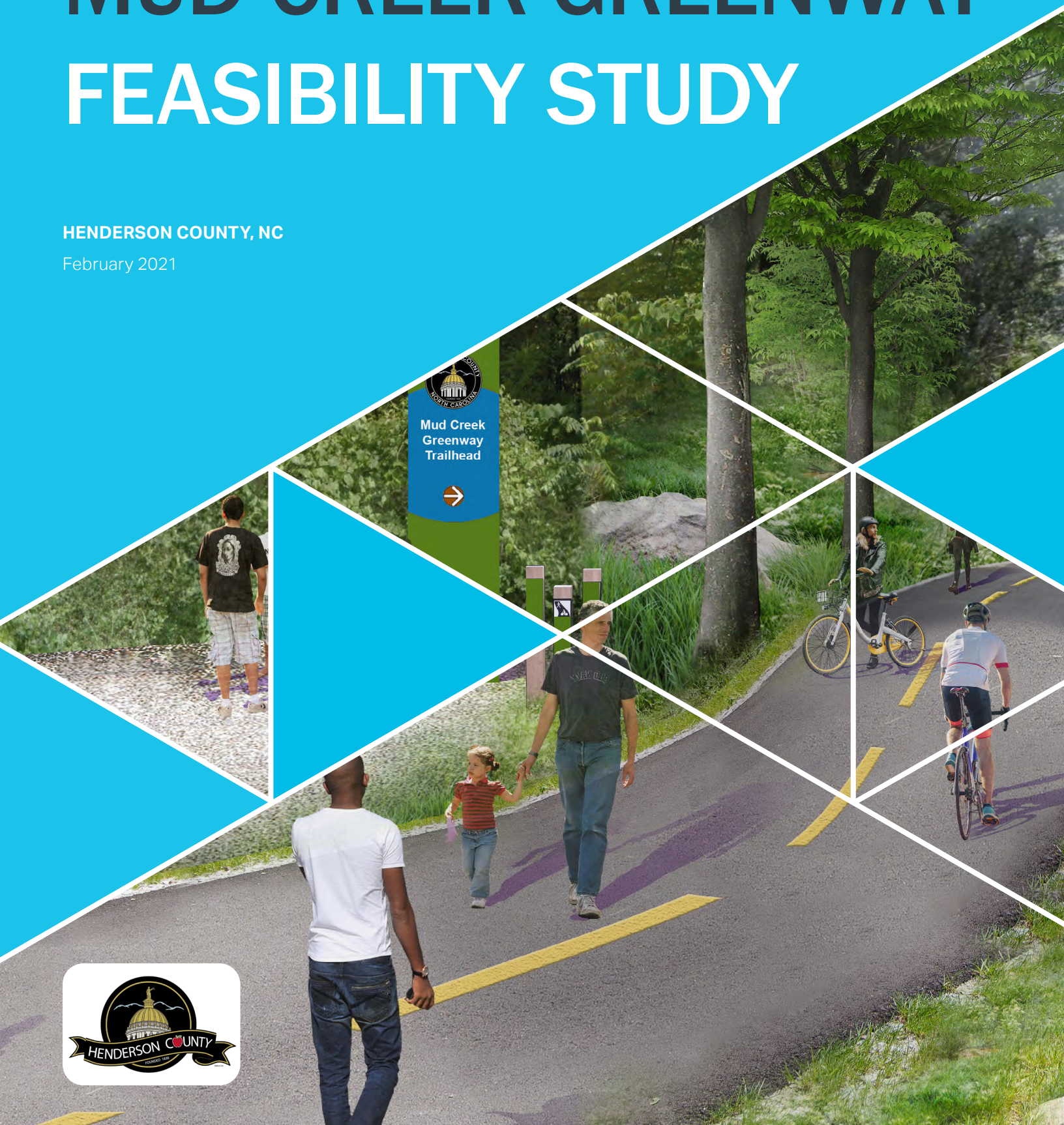
AECOM

MUD CREEK GREENWAY FEASIBILITY STUDY

HENDERSON COUNTY, NC

February 2021



Acknowledgements

Thank you to the following groups for their contributions in the Mud Creek Greenway Feasibility Study:

Henderson County

French Broad River Metropolitan Planning Organization

AECOM

Site Design Studio (SDS)

Table of Contents

EXISTING CONDITIONS

CHAPTER 1

1.1 Introduction

The purpose of this study is to examine the feasibility of constructing a greenway along Mud Creek from Erkwood Drive, north to White Street. This multi-use path, parallel to Mud Creek, will provide safe pedestrian and bicycle amenities connecting the neighborhoods and commercial areas. The study will examine existing conditions, potential opportunities and barriers, trail alignment, cost estimates for construction with a proposed plan for implementation, and research of funding options and available grants. The project includes communication with property owners and stakeholders along the preferred alignments to understand their expectations regarding this greenway and multi-use paths. All recommendations will be informed by a thorough analysis of current land use, inventory of existing physical conditions, safety evaluation of all proposed greenway/path designs, and public input. All recommendations, approximated costs, and data are based on Geographic Information Systems (GIS) data provided by Henderson County, Google aerial imagery, and available lidar topography.

As the study progressed, the following sections were addressed:

1. Existing Conditions
2. Opportunities and Barriers
3. Public Participation
4. Trail Recommendations
5. Action Plan
6. Maintenance

1.2 Existing Conditions

1.2.1 Project Study Area

Mud Creek, located in Henderson County, North Carolina, cradles the eastern edge of the City of Hendersonville. The creek runs north/south from Jackson Park, under South Main Street and White Street, and behind the Publix Supermarket located on Greenville Highway NC 225. The Mud Creek Greenway's proposed location is along the Mud Creek transect between White Street and Erkwood Drive, just south of Hendersonville, heading toward the Westwood neighborhood (**Figure 1**). The study area is located within the City of Hendersonville and its Extra-Territorial Jurisdiction (ETJ).

This report analyzes both natural and built environmental constraints. Other considerations that were analyzed included connections to existing and planned greenways that are adjacent to the study area limits and existing conditions. Also, site visits combined with a geographic information systems (GIS) analysis were performed to identify the following: community features, environmental resources, and demographic data. Additionally, existing plans were reviewed to acquire information on the study area's history.

1.2.2 Community Features

The project study area is bounded by a handful of single-family homes located in neighborhoods (west, southeast, and south of Mud Creek) and community resources, such as grocery stores, churches, and businesses. A comprehensive list of nearby community resources is provided below. Community resources containing an asterisk are located directly inside of the project study area, while the remaining resources touch or border the study area of interest.

Businesses

- Johnson Family Farm and Produce
- Stein Mart
- Fresh Market
- Publix Supermarket*
- Ingles Market
- Walgreens
- Blue Ridge Health
- Dog in Suds Pet Grooming*
- Carolina Ace Hardware and Garden Center

Major Employer

- Ingles Markets Inc.

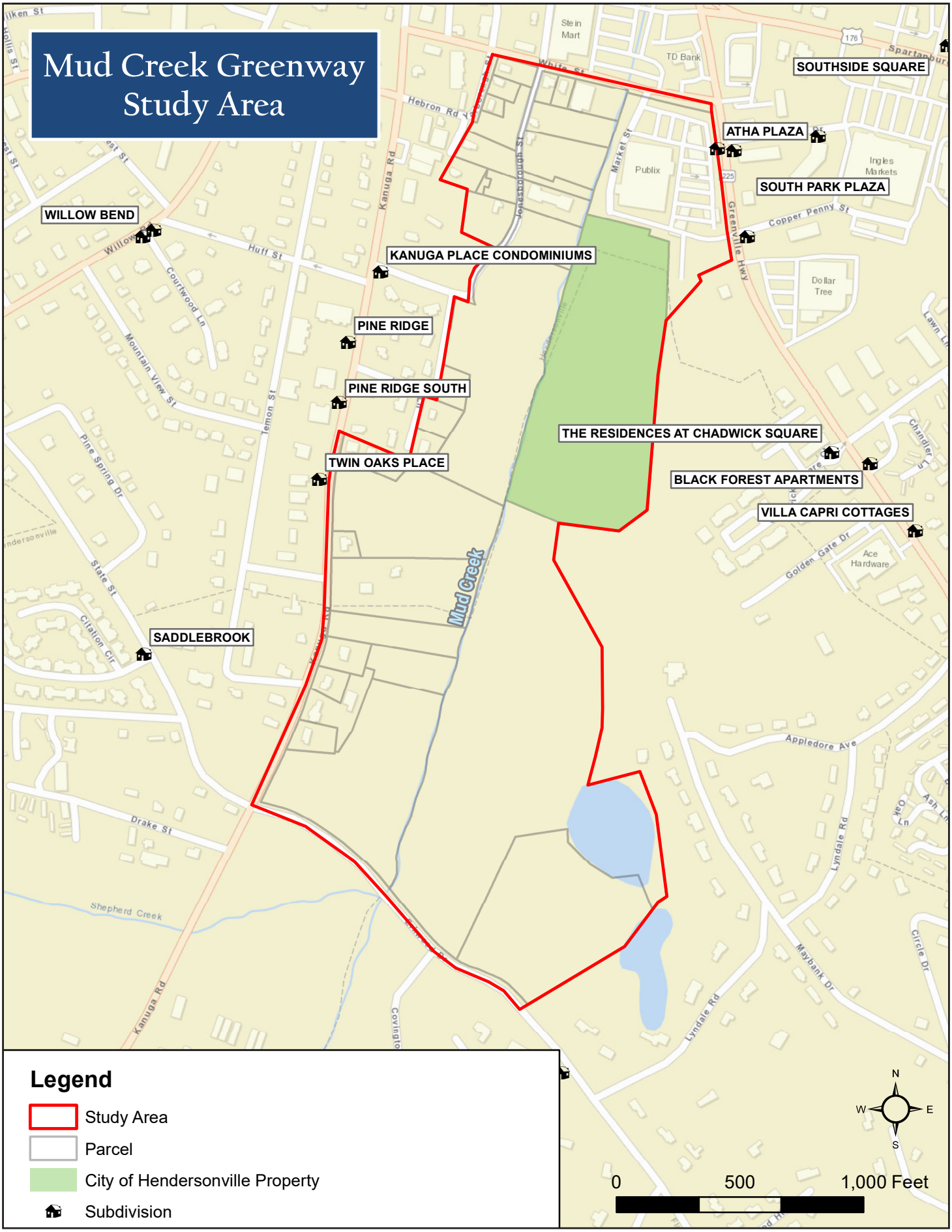
Churches/Community Centers

- West Hendersonville Baptist
- First Presbyterian Church
- Living Faith Family Church
- Edneyville Community Center
- Whitmore Activity Center

Subdivisions

- Residences at Chadwick Square*
- Atha Plaza
- South Park Plaza
- Kanuga Place Condominiums
- Pine Ridge
- Pine Ridge South
- Twin Oaks Place
- Ashely Place

FIGURE 1. Mud Creek Greenway Proposed Study Area



Existing Conditions

1.2.3 Environmental Screening

A desktop environmental screening was performed to understand the potential impact the proposed greenway would have on the natural and built environments. The following environmental and built features were analyzed in the project study area using GIS (**Figure 2**): land cover, land use, zoning, streams/wetlands, utilities, topography, farmland soils, existing roadway projects, listed endangered or protected species, and transit stops.

The Mud Creek Greenway study area is predominately comprised of open space containing Mud Creek and its respective floodplain. The study area includes a 13.09-acre parcel owned by the City of Hendersonville located south of the Publix Supermarket. The existing sanitary sewer runs west and parallel with the proposed greenway. It will be replaced and relocated further east of its existing location, aligning closer to the creek. This effort is part of the Mud Creek Interceptor Sanitary Sewer Improvements project. There are two Apple Country Public Transit stops located on the eastern edge of the study area at the Publix Supermarket on Copper Penny Street and at the Chadwick Square Apartment Complex.

Land Use/Land Cover

- Agriculture (south)
- Residential
- Retail/commercial businesses (northeast/northwest)
- Wooded area (west)
- Wetlands/wetland vegetation (east)
- Open land/clearing (west-access to sewer easement)

Zoning

- C-2: Secondary Business
- R-15: Medium Density Residential
- R-20: Low Density Residential
- PCD: Planned Commercial Development

Streams/Low lying lands

- Mud Creek
- Streams and tributaries
- 4 potential stream crossings
- Standing water (east and southeast)

Utilities

- 38 existing manholes
- 9 proposed manholes
- Gravity main/sewer system present
- Walls/riprap (southwest border of Publix Supermarket)
- Electric: One overhead transmission line with 12 utility poles that runs north to south within the project study area
- Telephone: Overhead telephone lines are located along Greenville Highway, White Street, Jonesborough Street, Kanuga Road and Erkwood Drive
- Natural Gas: There are no natural gas utilities within the project study area

Topography

- Wooded area: low elevation (west)
- Wetland/wetland vegetation: low elevation (east)

Farmland Soils

- According to NRCS soils data, approximately 20.4 acres, or 22 percent, of the study area contains prime farmland soils, all of which are concentrated on the western side of the study area.
- The study area also contains approximately 54.7 acres (60.1 percent) of farmland that is classified as "Prime farmland if drained and either protected from flooding or not frequently flooded during the growing season". These soil types are located along Mud Creek and on the south and east side of the study area.
- A smaller portion of the soils – 4.5 acres or 5.0 percent are classified as farmland of statewide importance and are located in the southeast of the study area.
- The remaining 11.2 acres (12.9 percent) is classified as not prime farmland.

Existing Projects

- R-5748: Kanuga Road and Greenville Highway
- U-5886: Improvements to White Street from Willow Road to Greenville Highway
- Sewer line replacement project: West and parallel with Mud Creek

Listed Species

Listed species for Henderson County are documented below in **Table 1**. Species with an "X" in the last column of the table correspond with the USFWS IPaC list. These species are most likely to be present within the study area. In the case of the Rusty-Patched Bumble Bee, the occurrence is historical and therefore does not require a survey.

Table 1: Listed Species for Henderson County

Common Name	Scientific Name	Federal Status	USFWS
Vertebrate			
Bald eagle	*Haliaeetus leucocephalus*	BGPA	
Bog Turtle	*Glyptemys muhlenbergii*	T (S/A)	X
Carolina northern flying squirrel	*Glaucomys sabrinus coloratus*	E	X
Gray bat	*Myotis grisescens*	E	X
Northern long-eared bat	*Myotis septentrionalis*	T	X
Invertebrate			
Appalachian elktoe	*Alasmidonta raveneliana*	E	X
Rusty-patched bumble bee	*Bombus affinis*	E	
Vascular Plant			
Bunched arrowhead	*Sagittaria fasciculata*	E	X
Mountain sweet pitcherplant	*Sarracenia rubra ssp. jonesii*	E	X
Small whorled pogonia	*Isotria medeoloides*	T	X
Swamp pink	*Helonias bullata*	T	X
White fringeless orchid	*Platanthera integrilabia*	T	
White irisette	*Sisyrinchium dichotomum*	E	X

E=Endangered
T=Threatened
BGPA=Bald and Golden Eagle Protection Act

Source: U.S. Fish and Wildlife Service IPaC List

According to the Natural Heritage Letter, there are occurrences of Mountain Sweet Pitcher Plant and Bunched Arrowhead within 1-mile of the site. There are also several natural and managed areas within 1-mile of the study area (**Table 2**).

Table 2: Natural and Managed Areas within 1-mile of the Study Area

Site Name	Owner	Within Study Area
Sites Documented Within a One-mile Radius of the Project Area		
Jackson Park Wetlands	-	
Ochlawaha Bog	-	
Managed Areas Documented Within a One-mile Radius of the Project Area		
Henderson County Open Space	Henderson County: multiple local government	
City of Hendersonville Open Space	City of Hendersonville	X
Ochlawaha Plant Conservation Preserve	NC Department of Agriculture, Plant Conservation Program	

Source: The North Carolina Natural Heritage Program

Grey and northern long-eared bats would be negatively impacted if any trees would be cut down for this project. The closest known hibernation sites are within nine miles of the project area. This distance is not close enough to trigger a permit unless an individual were to be found on the project site. When on site, biologists would need to survey for any potential roost trees within the project area. The following guidance from the United States Fish and Wildlife Service (USFWS) is provided below for reference.

Incidental take without a permit is prohibited:

- Within hibernation sites (includes disturbing or disrupting hibernating individuals and alternation of hibernation habitat, including cave or mine entrance, when bats are not present)
- Within ¼ mile of a known hibernation site
- Within a 150-foot radius of a known, occupied maternity roost during the pup season (June 1 to July 31)

Beyond the requirements of the Endangered Species Act, the following conservation steps are encouraged to help conserve this species:

- Prior to implementing a project, survey for northern long-eared bats. Such data allows us to better understand the bat's habitat use and distribution, track its status, evaluate threats and impacts, and develop effective recovery actions.
- Remove trees outside the pup season (June 1 to July 31) and/or active season (April 1 to October 31) to reduce the chance of impacting unidentified maternity roosts.
- Avoid clearing habitat within a 5-mile radius of hibernation sites when bats are emerging from or preparing for hibernation (April 1 to May 15 and August 15 to November 14, respectively).
- Manage forests to ensure a continual supply of snags and other suitable maternity roost trees.
- Conduct prescribed burns outside the pup season (June 1 to July 31) and/or the active season (April 1 to October 31), and avoid high-intensity burns.
- Perform bridge repair, retrofit, or maintenance outside the bat's active season (April 1 to October 31) in areas where they are known to roost on bridges or where such use is likely.
- Minimize use of herbicides and pesticides. If necessary, spot treatment is preferred over aerial application.
- Minimize light pollution during the active season by angling lights downward or via other light minimization measures.

There are enough water bodies large enough to warrant a survey for the Bald Eagle. If a nest tree were to be found, then there would have to be guidance issued by the Asheville USFWS office as to what size buffer would potentially be needed around the tree for noise pollution from construction and general disturbance. A permit is required to cut down a tree.

