct or indirect impacts to noise.

4.10 HAZARDOUS AND TOXIC SUBSTANCES

The Recommended Plan and No Action would have no effect on hazardous and toxic substances.

4.11 SOCIOECONOMICS

Recommended Plan
The Recommend Plan would provide long-term beneficial effects to the local community, including at-risk populations. The Recommend Plan is considered aquatic ecosystem restoration and would benefit the surrounding environment and communities. In addition, the Recommended Plan meets the directive of E.O. 13045 by avoiding any disproportionately high adverse human health or environmental effects on children. Therefore, no significant adverse impacts to the local community are anticipated as a result of the Recommended Plan.

No Action
Under the NAA, there would be no direct or indirect impacts to the local community.

4.12 HEALTH AND SAFETY

Recommended Plan
The Recommended Plan could have short-term minor effects to health and safety during construction. The Contractor would be required to implement health and safety measures as appropriate in accordance with local, state, and Federal laws such as blocking public access to the construction site. Therefore, no significant adverse impacts to health and safety are anticipated as a result of the Recommended Plan.

No Action
Under the NAA, there would be no direct or indirect impact to the health and safety.

4.12.1 Traffic and Transportation

Recommended Plan
The Recommended Plan would have short-term and long-term minor to moderate effects to traffic and transportation during construction. There would be no access to the existing parking lot area and the AppalCart bus loop, and the parking lot would be permanently removed under the Recommended Plan. In addition, there would be increased vehicle traffic on Rivers Street from construction activities, and the Contractor may be required to have temporary lane closures.

Impacts under the Recommended Plan would be mitigated by providing alternate access routes, and necessary traffic controls would be utilized during construction and the Contractor would adhere to North Carolina Department of Transportation (NCDOT) guidelines. In addition, the Contractor could perform the work during the summer when less students and staff are on campus. Therefore, no significant adverse impacts to traffic and transportation are anticipated as part of the Recommended Plan.

No Action
Under the NAA, there would be no direct or indirect impact to the traffic and transportation.

4.13 CUMULATIVE EFFECTS

The USACE must consider the reasonably foreseeable future/cumulative effects of the proposed project on the environment, as stipulated by NEPA. Cumulative effects are 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. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time.

The cumulative effects are based on the potential effects of the proposed project when added to similar impacts from other projects in the region. An inherent part of the cumulative effects analysis is the uncertainty surrounding actions that have not yet been fully developed. Therefore, uncertainties are included where there is incomplete or unavailable information.

Temporal and geographical limits for this project must be established in order to frame the analysis. These limits can vary by the resources that are affected. The restoration of Boone Creek would have some negative impacts on the environment. However, long-term, beneficial effects would result from the project and would include improvements to terrestrial and aquatic habitats. The temporal limits for assessment of this impact would initiate in 1972 with the passage of the Clean Water Act and end 50 years after completion of this project. The geographical extent would be broadened to consider effects beyond the Recommended Plan. The geographical extent considered is the New River Watershed which is part of the greater Watauga River Watershed.

The Watauga River Watershed has been heavily urbanized in the past. Other similar ecosystem projects have occurred within the watershed and directly downstream from the Recommended Plan. These downstream sections of Boone Creek were daylighted in the 1990s and 2010 and provide ecological uplift and benefits to the environment. In addition to past actions that have occurred within the watershed, there are presently construction projects ongoing at ASU that could have an impact on Recommend Plan.

Overall, urbanization within the Watauga River Watershed is expected to continue which could potentially cause further degradation to the natural environment. However, the reasonably foreseeable future actions that would have similar impacts as the Recommended Plan, are anticipated to have a positive cumulative effect on health and safety in the region and offset negative impacts that could arise from urbanization. Water quality standards and regulations are expected to remain as stringent in the future as today. Furthermore, some of these actions may benefit aquatic resources by preventing erosion or modifying flows to mimic natural conditions. In scoping of cumulative effects, no resources were identified as having a potential to be

significantly, adversely impacted.

5 MITIGATION OF ADVERSE EFFECTS

Mitigation measures are not required for this project. BMPs would be implemented during construction to minimize impacts.

6 IMPLEMENTATION REQUIREMENTS

6.1 PROJECT PARTNERSHIP AGREEMENT

The Town of Boone, North Carolina provided a Letter of Intent (LOI) on 27 August 2021, requesting Federal assistance under the Section 206 authority. After completion of the feasibility phase, the USACE Huntington District will execute a Project Partnership Agreement (PPA) with the Town of Boone and the Appalachian State University prior to construction.

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

The Non-Federal Sponsors (NFS) would be responsible for the acquisition of all LERRDs. Further details and maps pertaining to LERRDs may be found in the Real Estate Plan (Appendix E).