Cultural and Historical Resources

There are 374 historic and cultural resources located within 1-mile of the project study area. The following three sites are located adjacent to the study area:

Table 3: Nearby Historic Sites

Site ID	Name	Status
HN1978	Laughter House	Survey Only
HN1979	Dominic Podesta House	Survey Only
HN1980	McCall-Mallette-Overton House	Determined Eligible

Source: National Register of Historic Places/State Historic Preservation Office

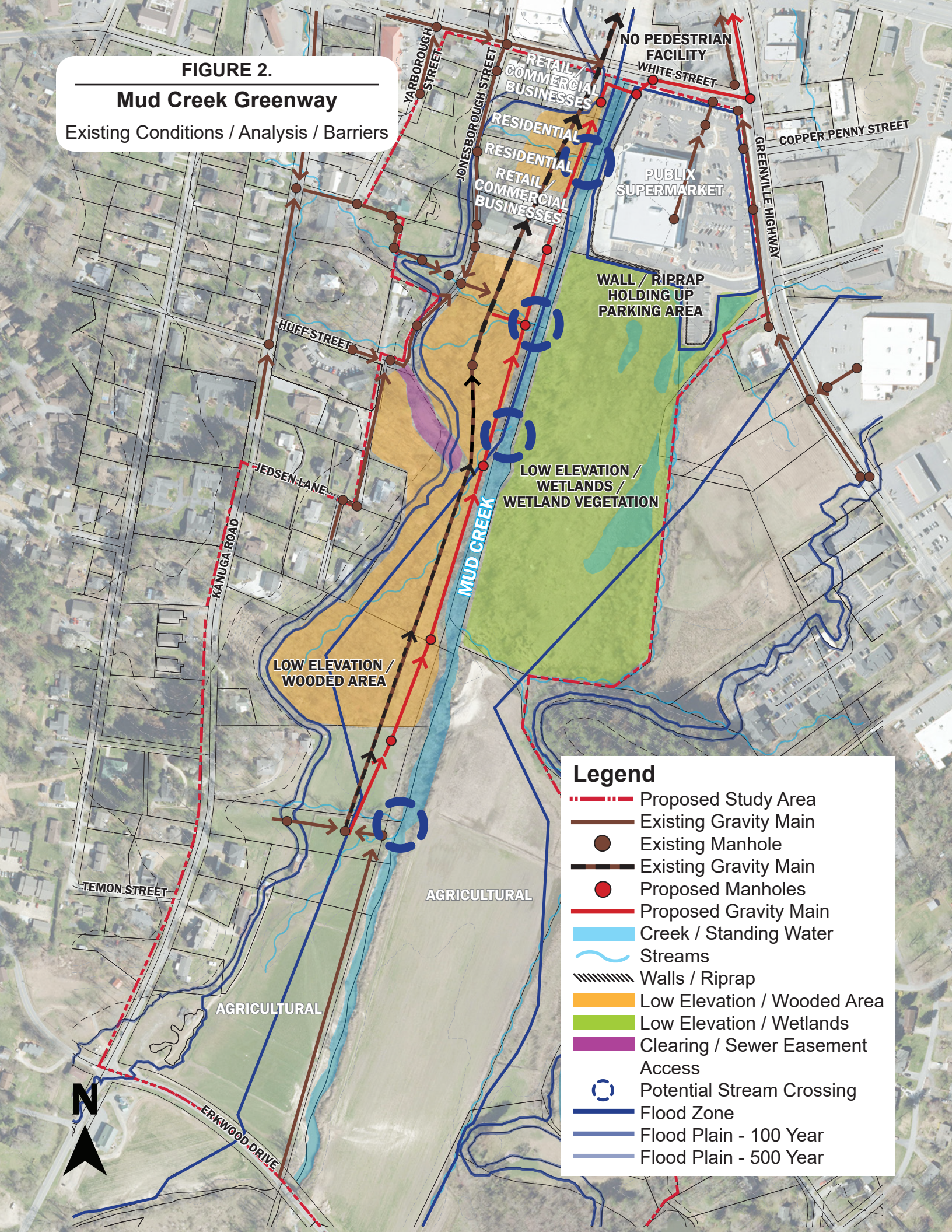


FIGURE 2.
Mud Creek Greenway
Existing Conditions / Analysis / Barriers
YARBOROUGH STREET
JONESBOROUGH STREET
RETAIL / COMMERCIAL BUSINESSES
RESIDENTIAL
RESIDENTIAL
RETAIL / COMMERCIAL BUSINESSES
NO PEDESTRIAN FACILITY
WHITE STREET
COPPER PENNY STREET
GREENVILLE HIGHWAY
PUBLIX SUPERMARKET
WALL / RIPRAP HOLDING UP PARKING AREA
HUFF STREET
JEDSEN LANE
KANUGA ROAD
MUD CREEK
LOW ELEVATION / WETLANDS / WETLAND VEGETATION
LOW ELEVATION / WOODED AREA
TEMON STREET
AGRICULTURAL
AGRICULTURAL
ERKWOOD DRIVE
N
Legend
Proposed Study Area
Existing Gravity Main
Existing Manhole
Existing Gravity Main
Proposed Manholes
Proposed Gravity Main
Creek / Standing Water
Streams
Walls / Riprap
Low Elevation / Wooded Area
Low Elevation / Wetlands
Clearing / Sewer Easement
Access
Potential Stream Crossing
Flood Zone
Flood Plain - 100 Year
Flood Plain - 500 Year

01. Southeast corner of Publix Supermarket parcel (looking south)

02. West of Publix Supermarket (looking west)

03. West of Publix Supermarket facing proposed greenway (looking south)

04. South of White Street facing south

05. White Street bridge over Mud Creek (looking west)

06. White Street (facing east)

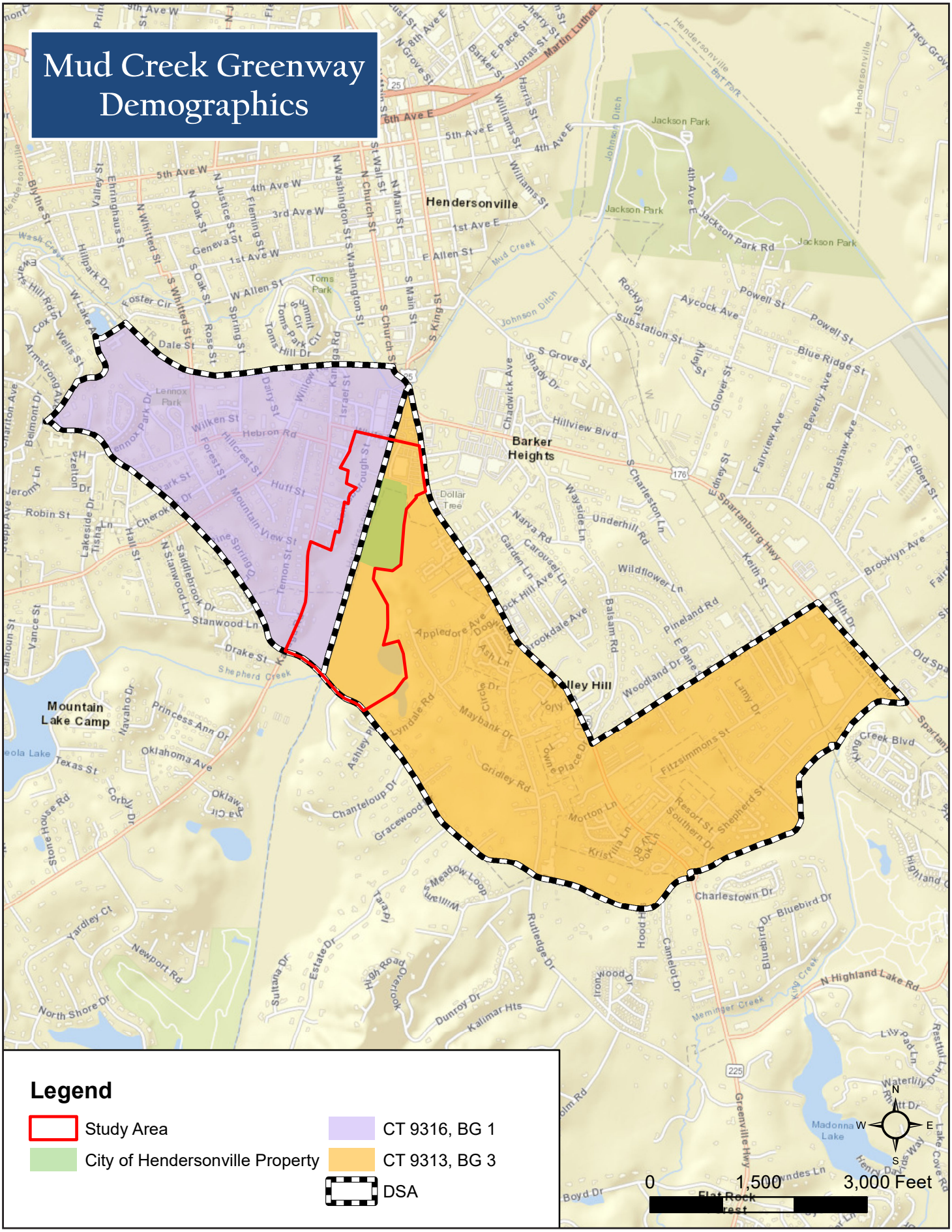
07. Kanuga Road (facing north)

08. Erkwood Drive (facing agricultural field)

1.2.4 Demographic Analysis

Demographic characteristics were investigated to gain a better understanding of the population living in the project study area and the surrounding community's transportation needs. There are two census tract (CT) block groups (BG) within the demographic study area (DSA) (**Figure 3**). There are two additional BGs that touch the edge of the study area to the south, but they have been excluded from this study because they do not fully represent the project study area. Datasets studied include the following: population, age, minority, race, Limited English Proficiency (LEP) and Language Assistance (LA), income, housing, car ownership, and commuting patterns. The demographic analysis was based on 2000 and 2010 US Decennial Census data and 2014-2018 American Community Survey (ACS) 5-Year estimate data analyzed at the place, county, and state levels. Select statistics at the city, county, and state levels are provided in tables below the demographic topics.

FIGURE 3. Mud Creek Greenway Demographic Study Area



Population and Age

According to the U.S. Census Bureau, the population of the DSA was 2,045 people in 2000 and 2,344 people in 2010 (for an annualized growth rate of 1.4 percent). The growth rate of the DSA during this period is comparable to the annualized growth rate of the state which grew at an annualized rate of 1.7 percent from 2000 to 2010 (**Table 4**). An increasing population for the DSA, the City of Hendersonville, Henderson County, and the state between 2000 and 2010 suggests a need for continual dedication to quality of life benefits for current residents, such as multimodal infrastructure. In recent years, the county has dedicated many efforts toward these types of improvements, including the development of multi-use trails like the Ecusta Trail.

Table 4: Population Change (2000-2010)

Geography	Census 2000 Population	Census 2010 Population	Annualized
DSA	2,045	2,344	1.4%
City of Hendersonville	10,420	13,137	2.3%
Henderson County	89,182	106,740	1.8%
North Carolina	8,049,313	9,535,483	1.7%

Source: Steven Manson, Jonathan Schroeder, David Van Riper, and Steven Ruggles. IPUMS National Historical Geographic Information System: Version 14.0 [Database]. Minneapolis, MN: IPUMS. 2019. http://doi.org/10.18128/D050.V14.0 Census 2000/Census 2010 Time Series Tables Geographically Standardized

Based on 2014-2018 ACS data, the median age was 41.5 in the DSA, 52.9 in Hendersonville, and 47.1 in Henderson County. The DSA's median age is comparable to the state's median age of 38.6. The largest age group in the DSA is 18 to 64 years at 58.8 percent and the smallest age group is 65 years and older at 18.6 percent (**Table 5**). Improved multimodal facilities appeal to all age ranges. They can help retain or attract younger populations, while also serving current age groups in Hendersonville interested in utilizing different modes of transportation.

Table 5: Age

Geography	Total Population	Under 18 Years	18 to 64 Years	65 Years or Older	Median Age
DSA	2,623	18.6%	58.8%	22.6%	41.5
City of Hendersonville	13,890	14.8%	52.3%	33.0%	52.9
Henderson County	113,625	19.4%	55.6%	25.1%	47.1
North Carolina	10,155,624	22.6%	62.0%	15.5%	38.6

Source: U.S. Census Bureau (2014-2018). Sex by Age. American Community Survey 5-year Estimates (2014-2018), Table B01001.

Minority and Race

The U.S. Census defines minorities as all races that are non-white and Hispanic populations that are also White. The minority population in the DSA is 12.4 percent of the total population (2,623 total population). The minority population for Hendersonville is higher at 19.8 percent (13,809 total population). The minority population for Henderson County is lower than the city at 16.8 percent (113,625 total population). The state contains the highest minority population at 36.4 percent (10,052,564 total population). The DSA is predominantly white (94.5 percent), with a small percentage of African American (2.0 percent), Asian (0.4 percent), some other race (0.4 percent), and two or more races (2.7 percent). The Hispanic/Latino population comprises approximately 8.6 percent of the DSA.

Source: U.S. Census Bureau (2014-2018). Race. American Community Survey 5-year Estimates (2014-2018), Table B02001.

Such minority and racial compositions listed in **Table 6** indicate a minimally diverse composition of people living in the DSA, Hendersonville, Henderson County, and North Carolina.

Table 6: Minority

Geography	Total Population	Minority Population	Hispanic	Total Non-White
DSA	2,623	12.4%	8.6%	5.5%
City of Hendersonville	13,809	19.8%	9.0%	13.7%
Henderson County	113,625	16.8%	10.1%	9.2%
North Carolina	10,155,624	36.7%	9.2%	31.1%

Source: U.S. Census Bureau (2014-2018). Hispanic or Latino Origin by Race. American Community Survey 5-year Estimates (2014-2018), Table B03002.

Limited English Proficiency and Language Assistance

Overall, the primary language group spoken of person who speak English less than "very well" in the DSA, the city, the county, and the state is Spanish. The DSA contains the highest Spanish-speaking group at 6.2 percent. Within the DSA, CT 9313 BG 3 has a higher rate of residents who meet the criteria of LA than the county and the state (10.1% Spanish-speaking).

Source: U.S. Census Bureau (2014-2018). Age by Language Spoken at Home by Ability to Speak English for the Population 5 Years and Over. American Community Survey 5-year Estimates (2014-2018), Table B16004.

Income and Housing

The median household incomes for the DSA, Hendersonville, Henderson County, and North Carolina are $41,933, $38,412, $52,815, and $52,413, respectively. The median housing values for the same locations are $161,100, $175,000, $203,400, and $165,900, respectively. The DSA contains 80.8 percent of occupied housing units, Hendersonville has 87.5 percent, 84.8% percent for Henderson County, and 85.7 percent for the state.

Source: U.S. Census Bureau (2014-2018). American Community Survey 5-year Estimates (2014-2018), Table B19049 and Table B25077. NCDOT Demographic Tool 2020-Community Overview Profile and Health Indicators Profile.

Car Ownership

Table 7 shows the car ownership by household in the study area and comparison areas. The DSA contains 1,258 occupied housing units. Of those housing units, 5.1 percent of households have no vehicle available, 43.1 percent of households have one vehicle available, and 51.8 percent of households have two or more vehicles available. Multimodal infrastructure like greenways would particularly benefit residents that do not have access to vehicles or share vehicles within a household.

Table 7: Car Ownership

Geography	Occupied Housing Units	No Vehicle Available	One Vehicle Available	Two or More Vehicles Available
DSA	1,258	5.1%	43.1%	51.8%
City of Hendersonville	7,294	12.2%	50.6%	37.2%
Henderson County	48,281	4.7%	32.6%	62.7%
North Carolina	3,918,597	5.9%	31.9%	62.2%

Source: U.S. Census Bureau (2014-2018). Tenure by Vehicles Available. American Community Survey 5-year Estimates (2014-2018), Table B25044.

Commuting Patterns

The overwhelming majority of the DSA's residents commute to work using a car with a total of 75.3 percent of the working population 16 years and older who commute alone using this mode of travel. In the DSA, 15.4 percent of the population commute by carpool, zero percent commutes by public transportation, 7.1 percent commute by bike/ped, and 2.2 percent commute by another mode. Commuting patterns, which are shown in **Table 8** show a higher dependency on vehicle usage in Henderson County and statewide as compared to the DSA and the City of Hendersonville. Supporting the development and use of transportation networks for active modes (bike and pedestrian travel) may provide an opportunity for a more diverse selection of commuting options to work, as well as enabling workforce participation by people with reduced access to vehicles.

Table 8: Commuting Patterns

Geography	Mean Commute Time	Commute Alone by Auto	Carpool	Public Transportation	Bike/Ped	Other Mode
DSA	N/A	75.3%	15.4%	0.0%	7.1%	2.2%
City of Hendersonville	18.4	78.0%	12.5%	1.3%	6.4%	1.7%
Henderson County	21.2	85.1%	11.8%	0.2%	2.0%	0.9%
North Carolina	24.5	85.6%	9.9%	1.1%	2.2%	1.1%

Source: U.S. Census Bureau (2014-2018). American Community Survey 5-year Estimates (2014-2018), Table S0801 and Table B08301. NCDOT Demographic Tool 2020-Community Overview Profile.

Demographic data will change with the Census and staff will need to re-evaluate it.

This page intentionally left blank

1.2.5 Existing Plans and Regional Connections

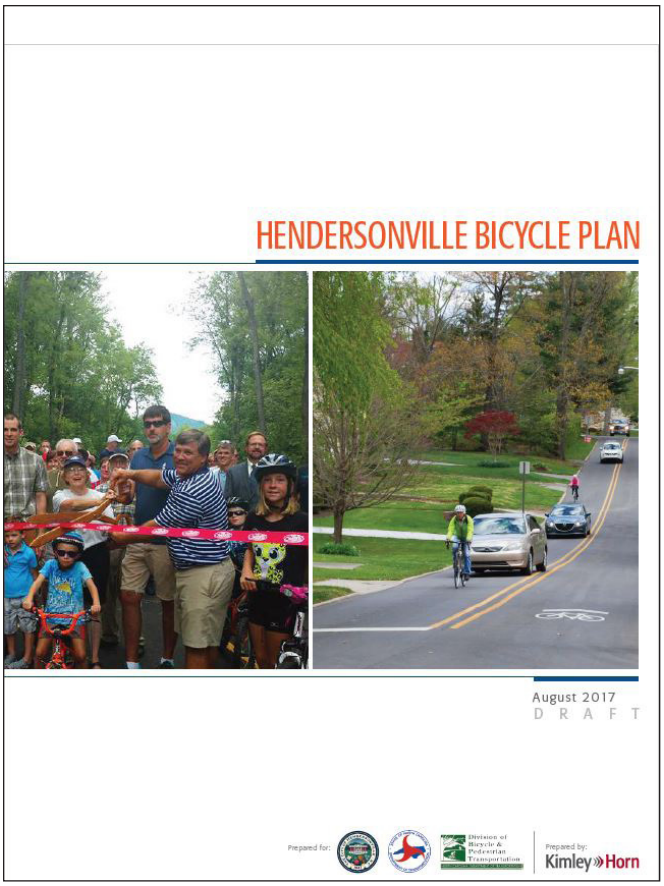
Although the proposed greenway is relatively new, the following studies reference nearby locations and amenities that are relevant to the study area:

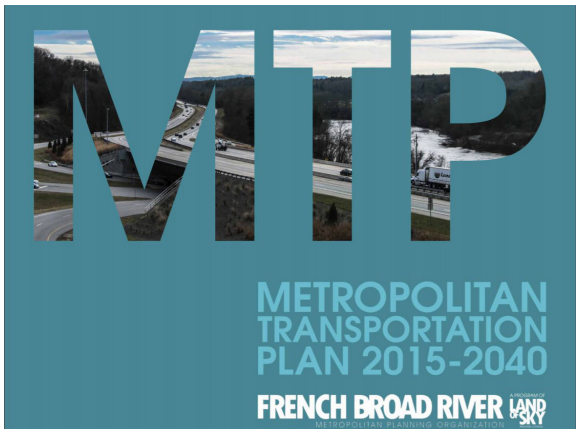
- Hendersonville Bicycle Plan (2017)
- Henderson County Greenway Master Plan (April 2019)
- French Broad River MPO's Metropolitan Transportation Plan (2015-2040)

Both the *Hendersonville Bicycle Plan* and the French Broad River Metropolitan Planning Organization's *Metropolitan Transportation Plan* (MTP) recommend improvements to Kanuga Road and Greenville Highway that included bicycle lanes. The North Carolina Department of Transportation (NCDOT) proposes improvements along Kanuga Road as part of the project R-5748, which is expected to be constructed in 2023. However, because of safety concerns expressed by the citizens, bicycle lanes were not included in the project, and instead a greenway was proposed along Mud Creek as an alternative for north-south travel. The greenway will follow the city-owned sewer easement along Mud Creek and is viewed as a more viable option to safely support cyclist and pedestrian mobility along the Kanuga Road corridor.

According to the *Henderson County Greenway Master Plan* (April 2019), the Mud Creek Greenway will tie into Phase 1 of the Ecusta Trail, a 19-mile multi-use greenway located along the railway corridor connecting Hendersonville to Brevard. The two-mile Oklawaha Greenway connects Jackson Park to Patoon Park and it is a segment of the Ecusta Trail. More specifically, the Mud Creek Greenway is a key segment of the larger multi-modal system that could tie into the Ecusta Trail southeast of Tom's Park (**Figure 4**; circled in red).

NCDOT is also planning improvements to White Street from Willow Road to Greenville Highway as part of project U-5886, These improvements would include a roundabout at White Street and Kanuga Road and potentially bicycle facilities. U-5886 is also expected to be constructed in 2023.





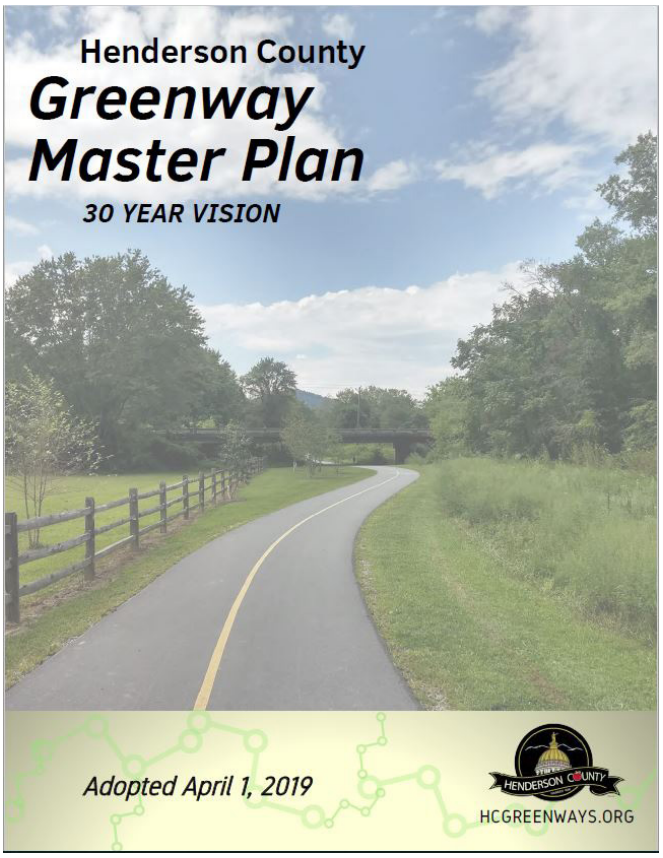
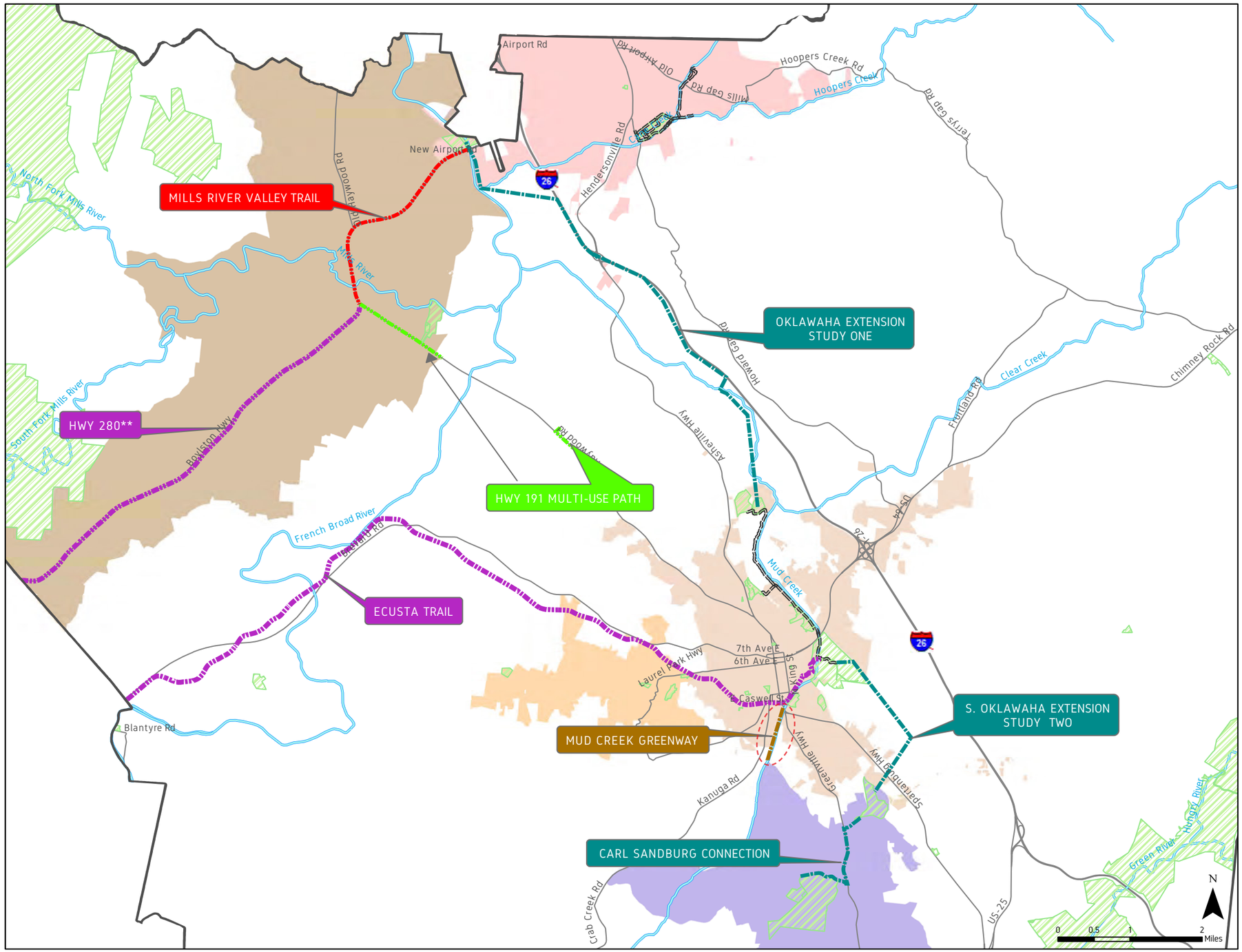


FIGURE 4. Mud Creek Greenway Connection Regional Trails



STATUS OF FEASIBILITY STUDIES IN THE AREA

CURRENT STATUS:
- PRELIMINARY ENGINEERING
- UNDERWAY
- FUNDED
- NCDOT PRECONSTRUCTION
- COMPLETED

MUNICIPALITIES:
- VILLAGE OF FLAT ROCK
- TOWN OF FLETCHER
- CITY OF HENDERSONVILLE
- TOWN OF LAUREL PARK
- TOWN OF MILLS RIVER

ELEMENTS:
- EXISTING GREENWAYS
- PARKS*
- MAJOR RIVERS/STREAMS
- MAJOR ROADS
- COUNTY BOUNDARY

*Parks include county parks, city parks, state parks/forests, and national parks/forests.
**The feasibility study completed for Hwy 280 was conducted by Conserving Carolina. At this time, the Town of Mills River has no plans to move the project forward.

Please note that all greenways delineated in this map are representative of desirable locations to make greenway connections. The mapped lines of non-existing greenways are theoretical in nature.

Source: Henderson County Greenway Master Plan (2019)

OPPORTUNITIES & BARRIERS

CHAPTER 2

2.1 Opportunities and Barriers

Identifying opportunities for greenway community connections and potential barriers to overcome is a critical part of the feasibility process. The opportunities and barriers analysis will inform the effects the greenway could have in the community. Additionally, this analysis will provide insight into the challenges associated with implementation, how the Mud Creek Greenway will connect to the broader greenway network and to adjacent areas and how it will provide an improved quality of life through promoting active transportation options promoting health and wellness and for users to reconnect with the natural environment providing a visual and environmental asset to the community.

Below are the elements considered in this analysis:

- Connections to destinations and points of interest
- Connectivity across the region
- Potential economic development opportunities
- Environmental protection
- Physical and topographic barriers
- Constraints associated with the floodplain
- Constraints associated with utilities
- Impacts to landowners and to the natural and human environment
- Challenges associated with right-of-way (ROW)
- Funding opportunities

2.1.1 Connectivity, Destinations and Points of Interest

Greenways are often linear corridors of land that are recognized for their ability to connect communities together. For example, the proposed Mud Creek Greenway could tie into the Ecusta Trail due south of Spartanburg Highway (**Figure 4**). The trail closely follows Mud Creek and begins near the Henderson County Parks & Recreation building in Jackson Park and travels four miles to Berkeley Mills Park. This trail is an asphalt path that is used by both cyclists and pedestrians.

There are several businesses located around the proposed greenway. Surrounding residents could utilize the greenway to access the following businesses: Johnson Family Farm and Produce, Stein Mart, Fresh Market, Publix Supermarket, Ingles Market, Walgreens, Blue Ridge Health, Dog in Suds Pet Grooming, and Carolina Ace Hardware and Garden Center. The Mud Creek Greenway will promote nearby users to utilize the trail to reach these surrounding destinations and points of interest near the study area.

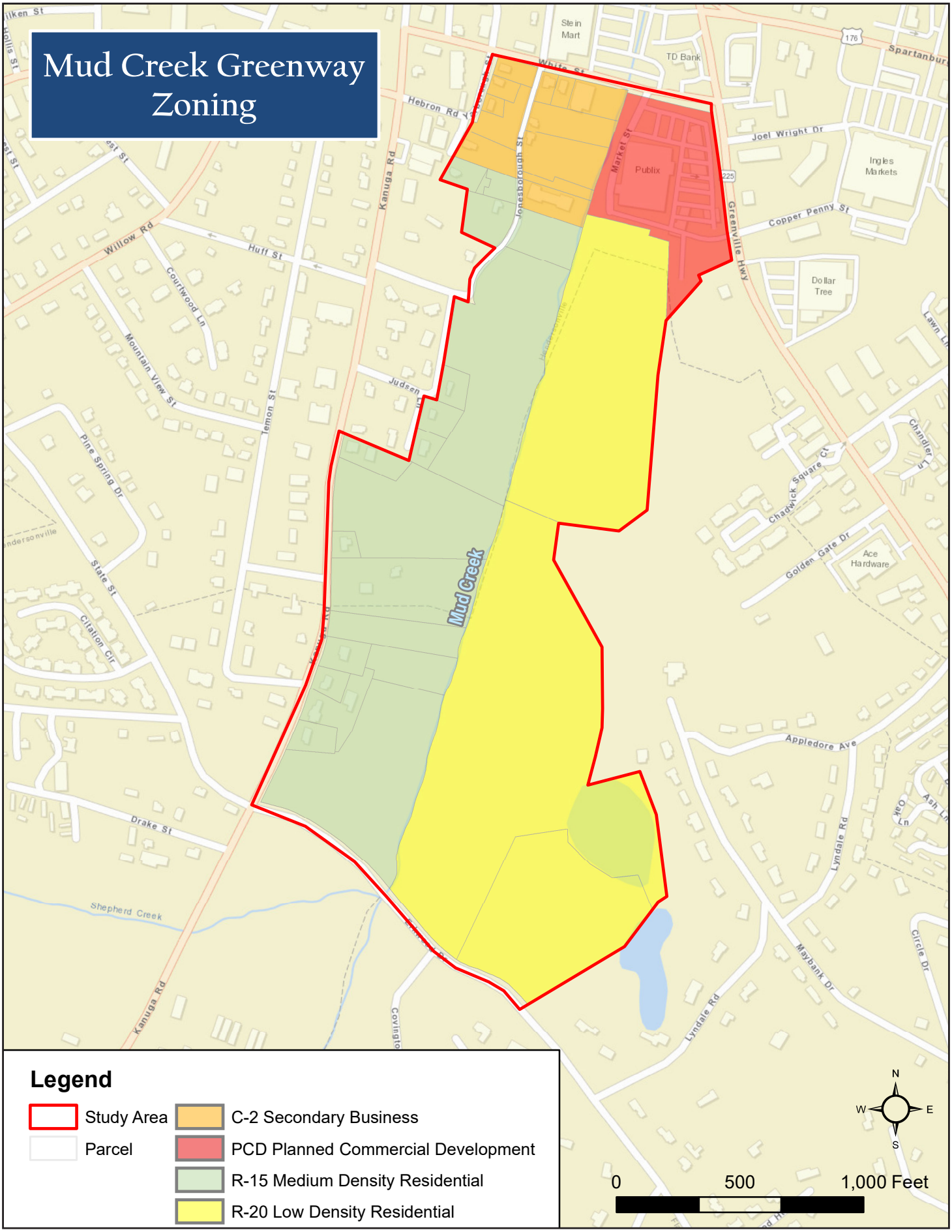
2.1.2 Economic Development Opportunities

In a City Parks forum briefing (2002) by the American Planning Association (APA), it suggested that cities use parks for economic development purposes. This review identified several examples of parks that led to enhanced property values, increased municipal revenue, and attracted more homebuyers, workers, and affluent retirees. A prime example of a trail used to spur economic development is the Swamp Rabbit Trail located in Greenville County, South Carolina. This 22-mile multi-use trail was strategically built to attract investment along the Reedy River railroad corridor. According to APA, this trail earned the "People's Choice" designation as one of the Great Places in America in 2017. The Swamp Rabbit Trail generates $6.7 million in tourism economic impact annually.

The current zoning within the study area (**Figure 5**) is secondary business (C-2), medium density residential (R-15), low density residential (R-20), and planned commercial development (PCD). The mix of residential and commercial land uses are well suited for a greenway that would appeal to multiple greenway users. There is high potential for redevelopment in the commercial areas near White Street and Jonesborough Street. Currently, the proposed greenway will run east of Mud Creek through two parcels that are of vacant land. Future land uses indicate that some of the study area is designated as conservation land; support for conservation areas (potentially by nearby single-family homeowners) will reduce changes and pressures from adjacent land uses and their respective owners.

Traditionally, greenways are known to be a potential catalyst for redevelopment because they promote health and wellness, outside connectivity and multi-modal usage. To back this trend of healthy living and active transportation lifestyles, eco-tourism could be a viable opportunity along all of Mud Creek. Eco-tourism, also known as environmentally responsible tourism, could take shape in the form of sustainable agricultural workshops in the southern parcels of the study area, or even long-distance walking tours. Not only will eco-tourism boost economic development in Henderson County, it will help create a unique sense of place for residents and tourists to visit.

FIGURE 5. Current Zoning within the Study Area



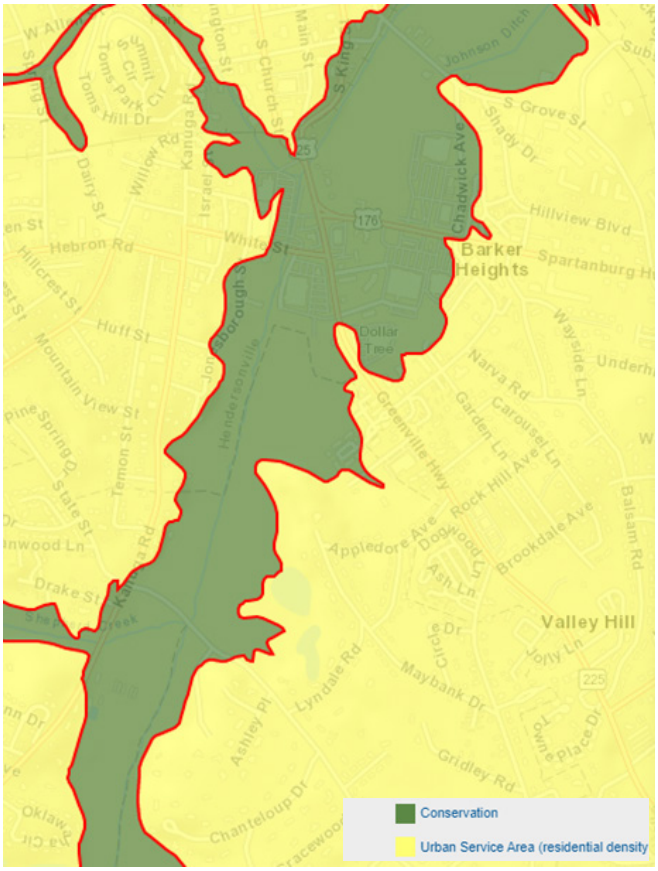


Photo: Future Land Use within the Study Area. Source: Henderson County

2.1.3 Environmental Considerations

Greenways are financial investments for a community and are a good indicator of where future development will take place. However, efforts must be made to ensure the proposed alignment avoids and mitigates potential impacts to sensitive environmental areas as much as possible.

A 2.23-mile stretch of Lower Mud Creek joined the Clean Water Act Section 303(d) lists in 1997. Agricultural operations and stormwater runoff degraded the water quality, prompting wetland restoration, streambank stabilization, and the installation of Agricultural Best Management Practices (BMPs). Restoration efforts combined with the enactment of urban stormwater control measures in the City of Hendersonville helped to remove Mud Creek from the CWA section 303(d) list in 2014. Today, the City of Hendersonville's Stormwater Management Program works to ensure that stormwater is effectively controlled in order to reduce pollution generated from stormwater runoff.

According to the growth management plan in the Henderson County Comprehensive Plan (2020), growth should be directed away from the floodplains. Future land use data from the County supports this directive with the placement of conservation land areas around Mud Creek. The Urban Service Area surrounds the conservation area; the goal is to maximize residential density where utilities are present. While the greenway could support the Urban Service Area, the alignment should also aim to preserve the natural features surrounding Mud Creek, such as native plant species, animal habitats, and water quality.

2.1.4 Physical and Topographic Barriers

The relatively flat terrain within the study area ranges in elevation from 2,084 feet (lowest elevation on Mud Creek) to 2,132 feet (highest elevation on Kanuga Road). There are steep slopes adjacent to the bed of Mud Creek. Thus, sections of the greenway near the creek may require barriers or railings for safety. In addition, there are several streams and tributaries that stem from Mud Creek that may require elevated footbridge if extensions were made along the greenway. Grade changes along the proposed greenway alignments should be minimized to remain in compliance with the Americans with Disabilities Act (ADA).

2.1.5 Floodplain Constraints

Mud Creek and its respective streams and tributaries traverse the study area. It runs north to south around the western edge of the City of Hendersonville and serves as a natural and community asset for nature enthusiasts and active transport users in the area. The construction of the Mud Creek greenway would further promote connectivity throughout Henderson County. A greenway along Mud Creek would make the most out of the natural scenery, relatively flat topography, and land unsuitable for other development activities.

The entire study area falls within the Mud Creek floodplain. There are several floodplain depressions located due south of the Publix Supermarket. Water collects here when heavy rainfalls occur. These depressions may result in the formation of wetlands. Greenways can be used as land management tools to help protect floodplain ecosystems. The planting of native seedlings and tubelings within the depressions will help to restore ecosystem functions that were offset from the development of the Publix Supermarket. Similar restoration efforts should be considered along the proposed alignment of the greenway if impermeable surfaces are used during construction.

The Henderson County Floodplain Development Local Program is responsible for the Flood Damage Prevention Ordinance and all reporting for unincorporated areas of Henderson County. Should the City's property (located east of Mud Creek) fall within a potential greenway alignment, they should be contacted since the property is located in their Extra Territorial Jurisdiction.