6.3 MONITORING AND ADAPTIVE MANAGEMENT

Section 2039 of WRDA 2007, 33 U.S.C. § 2330a, directs the Secretary to ensure that when conducting a feasibility study for a project (or a component of a project) for ecosystem restoration that the recommended project can include a plan for monitoring the success of the ecosystem restoration for a period of up to 10 years from completion of construction of an ecosystem restoration project.

The USACE Huntington District shall prepare a monitoring plan for the project and conduct monitoring in conjunction with the non-Federal sponsors. The principal goal of a resulting project is to restore stream connectivity and habitat to restore natural stream flows and processes. Baseline data for current conditions of Boone Creek are detailed in this DPR/EA. The following specific monitoring objectives were established to determine the effectiveness of this project:

- Restore stream habitat as measured by the presence of naturalized stream hydrology and hydraulics

- Reestablish natural fluvial geomorphic parameters (hydraulics, substrates) and structures to support riverine and riparian habitats within the study area. Improvement is measured via the predicted increase in the SQAM scores.

6.4 OPERATION, MAINTENANCE, REPAIR, REPLACEMENT, AND REHABILITATION

The non-Federal sponsors' operation and maintenance responsibilities, required to assure the continued functionality of the Recommended Plan, will include but not be limited to inspecting the project annually and after high water events, and correcting adverse conditions such as loss

of stone. All operation and maintenance responsibilities will be the non-Federal sponsors' obligation in perpetuity upon completion the project. It is estimated that the annual OMRR&R is approximately $13,000.

6.5 REGULATORY REQUIREMENTS

The Recommended Plan will be in full compliance with all local, state, and Federal statutes as well as Executive Orders. Compliance is documented in Table 13913.

7 STATUS OF ENVIRONMENTAL COMPLIANCE

The Recommended Plan will be in full compliance with all local, state, and Federal statutes as well as Executive Orders prior to issuance of a FONSI. Compliance is documented below in Table 13913.

Table 139 – Environmental Compliance Status

Statute/Executive Order	Full	Partial	N/A
National Environmental Policy Act (considered partial until the FONSI is signed)		X	
Fish and Wildlife Coordination Act		X	
Endangered Species Act	X		
Clean Water Act		X	
Wild and Scenic Rivers Act	X		
Clean Air Act	X		
National Historic Preservation Act		X	
Archeological Resources Protection Act	X		
Comprehensive, Environmental Response, Compensation and Liability Act	X		
Resource Conservation and Recovery Act	X		
Toxic Substances Control Act	X		
Quiet Communities Act	X		
Farmland Protection Act	X		
Executive Order 11988 Floodplain Management	X		
Executive Order 11990 Protection of Wetlands	X		
Executive Order 13045 Protection of Children from Environmental Health and Safety Risk	X		

8 PUBLIC INVOLVEMENT

8.1 AGENCIES CONTACTED

Coordination with the NCWRC, North Carolina SHPO, Tribal Nations, USFWS, NRCS, NCDEQ, and Watauga County floodplain manager is ongoing. All required coordination will be completed prior to publication of the Draft EA. Agency correspondence is included in Appendix C.

8.2 PUBLIC REVIEW AND COMMENTS

The Draft DPR and Integrated Environmental Assessment, along with the Draft FONSI, will be available for public review and comment for a period of 30 days, as required under NEPA. A Notice of Availability will be published in the local newspaper, the Watauga Democrat, and the ASU student news, The Appalachian, advising the public of this document's availability for review and comment. A copy of the Draft EA will also be placed in the Watauga County Public

Library and Belk Library and made available online at https://www.lrd.usace.army.mil/News/Project-Documents-Notices-Public-Review/. The mailing list for the Draft EA is located in Appendix B.

9 RECOMMENDATION

Alternative B reach 1 and reach 2 is recommended to be implemented by the USACE Huntington District to provide ecosystem restoration benefits to the Town of Boone and ASU. This plan would daylight approximately 1,200 LF of Boone Creek on the campus of ASU in Boone, North Carolina. The project is necessary to provide ecosystem restoration benefits such as restored degraded ecosystem structure, function, and dynamic processes to a less degraded, more natural condition, improved ecological conditions for aquatic and terrestrial wildlife, and improved aesthetics and nature-based recreation opportunities for ASU. In addition, the project would provide some reduction in flooding on the ASU campus and disruption to classes around the study area as flood waters flow through campus buildings during high flow events. Work under the Section 206 Authority provides continuing authority for aquatic ecosystem restoration and protection for projects that improve the quality of the environment consistent with the public interest and that are found to be cost-effective. The CAP Authority for Section 206 projects has a Federal Funding Limit of $10,000,000. Therefore, the project can be successfully addressed through the Section 206 Authority.

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