The project study area falls within the floodplain and is subject to the county's Flood Damage Prevention Ordinance and all reporting for unincorporated areas of Henderson County. Should the City's property (located east

of Mud Creek) fall within a potential greenway alignment, they should be contacted since the property is located in their Extra Territorial Jurisdiction.

The project study area falls within the floodplain and is subject to the county's Flood Damage Prevention Ordinance in the City's Code of Ordinances. As such, a floodplain development permit would be required, which includes a site development plan with proposed elevations, identification of structures to be built along the greenway, and the location of the floodplain and floodway.

Mud Creek is defined as "Class C" so it is not a water supply watershed. Therefore, it would seem only a 30 ft buffer would apply. Close coordination with the county will be needed to determine allowable practices within the buffer and verify if a variance is warranted.

2.1.6 Utility Constraints

Sewer and electric utilities are present within the project study area. The City of Hendersonville retains a sewer easement along Mud Creek. The Mud Creek Sewer Interceptor Replacement is listed in the City's Capital Improvement Plan and is projected for fiscal-year 2030. The City indicated it is willing to make necessary preparations to support this project once it begins the sewer work on-site in preparation of the NCDOT road project. Placing greenways near or along sewer lines may reduce the number of trees that are removed during clearing for construction. While it may decrease costs by reducing the need for tree removal and increased accessibility, it can incur costs associated with maintenance accommodations required to access the utility.

Overhead transmission lines may also result in planning and construction setbacks. There is an overhead transmission line that runs north to south within the project study area. It follows Mud Creek north from Erkwood Drive for approximately 1,200 feet before turning north east towards Greenville Highway. There are 12 utility poles within the study area associated with this transmission line. In addition, there are overhead telephone lines located along Greenville Highway, White Street, Jonesborough Street, Kanuga Road, and Erkwood Drive. Electric utility easements are typically tied to private properties which could result in land acquisition difficulties.

If abandoned utility lines were to be found on site, field run surveying and possibly SUE or Subsurface Utility Engineering would be needed; if such utilities are found, then coordination with utility providers would be necessary.

No natural gas utilities are present in the study area.

2.1.7 Landowner Impacts

The goal of the project is to avoid or minimize impacts to adjacent parcels. There are 49 parcels located within the project study area, which primarily includes residential parcels and commercial businesses that surround Mud Creek to the west, north, and east (**Figure 2**). Due to the proposed linear nature of the greenway, parcel impacts will be limited. It is unlikely that the greenway alternatives will involve direct impacts to any privately-owned parcels running business operations. However, if this were the case, implications to the business operations could include a loss of parking and alterations to accessing the Publix parcel from White Street. In addition, greenway alternatives that include crossing access driveways will need to include appropriate signage and pavement markings to protect the safety of the greenway users.

2.1.8 Right-of-Way (ROW) Constraints

Existing ROW that preserve an intact corridor typically offer the most efficient opportunities for greenway construction. For Mud Creek, there is an option to use the new sewer easement for the greenway alignment. Since this easement runs along the creek it will provide nice views and opportunities along the creek for recreation, environmental education and programmed and non-programmed community activities.

NCDOT owned ROW within the study area is associated with Kanuga Road, White Road, and Greenville Highway. NCDOT has two projects listed in the State Transportation Improvement Program (STIP) that are located within the project study area: the improvements along Kanuga Road and Greenville Highway (R-5748) and improvements to White Street from Willow Road to Greenville Highway (U-5886). Both of NCDOT's projects are scheduled to begin construction in 2030 or later. Greenway route options that are adjacent to either of NCDOT's projects, would be paid for in full by NCDOT if the multimodal facilities appear in an adopted plan (Complete Streets Policy). If a facility need is identified but not listed in an adopted plan, a cost-share would be implemented (Note: excludes on-road bicycle facilities which would still be paid in full).

2.1.9 Funding Opportunities

The Henderson County Greenway Master Plan (2019) identifies the following funding and community partnerships:

- "The County should utilize public-private partnerships and work with local business owners, industries, and the Partnership for Health to secure funding to complete the Greenway Network.
- The County and surrounding municipalities should consider setting aside funding each budget year for greenway development that would be used for grant match and other related funding needs related to the Greenway Network.

- The County should work with the Tourism Development Authority (TDA) to secure funding for portions of the Greenway Network that will increase tourism and enhance economic development.
- The County should coordinate with municipalities to seek funding that is only available to municipal governments for the creation of the identified Greenway Network within those municipalities."

Additional funding sources are listed below and are categorized by federal, state, and local funding opportunities.

Federal

- Transportation Alternative Program (TAP)
- Transportation Equity Act for the 21st Century (TEA21)
  - Recreational Trail Program
- Surface Transportation Program (STP) funds
- Transportation Enhancement Programs
- Congestion Mitigation and Air Quality Improvement Program (CMAQ)
- Community Development Block Grant Program
- Land and Water Conservation Fund (LWCF) Grants
- Watershed Protection and Flood Prevention (Small Watersheds) Grants
- Conservation Reserve Program
- Wetlands Reserve Program
- Hazard Mitigation Grant Program
- Flood Mitigation Assistance
- Conservation Contracts

State

- North Carolina Parks and Recreation Trust Fund
- North Carolina Land and Water Fund
- Clean Water Management Trust Fund
- Water Resources Development Project
- North Carolina Department of Transportation

Local

- Taxes
- Impact fees
- Bond referendums
- Local Capital Improvements Program
- Private funding
- Donations
- Local businesses
- Trail sponsors
- Volunteer work
- "Buy-a-Foot" Programs
- American Greenways DuPont Awards
- REI Environmental Grants
- Friends of the Oklawaha
- Friends of the Ecusta Trail

PUBLIC PARTICIPATION

CHAPTER 3

3.1 Public Participation

Engaging the community and stakeholders is critical for the success of the feasibility study and to reflect the community's needs and desires. A detailed, thorough, transparent public participation process guided the project throughout its entirety, building and maintaining public trust and engagement.

Stakeholders were engaged during the following three levels: Oversight Committee meetings, Property Owner Meetings, and a Virtual Public Meeting.

3.1.1 Oversight Committee

The purpose of the Oversight Committee was to guide the development of the feasibility study. Henderson County, the City of Hendersonville, and French Broad River MPO staff made up the Oversight Committee and met with the project team when needed during the duration of the project.

3.1.2 Property Owner Meeting

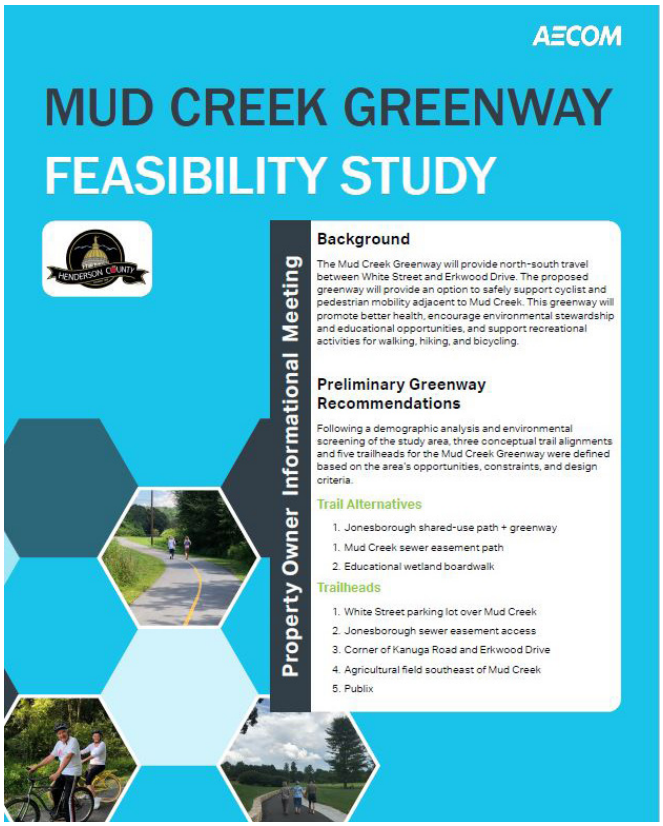
The Property Owner Meeting took place virtually on September 29th, 2020. The purpose of the meeting was to help determine the property owners' willingness to provide easements in an unobtrusive way and to provide an avenue to express their concerns. Letters were sent out prior to the meeting to introduce the project and to invite attendees. During this meeting, the team provided an overview of the project, as well as preliminary greenway recommendations, cost estimates, and cross sections. An interactive handout was provided to the property owners with the project information and a survey to complete following the meeting. A second meeting was held with one of the property owners that was interested in assessing his property for future sewer interceptor and greenway development on October 26th, 2020..

3.1.3 Virtual Public Meeting

Henderson County announced a press release detailing the project and Virtual Public Meeting that was hosted on their website. The purpose of the Public Meeting was to offer stakeholders and the general public an opportunity to review the planning process, the greenway alternatives, trailhead locations developed during the process, and recommendations of the study. The website contains the same information that was presented at the Property Owner Meeting, such as preliminary greenway recommendations, cost estimates, and cross sections. Additionally, the website hosts a narrated presentation on the project.

3.2 Survey Results

Online surveys were distributed to both the property owners and the general public. Overall, 6 responses were collected from property owners and 64 responses were collected from the general public. Survey responses were collected between November 2nd, 2020, and November 30th, 2020. Select survey results are provided on the following pages.



Property Owner Responses

If you were approached by the City of Hendersonville, Henderson County, or a non-profit about the potential use, sale, or donation of an easement of some of your property for the benefit of the greenway, would you be open to discussions?

- 50% Open and interested
- 33% Interested but with concern
- 17% Strongly against a discussion

Is Mud Creek Greenway a good alternative for off-road facilities and bicycle and pedestrian connections?

- 100% Yes

Is there a service, facility, or general location that you would like to have access to on the greenway?

1. Greenville Highway
2. South Market Village
3. Ecusta Trail
4. White Street
5. Jonesborough Street
6. Downtown

There are two proposed shared-use path options for Jonesborough Street. Would you feel more comfortable using the attached path or the detached path along the road?

- 83% Attached
- 0% Detached
- 17% Blank

Public Responses

Do you currently bicycle or walk on greenways?

81% Yes

19% No

Would you prefer to bike or walk along an on-road facility or an off-road facility?

86% Off-road (Cross sections C3, C4, and C5)

14% On-road (Cross sections C1, C2 A, C2 B, and C6)

Is Mud Creek Greenway a good alternative for off-road facilities and bicycle and pedestrian connections?

86% Yes

14% No

Is there a service, facility, or general location that you would like to have access to on the greenway?

1. Ecusta Trail
2. Greenville Highway
3. Kanuga Road
4. South Market Village
5. White Street
6. Jonesborough Street
7. Greenway connections to parks and other recreational facilities

There are two proposed shared-use path options for Jonesborough Street. Would you feel more comfortable using the attached path or the detached path along the road?

73% Attached

27% Detached

RECOMMENDATIONS

CHAPTER 4

4.1 Design Considerations

This study considers both natural and human environmental constraints. Local, state, and federal design guidelines are also referenced. Other considerations to the greenway design include connections to existing and planned greenways, sidewalks that are adjacent to the study area limits; right-of-way constraints, floodplain/floodway, and existing streams near Mud Creek. The following section of the study further evaluates these design considerations.

4.1.1 Natural Environment

The following natural environmental considerations were taken into account for this study:

- Topography
- Floodplain/Floodway
- Streams and Wetlands

Topography

The study area has a relatively flat terrain. Grade changes along the greenway alternatives have been minimized to remain in compliance with the American's with Disabilities Act (ADA). Steep slopes going down to Mud Creek may require a railing for safety.

Floodplain/Floodway

With Mud Creek as the center focal point for the study area, the majority of the study area is within the floodplain/floodway. As shown through previous greenway projects along the creek like The Ecusta Trail, Mud Creek serves as a natural asset to surrounding communities. Providing a greenway along Mud Creek would take advantage of the river's scenery and relatively flat topography. The addition of a boardwalk would help repurpose land that is unsuitable for other development activities.

Streams and Wetlands

Several streams are located near Mud Creek and have been avoided to eliminate unnecessary bridge construction along the proposed trail alignments. Wetlands located east of Mud Creek could serve as a natural park and will require elevated boardwalks for greenway users to access.

4.1.2 Human Environment

The following human environmental considerations were taken into account for this study:

- Right-of-Way
- Bridges
- Streets
- Land Owners
- Utilities
- Existing pedestrian infrastructure

Right-of-Way

Existing rights-of-way typically offer the most efficient opportunities for greenway construction. However, right-of-way is limited along Jonesborough Street which influenced the direction and placement of the proposed alignment for Alternative 1.

Bridges

There are two bridges that cross over Mud Creek in the study area and they are located on White Street and Erkwood Drive. The proposed greenway options attempt to minimize the need for new pedestrian bridge crossings between the two major bridges.

Streets

White Street, Jonesborough Street, and Erkwood Drive heavily influenced the proposed placement of multi-use paths within this study. Greenway alternatives that involve the crossing of these streets and/or connections to other bicycle and pedestrian infrastructure near these streets would need to include appropriate signage, pavement markings, lighting, and other safety measures.

Land Owners

There are 49 parcels located within the project study area, which includes commercial and residential uses that are located between Kanuga Road and Greenville Highway. Greenway alternatives that include crossing access driveways will need to include appropriate signage and pavement markings to protect the safety of the greenway users. This is true for the proposed pedestrian crossing on Jonesborough Street that will link to Mud Creek.

Utilities

Existing powerlines to the west of Jonesborough Street influenced the proposed path of Alternative 1. If a utility easement exists, it may make it easier to acquire this land for a multi-use path.

Existing Pedestrian Infrastructure

Existing sidewalks north of White Street influenced a proposed trailhead location. The sidewalk will be used to connect the proposed trail alternatives.

4.2 Design Criteria

The design criteria were developed for the project taking into account greenway design standards as prescribed by the American Association of State Highway Transportation Officials (AASHTO), the Americans with Disabilities Act (ADA), and Designing Sidewalks and Trails for Access: Part 2 and the Manual on Uniform Traffic Control Devices (MUTCD). These design criteria were taken into consideration to develop general typical sections that have been incorporated into the feasibility study.

The greenway design will be compliant with the Americans with Disabilities Act (ADA) Accessible Design Standards. Not only will this allow for more users of the greenway, but it will directly benefit a large portion of residents who are elderly but are still active. The North Carolina Bicycle Facilities Planning and Design Guidelines (1994) for multipurpose recreational trails, the AASHTO Guide to Bicycle Facilities, 4th Edition, the North Carolina Complete Streets Planning and Design Guidelines (1994) for multipurpose recreational trails, the AASHTO Guide to Bicycle Facilities, 4th Edition, the North Carolina Complete Streets Planning and Design Guidelines, FHWA's Manual on Uniform Traffic Control Devices (MUTCD) were used as the design criteria for the project. **Table 9** provides specific references to the criteria used to design the greenway (North Carolina Department of Transportation 1994); (AASHTO 2012); (NCDOT 2012); (FHWA 2012). Further greenway criteria mentioned in the Henderson County Greenway Master Plan are described below, including additional recommendations for guard rails and the restriction of motor vehicle traffic.

According to the Henderson County Greenway Master Plan, the following design considerations and standards have been discussed:

- All greenways are suggested to be constructed as 10' to 12' wide paved trails
- Phasing should be considered where a paved trail cannot be achieved
- Appropriate hydraulic modelling should be performed whenever a greenway is to be constructed in a floodplain
- Greenway designs and plans should consider the surrounding environment and minimize adverse effects
- Amenities should be considered to create a complete, accessible, and comfortable experience for a wide variety of expected users
- The County should work with its partners to establish a regional trail branding and way-finding program
- Context Sensitive Solutions
- Complete Streets: Design and operate to enable safe access for all users
- Sustainable Design: Use recycled materials and products where feasible

Table 9: Trail Design Criteria

Width and Clearance		
Paved Width	10'-12'	Permit safe and frequent passing opportunities
Horizontal Clearances	3' Desirable, 2'	Minimum Provide clearance from trees, polls, walls, fences, and guardrails
Outside to Shoulder Slope	5' Desirable, 2' Minimum	Create separation between bicycle path and canals, ditches, rivers, and creeks. Handrail can be employed in areas with steep side slopes necessitating use of minimum shoulder widths.
Vertical Clearances	16'	Permit passage of maintenance vehicles
Horizontal Alignment and Superelevation		
Minimum	2%	Encourage adequate drainage
Grade		
Maximum Desireable	5%	
Sustained	2%	Accomodate a wide range of riders
Drainage		
Maximum Cross Slope	2%	Provide adequate drainage

Guard Rails

Wide separation between the trails and slopes or nearby roadway is encouraged. Five feet is typical for a separated distance, but some restrictions may limit the distance less than five feet. Where applicable, a barrier could be constructed to keep to greenway separated from unsafe areas without curb and gutter. Guard rails are common dividers and should be a minimum of 54 inches high.

Steep Slopes

Where a path is adjacent to parallel bodies of water or downward slopes of 1V:3H or steeper, a wider separation should be considered. A 5-foot (1.5 m) separation from the edge of the path pavement to the top of the slope is desirable. Depending on the height of the embankment and condition at the bottom, a physical barrier, such as dense shrubbery, railing, or fencing may be added.

Vehicle Restrictions

Lockable and removable bollards are recommended in order to restrict motor vehicle traffic from entering the greenway at intersections and driveways. Implementing such barriers will increase the safety of bicyclists and pedestrians and allow for the passage of emergency or maintenance vehicles.

The proposed greenway alignments highlighted on the following pages attempt to minimize the need for pedestrian bridge crossings. Design criteria for bridges and boardwalks are located below in **Table 10**.

Table 10: Bridge and Boardwalk Design Criteria

Bridge Criteria	Bridge Specifications
Width	12' Clear
Span	70'
Handrail Height	42"
Rubrail Height	4'-6'
Capacity	10,000lb vehicle load, 90psf Ped Live Load
Grade	2% Sustained
Boardwalk Criteria	**Boardwalk Specifications**
Width	12' Clear
Fall Preventative Railings	Install in areas that exceed 30" in height with railing supports on the exterior to prevent handle bar snags.
Railings	Railings should be 42" in height and the maximum space between on side railing shall not exceed 4" in width or at the bottom of the side railings between the decking and the railings. Sand smooth to prevent injury.
Cross Slopes	Not to exceed 2%
Maximum Grade	Not to exceed 5% longitudinally (or it is considered an ADA ramp which would trigger landings)
Weight Accomodation	Boardwalk shall accommodate the weight of a gator vehicle for maintenance and/or emergencies at a minimum.

Design: AASHTO LRFD Bridge Specifications, 6th Edition.
AASHTO 'LRFD Guide Specifications for Design of Pedestrian Bridges', 2009.

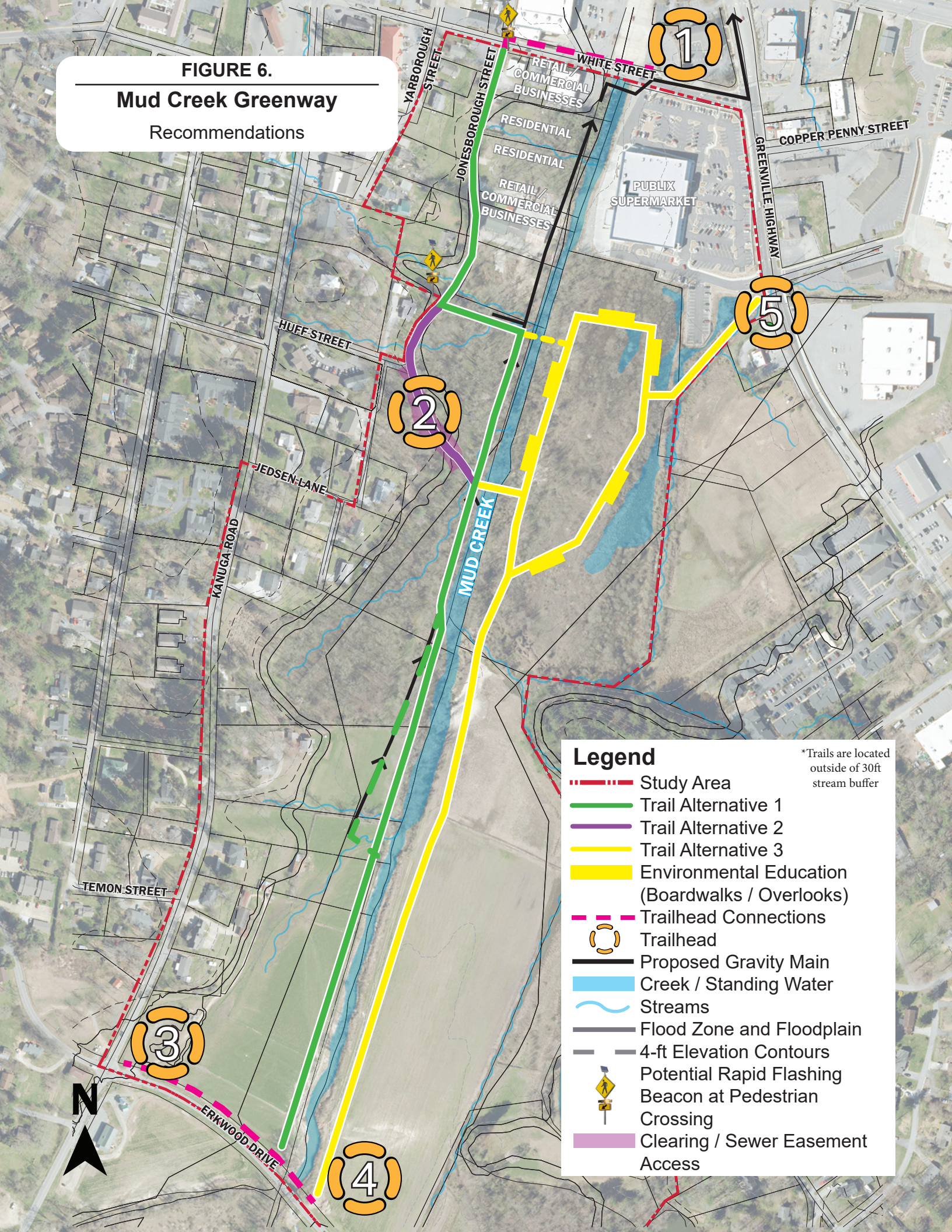


FIGURE 6.
Mud Creek Greenway
Recommendations
YARBOROUGH STREET
JONESBOROUGH STREET
WHITE STREET
RETAIL / COMMERCIAL BUSINESSES
RESIDENTIAL
RESIDENTIAL
RETAIL / COMMERCIAL BUSINESSES
COPPER PENNY STREET
GREENVILLE HIGHWAY
PUBLIX SUPERMARKET
HUFF STREET
JEDSEN LANE
KANUGA ROAD
MUD CREEK
TEMON STREET
ERKWOOD DRIVE
1
2
3
4
5
N
Legend
*Trails are located outside of 30ft stream buffer
Study Area
Trail Alternative 1
Trail Alternative 2
Trail Alternative 3
Environmental Education (Boardwalks / Overlooks)
Trailhead Connections
Trailhead
Proposed Gravity Main
Creek / Standing Water
Streams
Flood Zone and Floodplain
4-ft Elevation Contours
Potential Rapid Flashing Beacon at Pedestrian Crossing
Clearing / Sewer Easement Access

4.3 Greenway Recommendations

Three conceptual trail alignments and five trailheads were created based on the data collected and the opportunities and barriers that have been identified. Transects for the proposed alternatives are located at the end of this section. The recommendations are listed below and are described further in this section (**Figure 6**).

Trailheads

1. White Street parking lot over Mud Creek
2. Jonesborough sewer easement access
3. Corner of Kanuga and Erkwood
4. Agricultural field southeast of Mud Creek
5. Publix

Trail Alternatives

1. Mud Creek
2. Jonesborough Shared-Use Path
3. Educational Wetland Boardwalk

The alignments presented in this study were determined from an engineering judgment perspective, within the constraints of the design criteria. The designs were completed using available GIS and aerial photography. All three of the proposed trails will follow a portion of Mud Creek (**Figure 6**).

Trailhead Descriptions

The proposed trailheads are located at a parking lot on White Street, in the woods near Huff Street, at the corner of Kanuga Road and Erkwood Drive, southeast of Mud Creek before the creek travels under Erkwood Drive, and next to Publix. While not all trailheads are required, their location in respect to each trail alignment provide complimentary access points for users at the boundaries of each alignment, including the access to the center of each alignment. Aerial images of the proposed trailheads are displayed on Page 37.

Trailhead 1. Across from White Street and north of the Publix is an existing parking lot that is built on top of Mud Creek. This parking lot could be used as an easy access point to the greenway alignments from the northern end of the study area. Pedestrian crossings with a flashing beacon at White Street and Jonesborough Street would enhance safety measures for pedestrians crossing from the existing sidewalk on White Street to the proposed multi-use path on Jonesborough Street.

Trailhead 2. The center trailhead is proposed at the sewer easement access along Huff Street and Jonesborough Street. The area is already cleared and has a gate at the entrance. There is limited room for parking at this location.

Trailhead 3. The third proposed trailhead is located south at the corner of Kanuga Road and Erkwood Drive. The existing land is cleared.

Trailhead 4. This trailhead is located in the existing agricultural field, southeast of Mud Creek, and north of Erkwood Drive.

Trailhead 5. The final proposed trailhead is located at the southern entrance for Publix. This location provides existing parking for greenway users.

Opportunities and constraints associated with each trail alternative and trailhead are listed on the following page in **Table 11**.

Cross sections for the proposed alternatives are labeled in **Figure 7** and begin on Page 44.

Trailhead 1

Trailhead 2

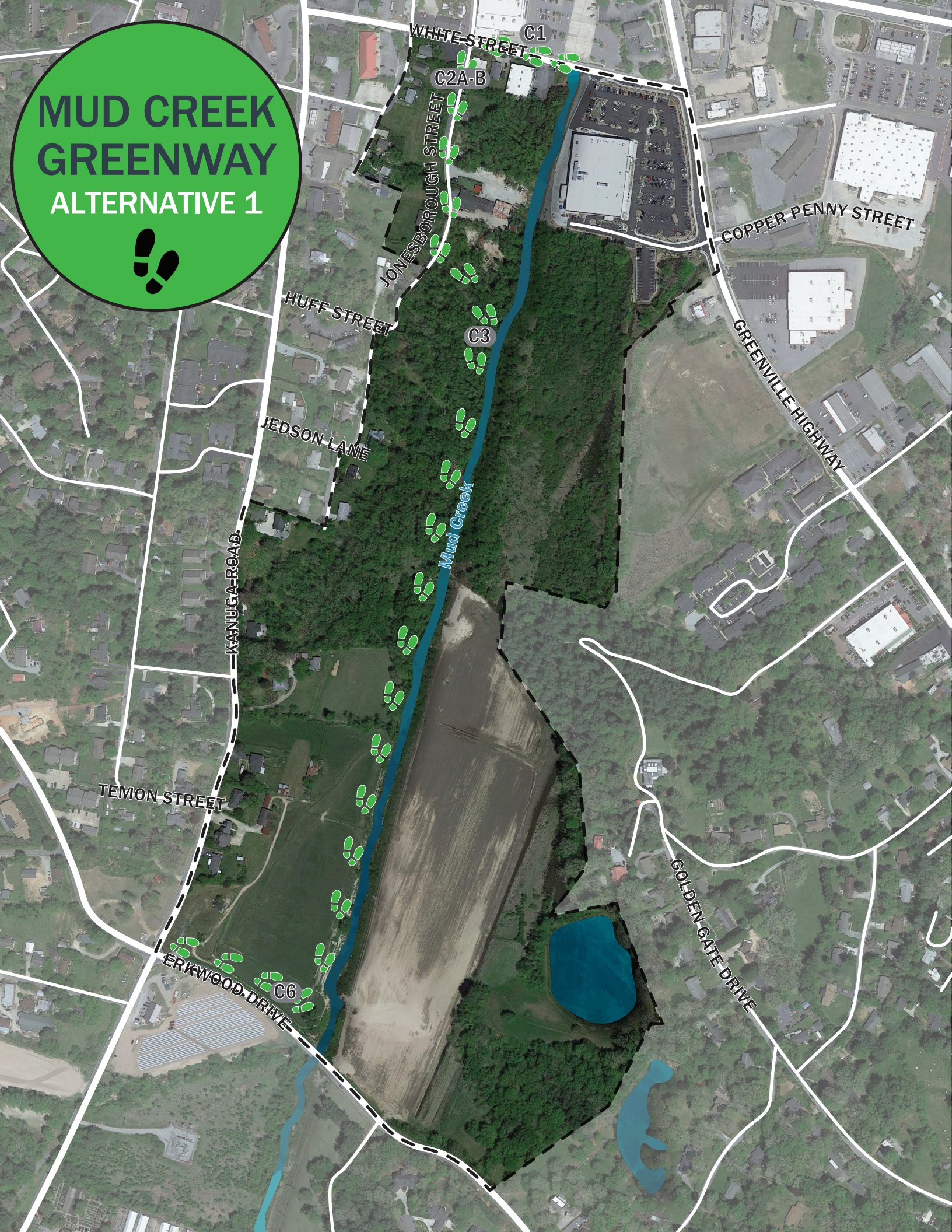
Trailhead 3

Trailhead 4

Trailhead 5

Table 11: Opportunities and Constraints for Trail Recommendations

Recommendation	Opportunities	Constraints
Alternative 1	• Impacts fewer parcels • Connects White Street to Erkwood Drive • Environmental education opportunities • A potential power easement could accommodate the alignment west of Jonesborough Street • Low speed limit on Jonesborough Street	• May impact agricultural parcel if it contains active farmland • Bridges/boardwalks required for five stream crossings • May require grading and clearing of trees on Jonesborough • Pedestrian crossing needed if the path changes sides of the street on Jonesborough
Alternative 2	• Opportunity for a side street connection along Jonesborough Street • Existing sewer easement access • Low speed limit and traffic volume on Jonesborough Street • Environmental education and recreational opportunities	• Jonesborough Street is narrow and contains curves (poor sight views) • If a bicycle boulevard along Jonesborough Street is created it would not accommodate pedestrians and pedestrian facilities would be required • Shared-use path construction along Jonesborough Street would involve utility relocation, ROW acquisition, and clearing • Requires speed control measures for vehicles
Alternative 3	• Environmental education opportunities in "lowlands" with boardwalks and overlooks • It has the potential to become a great community asset in a property that will otherwise have development challenges due to the presence of wetlands	• Bridge over Mud Creek required • Boardwalks will be required over wetland vegetation to the east of Mud Creek
Trailhead 1	• Existing parking lot • Close to northern trail entrance • Connects White Street to Erkwood Drive • Pedestrian accommodations needed to safely cross White Street	• Property acquisition associated with the parking lot • Implementing and/or constructing safety accommodations for users to cross White Street to access the northern entrance of the greenway • Bridges/boardwalks required for five stream crossings
Trailhead 2	• Existing sewer easement • Cleared land • Accessible from Huff Street and Jonesborough Street • Allows access to the center of the trail • Connects White Street to Erkwood Drive	• New construction for parking lot • Potential for interference with the sewer • Bridges/boardwalks required for five stream crossings
Trailhead 3	• Access from Kanuga Road and Erkwood Drive • Cleared land • Provides access to southern ends of the trail	• New construction for parking lot • Difficult for vehicles travelling south on Kanuga Road to access if the driveway is located on Erkwood Avenue • Bridge would be required to access the southern end of Trail Alternative 3 • Bridges/boardwalks required for five stream crossings
Trailhead 4	• Shorter distance required to connect to the trail alternatives	• Further distance from Kanuga Road • Increased impervious surface within the approximated stream buffer
Trailhead 5	• Existing parking • Connection to Publix • Access from Greenville Highway	• Additional expenses related to boardwalk connection of Alternative 3


MUD CREEK GREENWAY
ALTERNATIVE 1
WHITE STREET
C1
C2A-B
JONESBOROUGH STREET
HUFF STREET
C3
JEDSON LANE
COPPER PENNY STREET
GREENVILLE HIGHWAY
Mud Creek
KANUGA ROAD
TEMON STREET
GOLDEN GATE DRIVE
ERKWOOD DRIVE
C6

4.3.1 Alternative 1

Trail Alternative 1 would incorporate bicycle lanes on both sides of White Street between Trailhead 1 and Jonesborough Street. It would include a shared-use path on Jonesborough Street between White Street and the existing sewer easement clearing. This shared-use path could be attached or detached. The proposed alternative would include a marked crosswalk and flashing beacon on Jonesborough Street south of dog wash business. The greenway would connect to Mud Creek and follow it south to Erkwood Drive. There is an option to follow the proposed sewer line on this alignment. The trail would continue west towards Kanuga Road and Trailhead 3.

Opportunities

- This alternative Impacts fewer parcels.
- The alignment would connect White Street to Erkwood Drive.
- This alternative supports environmental education and recreational opportunities through the woods and along the creek.
- A potential power easement could accommodate the shared-use path west of Jonesborough Street.
- There is low speed limit and traffic volume on Jonesborough Street.

Constraints

- It may impact the agricultural parcel to the south of the project study area if it contains active farmland.
- Bridges and boardwalks will be required for stream crossings.
- The shared-use path may require grading and clearing of trees on Jonesborough Street.
- A signalized crossing will be needed if the path changes sides of the street on Jonesborough Street.

Preliminary Cost Estimates

The cost estimate includes the following items:

- Two marked crosswalks and one flashing beacon on White Street
- Bike lanes on both sides of White Street between Trailhead 1 and Jonesborough Street
- One marked crosswalk and one flashing beacon across Jonesborough Street
- Shared-use path on Jonesborough Street, greenway along Mud Creek, and shared-use path on Erkwood Drive (to Trailhead 3)

$3,380,000

Please see page 60 for cost estimate disclaimers.

Cross Sections

Please see cross section labels on the map.

C1

C2-A

C2-B

C3

C6


MUD CREEK GREENWAY
ALTERNATIVE 2
WHITE STREET
C1
C2A-B
JONESBOROUGH STREET
COPPER PENNY STREET
C2A-B
HUFF STREET
GREENVILLE HIGHWAY
C3
JEDSON LANE
Mud Creek
KANUGA ROAD
TEMON STREET
GOLDEN GATE DRIVE
C6
ERKWOOD DRIVE

4.3.2 Alternative 2

Alternative 2 includes a shared-use path on Jonesborough Street and connects south of Alternative 1. The shared-use path could be detached or attached to the street. It would travel through Trailhead 2 and utilizes the existing sewer easement. Alternative 2 would veer right towards the creek and follow it south back to Trailhead 4. Alternative 2 needs to be in conjunction with either Alternative 1 or Alternative 3. It can't stand be a stand alone project.

Opportunities

- There is an opportunity for a side street connection along Jonesborough Street.
- The alternative could follow the existing sewer easement access.
- There is low speed limit and traffic volume on Jonesborough Street.
- This alternative supports environmental education and recreational opportunities through the woods and along the creek.

Constraints

- Jonesborough Street is narrow and contains curves (poor sight views).
- If a bicycle boulevard is created along Jonesborough Street, it would not accommodate pedestrians and pedestrian facilities would be required.
- Construction of a shared-use path construction along Jonesborough Street would involve utility relocation, ROW acquisition, and clearing of vegetation.
- This alternative would require speed control measures for vehicles to ensure safety for greenway users.

Preliminary Cost Estimates

The cost estimate includes the following items:

- Shared-use path on Jonesborough Street
- Greenway through the woods and along Mud Creek
- Connections to proposed trailheads on White Street and Erkwood Drive

$1,400,000

Please see page 60 for cost estimate disclaimers.

Cross Sections

Please see cross section labels on the map.

C2-A

C2-B

C3

C6


MUD CREEK GREENWAY
ALTERNATIVE 3
WHITE STREET
JONESBOROUGH STREET
COPPER PENNY STREET
HUFF STREET
GREENVILLE HIGHWAY
C4
C5
JEDSON LANE
Mud Creek
KANUGA ROAD
C3
TEMON STREET
GOLDEN GATE DRIVE
ERKWOOD DRIVE

4.3.3 Alternative 3

Alternative 3 would connect to the southern terminus of Alternative 2 at Mud Creek and links to a raised boardwalk "park" south of Publix and east of Mud Creek. A connection to the "park" would continue east of the creek and run south towards Erkwood Drive. A potential connection could tie into Alternative 1 if it crossed Mud Creek and connected south of the crosswalk. A connection to Publix could occur east of the proposed boardwalk. The alternative also provides a southern connection to Trailhead 4 on Erkwood Drive.

Opportunities

- This alternative provides unique environmental education opportunities in "lowlands" with boardwalks and overlooks.
- The alternative has the potential to become a great community asset in a property that will otherwise have development challenges due to the presence of wetlands.

Constraints

- The alternative will require a bridge over Mud Creek if it allows access by users on the west side of the creek.
- Elevated boardwalks will be required over wetland vegetation to the east of Mud Creek.

4.4 Cross Sections

All trail alternatives with their respective cross sections are outlined on the following pages.

Preliminary Cost Estimates

The cost estimate includes the following items:

- Boardwalk and connection to Publix
- Potential bridge
- Bridge over Mud Creek
- Greenway extension south along Mud Creek

$3,215,000

Please see page 60 for cost estimate disclaimers.

Cross Sections

Please see cross section labels on the map.

C3

C4

C5

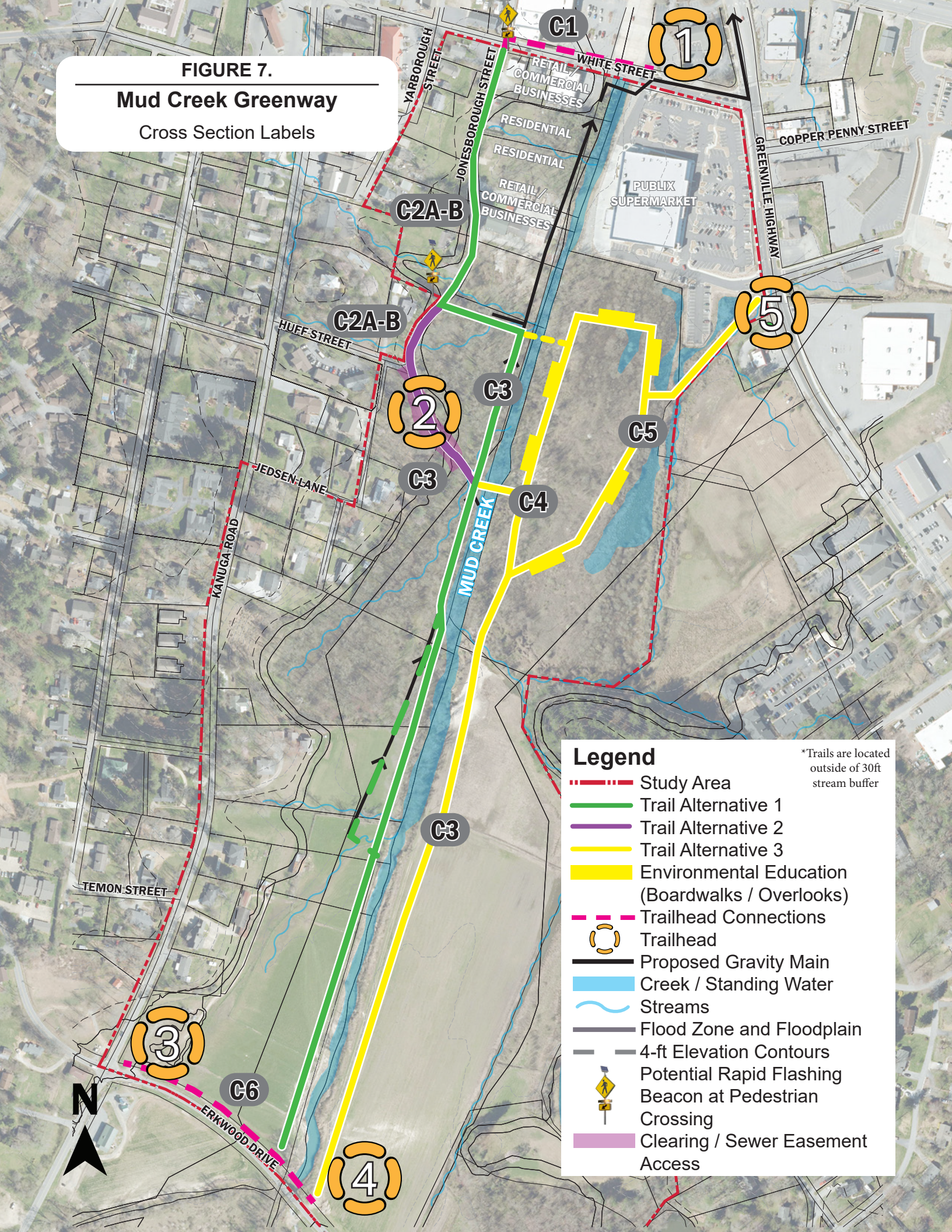
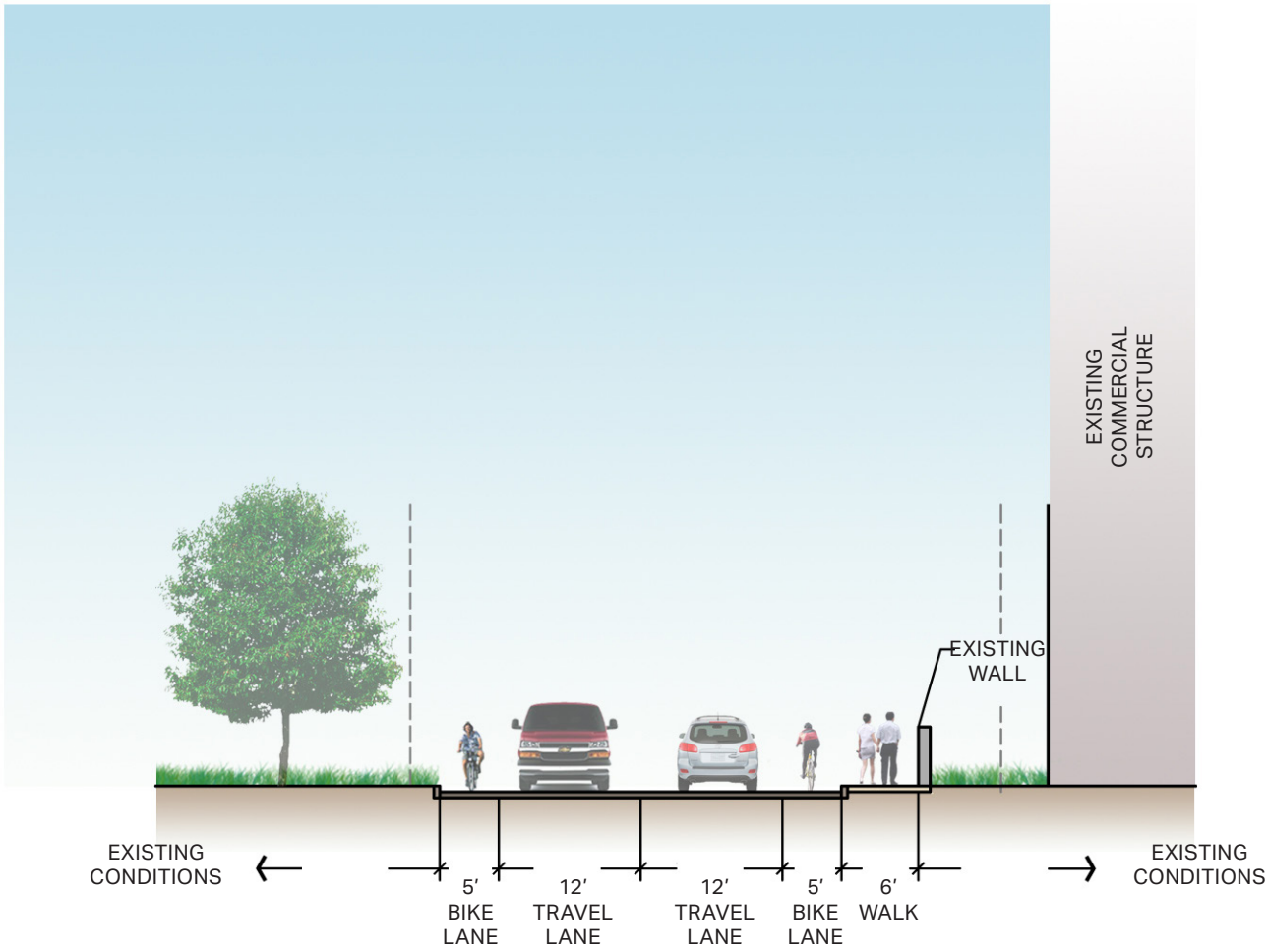


FIGURE 7.
Mud Creek Greenway
Cross Section Labels
C1
C2A-B
C2A-B
C3
C3
C3
C4
C5
C6
1
2
3
4
5
WHITE STREET
YARBOROUGH STREET
JONESBOROUGH STREET
RETAIL / COMMERCIAL BUSINESSES
RESIDENTIAL
RESIDENTIAL
RETAIL / COMMERCIAL BUSINESSES
PUBLIX SUPERMARKET
COPPER PENNY STREET
GREENVILLE HIGHWAY
HUFF STREET
JEDSEN LANE
KANUGA ROAD
MUD CREEK
TEMON STREET
ERKWOOD DRIVE
N
Legend
*Trails are located outside of 30ft stream buffer
Study Area
Trail Alternative 1
Trail Alternative 2
Trail Alternative 3
Environmental Education (Boardwalks / Overlooks)
Trailhead Connections
Trailhead
Proposed Gravity Main
Creek / Standing Water
Streams
Flood Zone and Floodplain
4-ft Elevation Contours
Potential Rapid Flashing Beacon at Pedestrian Crossing
Clearing / Sewer Easement Access

C1

White Street Section

2 - 5′ Bike lanes, 6′ sidewalk, and crosswalks to 12′ multi-use path on Jonesborough Street

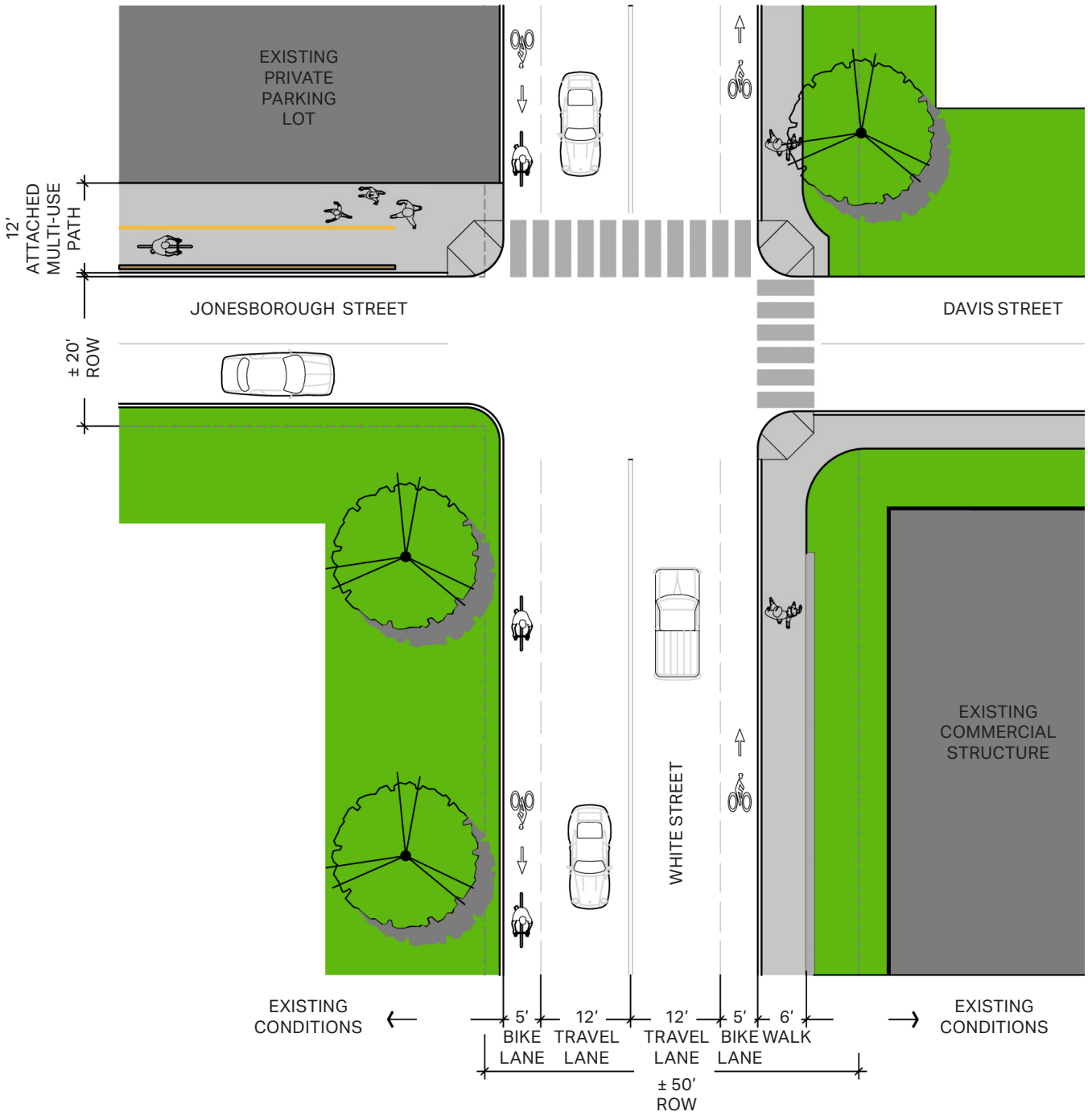


Not to Scale

C1

White Street Section

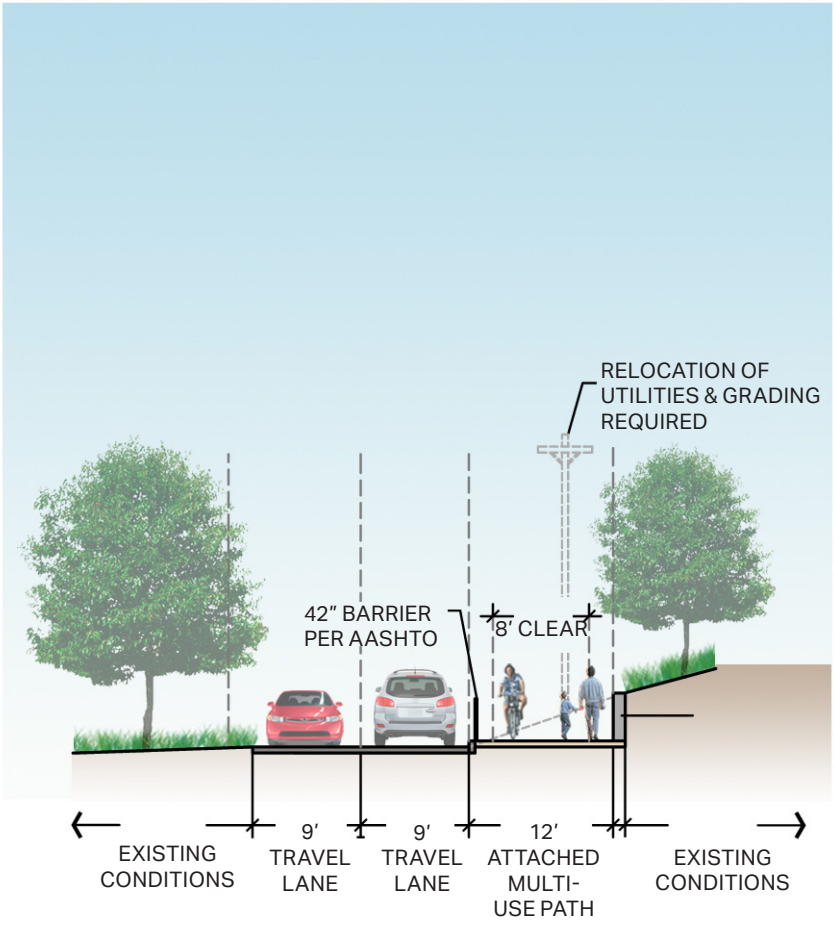
2 - 5′ Bike lanes, 6′ sidewalk, and crosswalks to 12′ multi-use path on Jonesborough Street



Not to Scale

C2A

Jonesborough Street Section
12′ Attached multi-use path

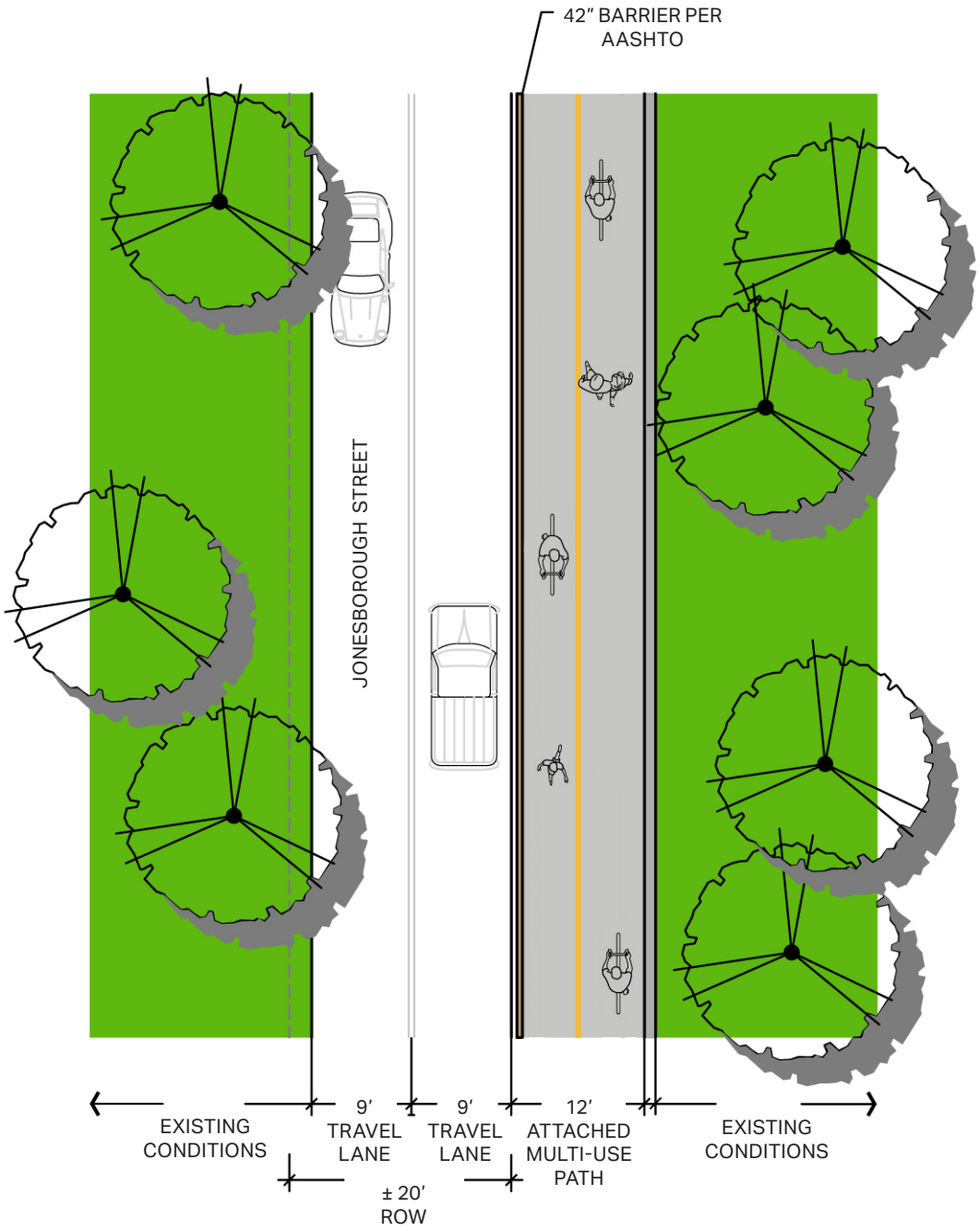


Not to Scale

C2A

Jonesborough Street Section

12′ Attached multi-use path

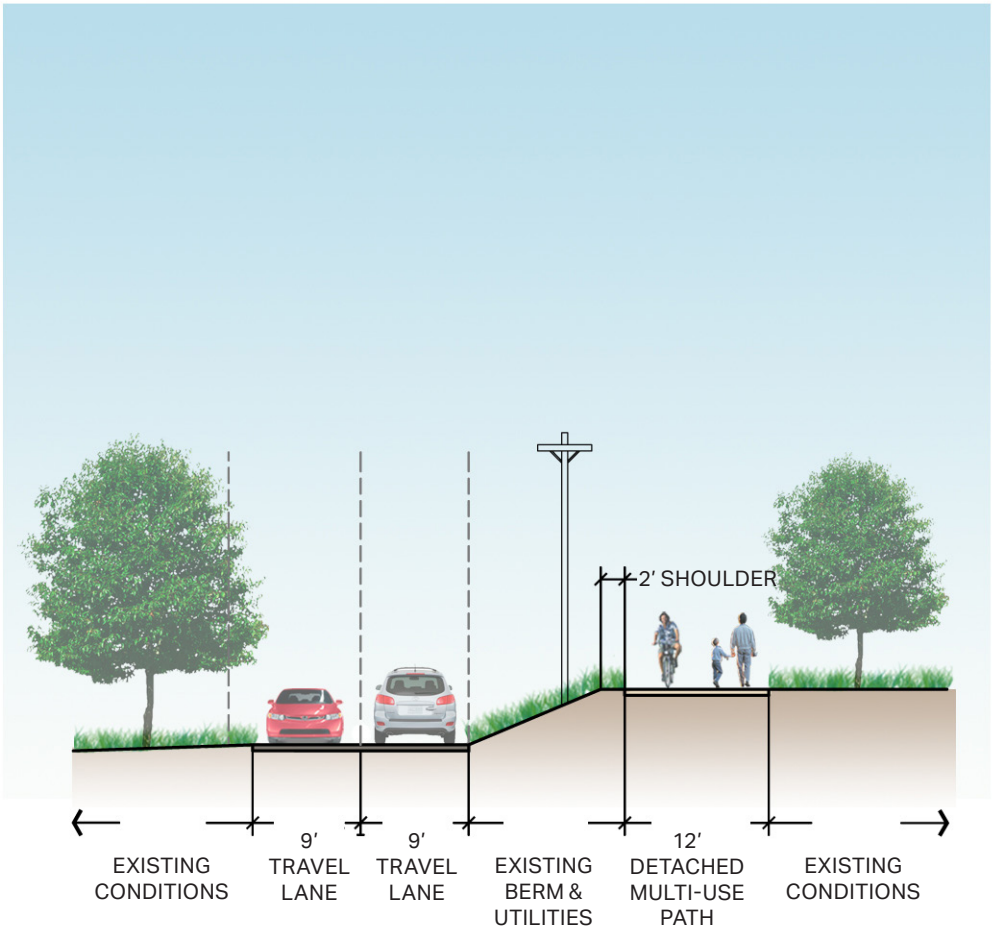


Not to Scale

C2B

Jonesborough Street Section

12′ Detached multi-use path

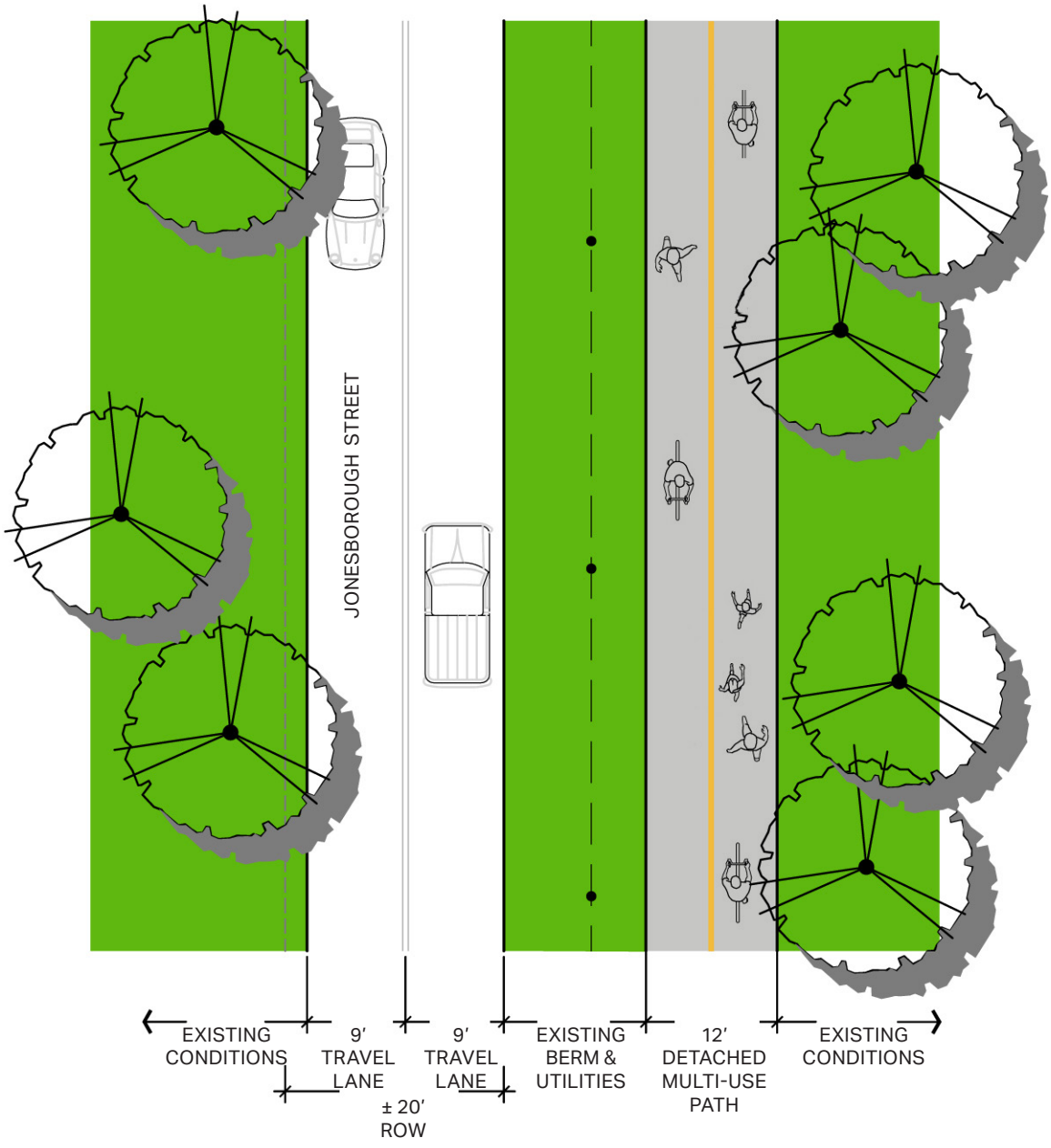


Not to Scale

C2B

Jonesborough Street Section

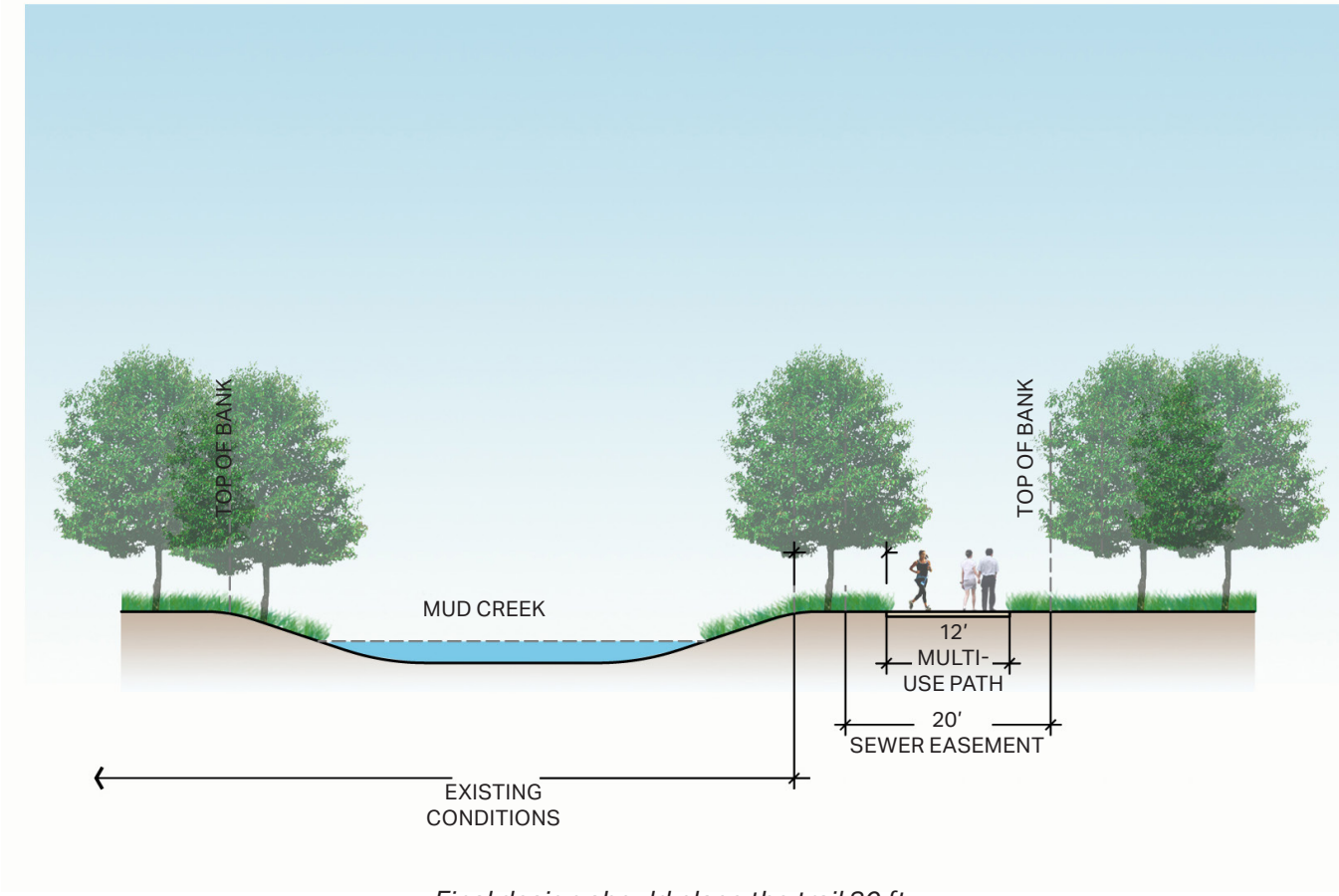
12′ Detached multi-use path



Not to Scale

C3

Mud Creek Section
12′ Multi-use path

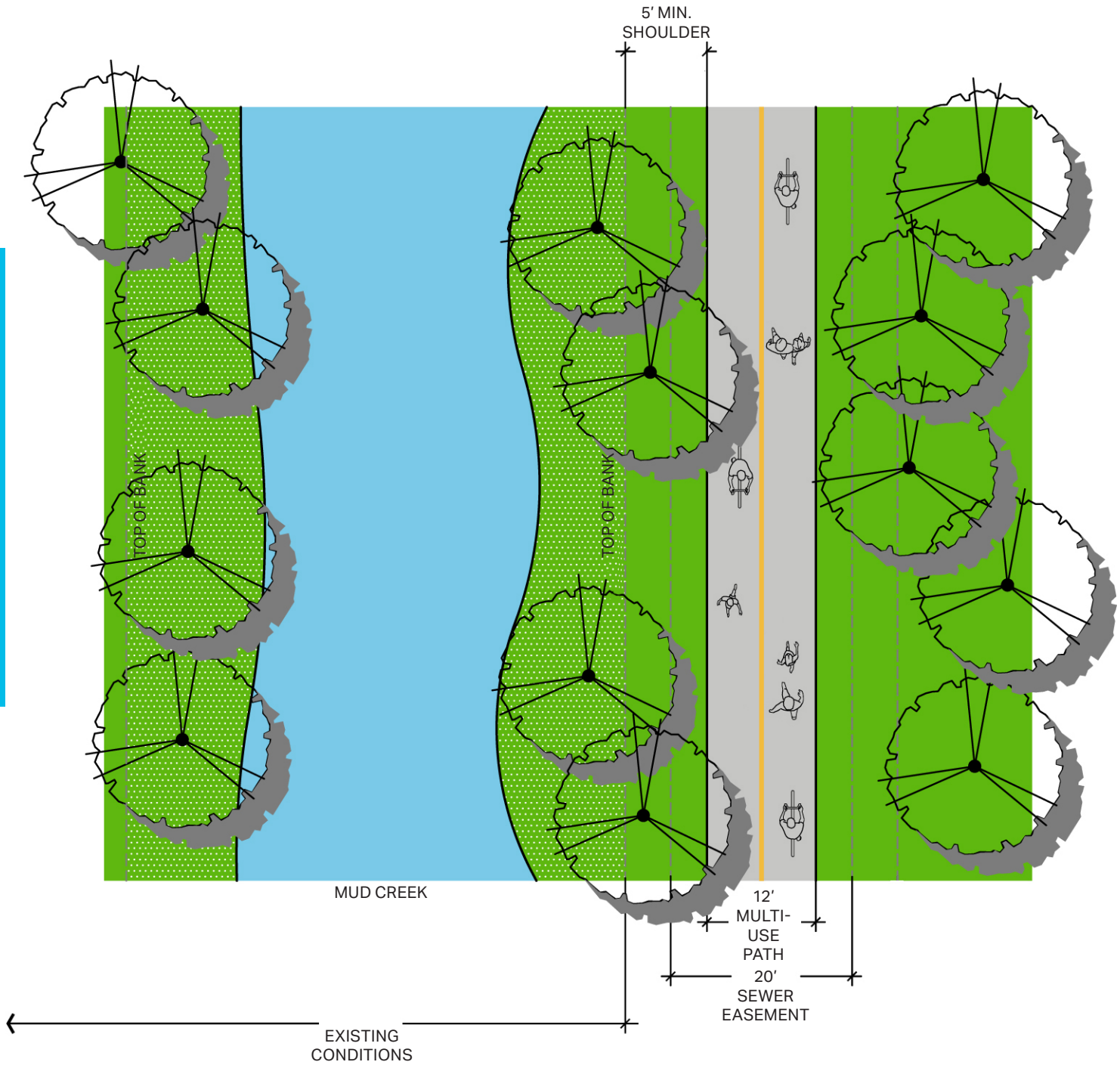


Final design should place the trail 30 ft from the stream (outside of 30 ft stream buffer) or permits will be required.

Not to Scale

C3

Mud Creek Section
12′ Multi-use path



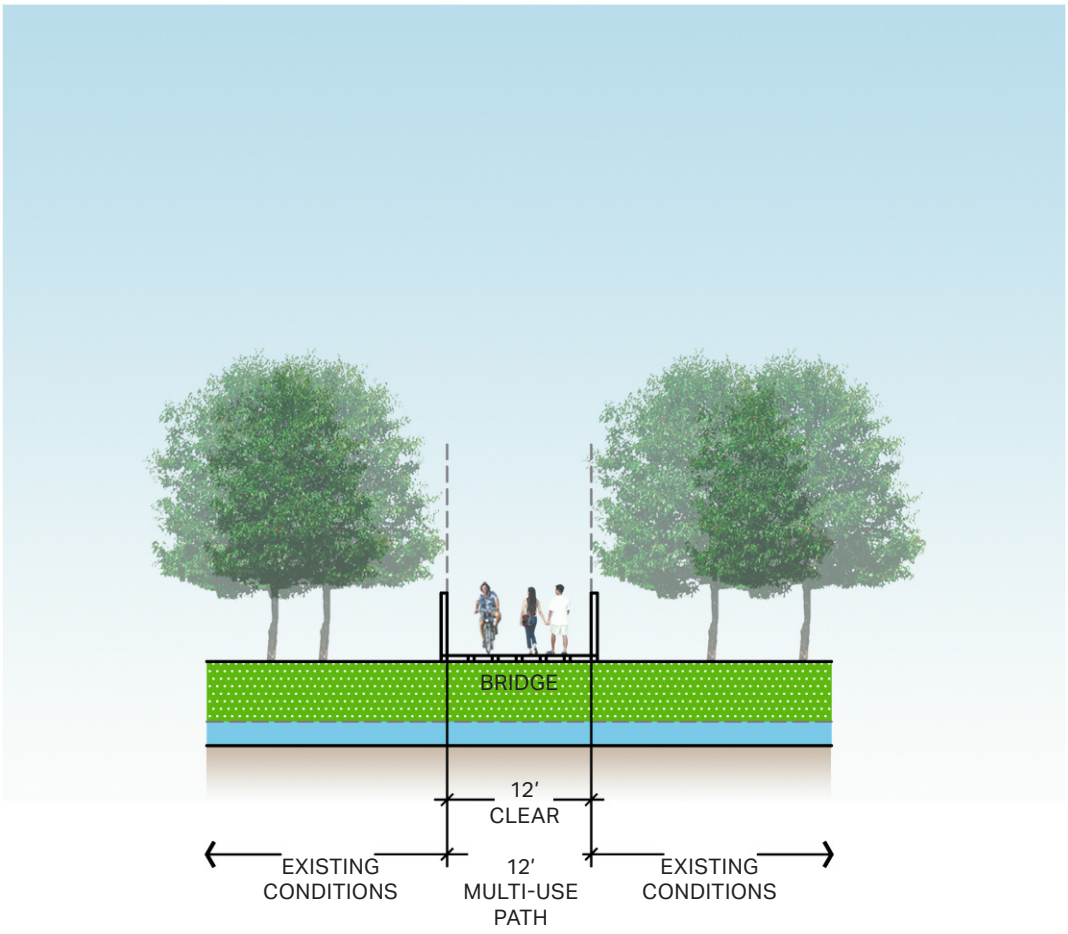
Final design should place the trail 30 ft from the stream (outside of 30 ft stream buffer) or permits will be required.

Not to Scale

C4

Mud Creek Section

± 12′ Pedestrian bridge

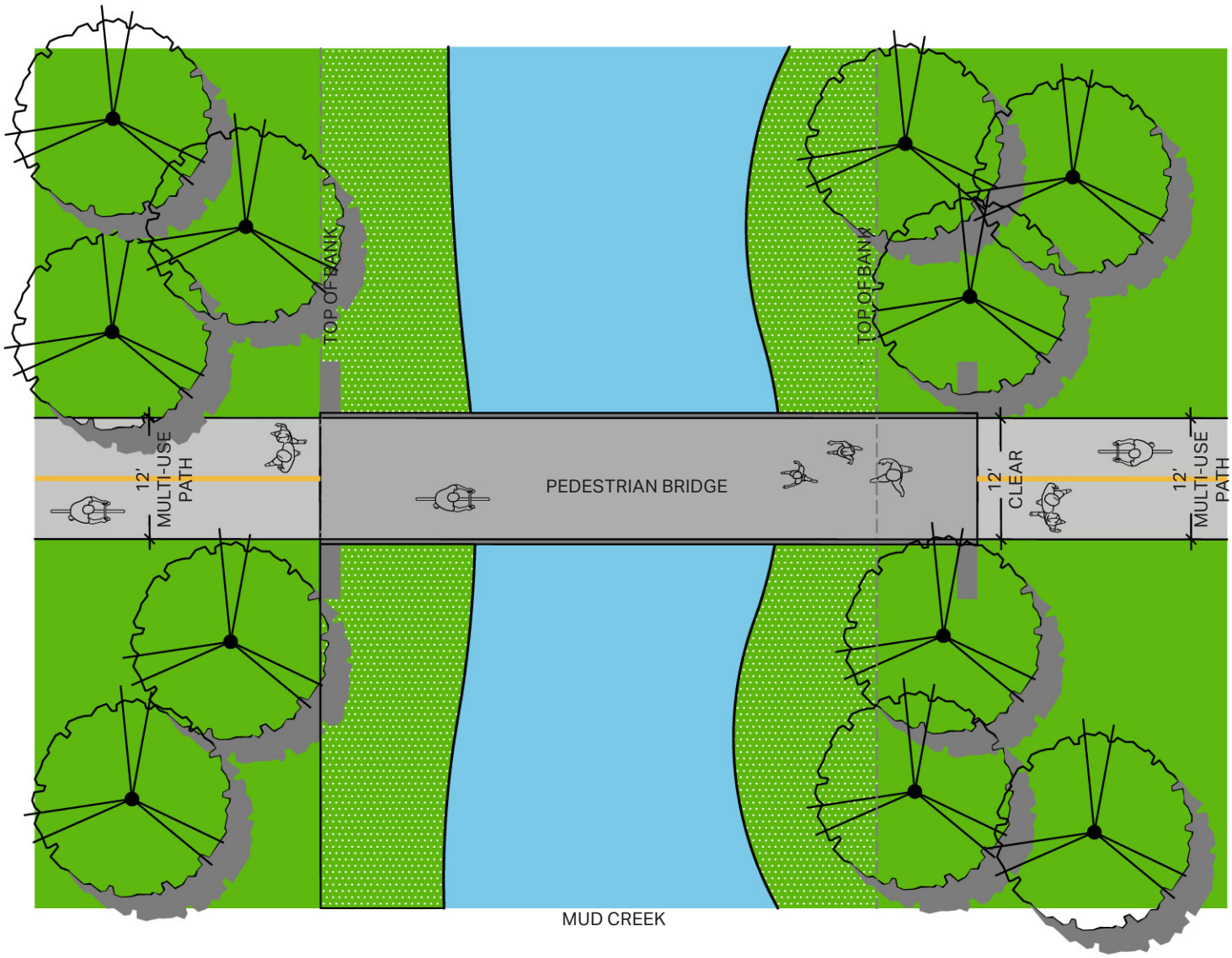


Not to Scale

C4

Mud Creek Section

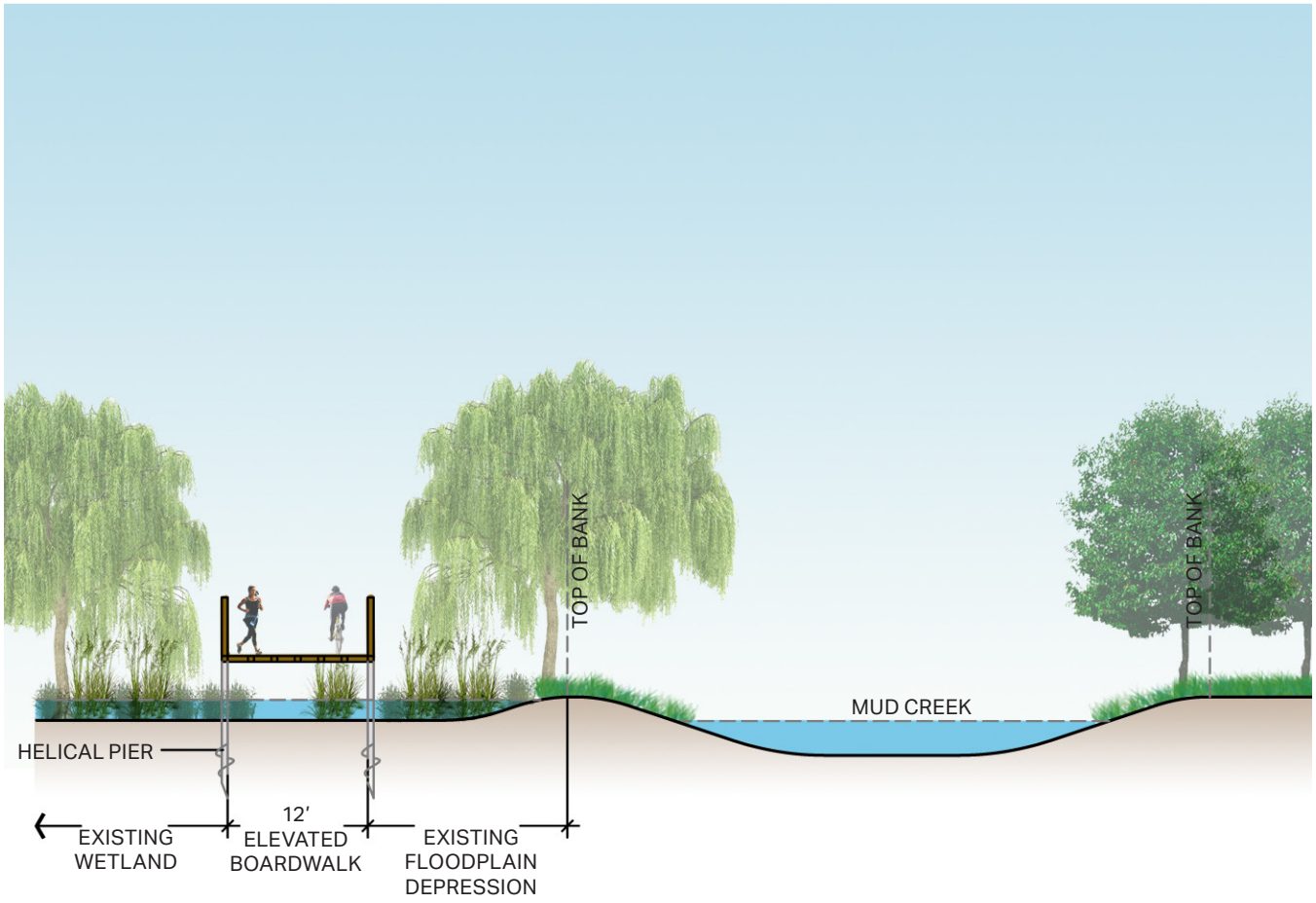
± 12′ Pedestrian bridge



Not to Scale

C5

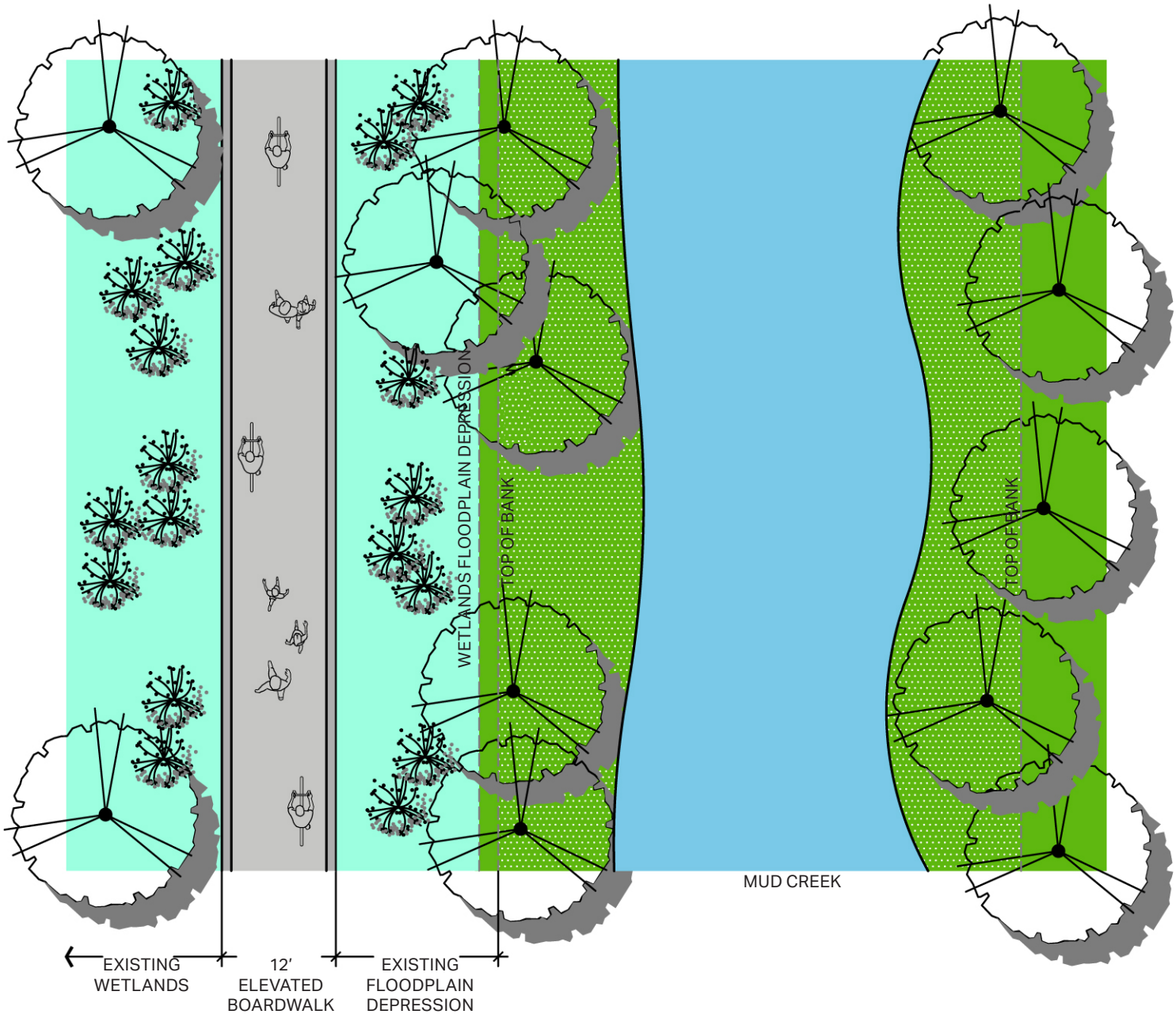
Mud Creek Section
12′ Elevated boardwalk



Not to Scale

C5

Mud Creek Section
12′ Elevated boardwalk

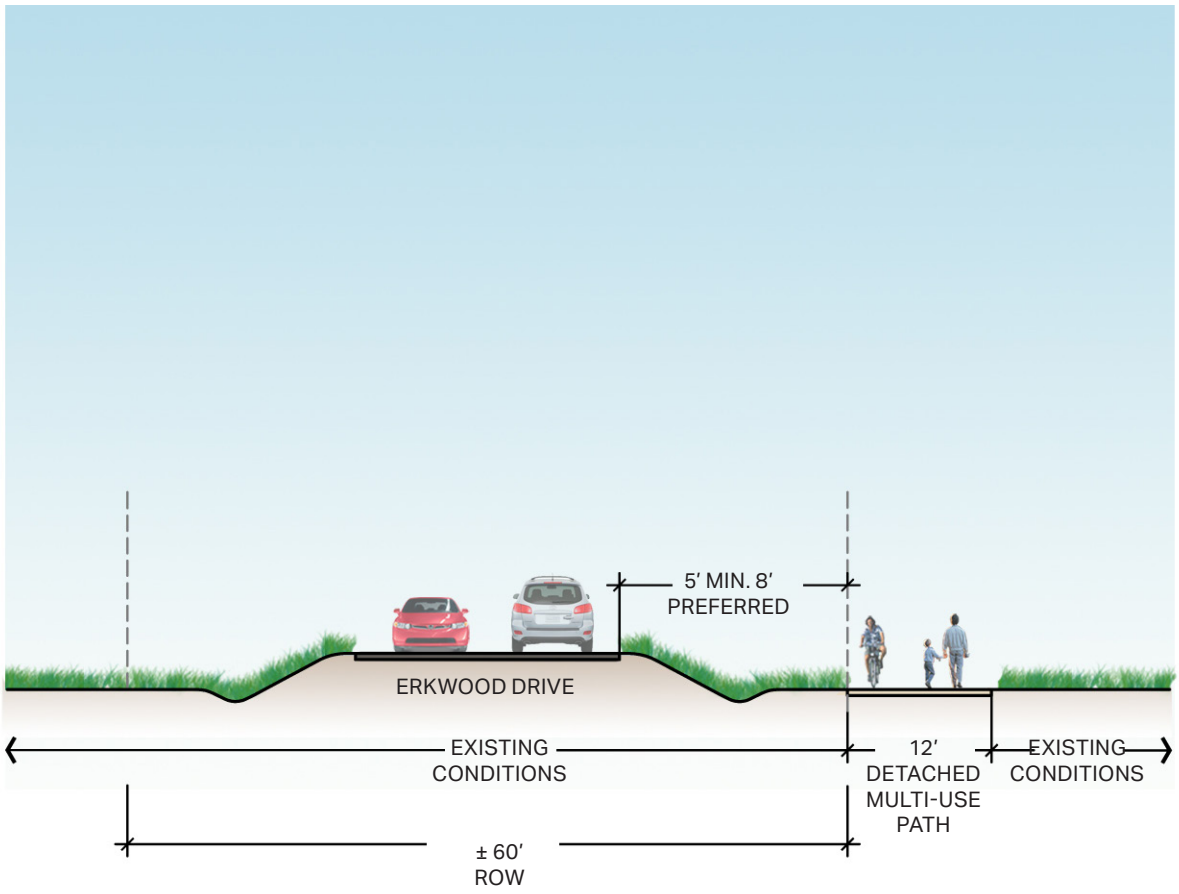


Not to Scale

C6

Erkwood Drive Section

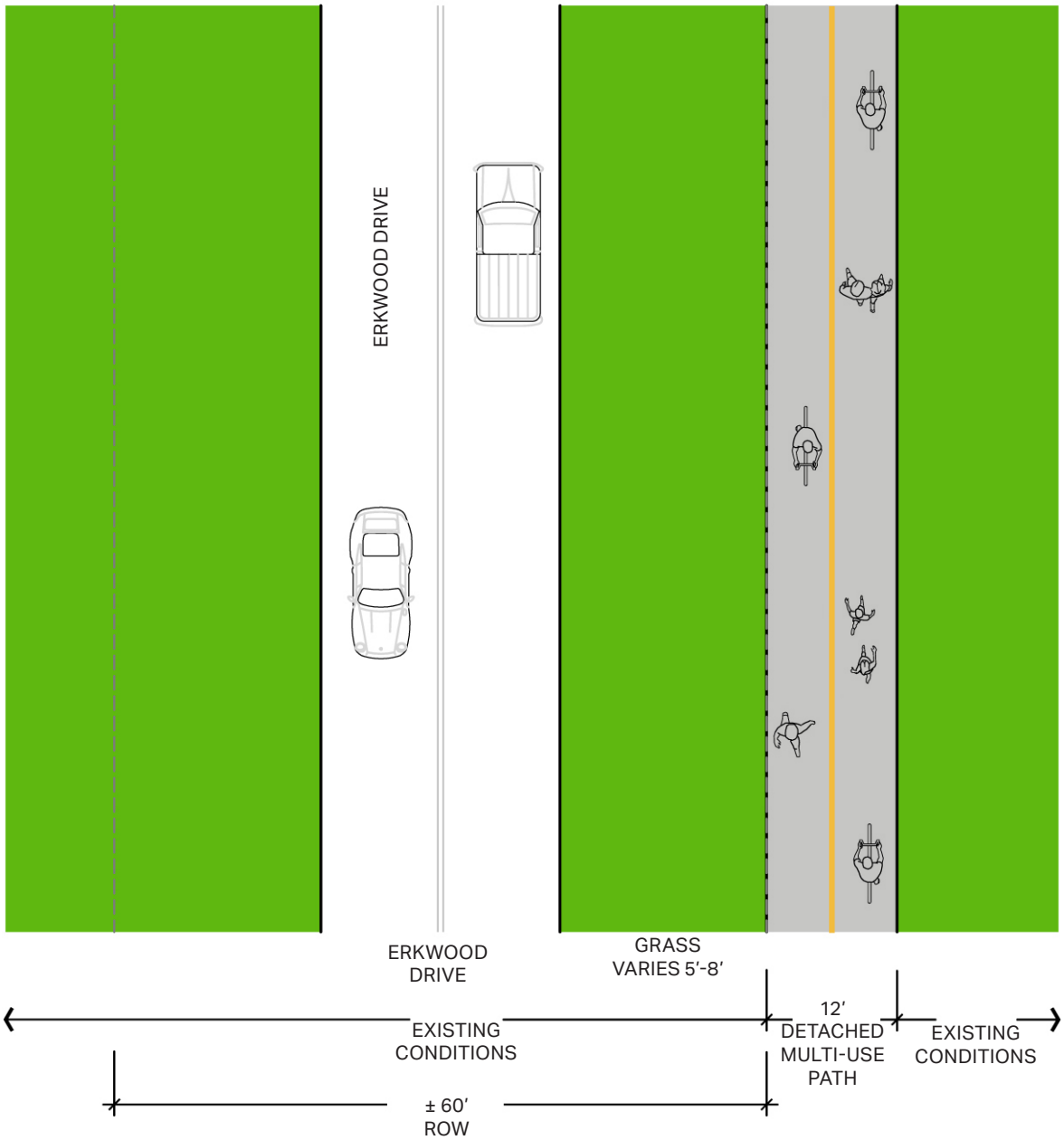
12′ Detached multi-use path



Not to Scale

C6

Erkwood Drive Section
12′ Detached multi-use path



Not to Scale

This page intentionally left blank

4.5 Cost Estimates

Cost estimates were derived from several sources, incldiuing the NCDOT BikePed Cost Estimation Tool. The information in **Table 12** was used to calculate the cost estimations for the trail recommendations made in this report. The alternatives were split into segments based on the proposed facility type for the greenway and are displayed in **Figure 8**.

Table 12: Cost Estimation Tool Inputs

Recommendation (Based on Segments)	Description	Length (ft)	Facility Width (ft)	Streams Crossed	Cost
Alternative 1A	2 marked crosswalks and 1 flashing beacon on White Street	N/A	N/A	0	$110,000
Alternative 1A	Bike lanes on both sides of White Street	330	5	0	$190,000
Alternative 1B	1 marked crosswalk and 1 flashing beacon + multi-use path on Jonesborough	738	12	0	$625,000
Alternative 1C	Multi-use path through woods and along Mud Creek	2,822	12	5	$1,985,000
Alternative 1D	Multi-use path along Erkwood	665	12	0	$470,000
				Total	**$3,380,000**
Alternative 2A Option A	Multi-use path on Jonesborough and greenway through the woods	605	12	1	$470,000
Alternative 2 Option B	Multi-use path connection to Alternative 1 (Alt1A, Alt 1B, and partial Alt 1C)	2,050	12	2	$1,400,000
Alternative 2 Option C	Multi-use path connection and Alternative 3 (3A, 3B, 3C, and 3D)	5,182	12	4	$3,685,000
				Total	*Depends on option*
Alternative 3A	Boardwalk (does not include bridges) + segment to Publix	2,414	12	0	$1,600,000
Alternative 3B	Potential bridge	124	12	1	$165,000
Alternative 3C	Bridge	119	12	1	$160,000
Alternative 3D	Multi-use extension south along Mud Creek (does not include bridges)	1,920	12	1	$1,290,000
				Total	**$3,215,000**

Notes:
*Some alignments will require some stream crossings. Additional studies should be conducted on streams to determine the type of structure.
*Boardwalk cost estimate includes permitting, design, and construction fees.
*All costs included are conceptual only and are subject to change based on construction market fluctuations, real estate values, final survey, design and engineering.
*Total cost estimates include fees for design, ROW, utilities, and construction.
*NCDOT Bicycle & Pedestrian Facility Cost Tool Disclaimer: All costs are based on 2019 prices and cost components are rounded to the nearest $5,000, with a minimum of $5,000 per component. This tool assumes that 10% of the utilities located within the project area would need to be relocated. This tool assumes established ecoregion typologies, construction market regions, and average land values specific to North Carolina. They are determined within the tool based on user inputs for project location. This location-based information is used in ROW, construction, and environmental mitigation calculations. This tool assumes a project impact area for ROW and environmental mitigation calculations based on chosen SIT, project type, project length, and project facility width. This tool is limited in accuracy by user inputs and the complexity of questions presented for each project. If the inputs are incorrect, the tool's accuracy will be diminished. This tool does not estimate costs associated with the purchase or taking of buildings within its ROW estimate calculations. It is assumed that projects would require land acquisition only. Estimates for the construction of new and/or the modification of existing structures (bridges or tunnels) have been simplified to estimate an assumed width of each structure based on the type of feature crossed and other factors. The construction of new and/or modification of existing structures can be exponentially complex based on project specifications. A separate feasibility study is highly recommended to address the high variability associated with structure costs.

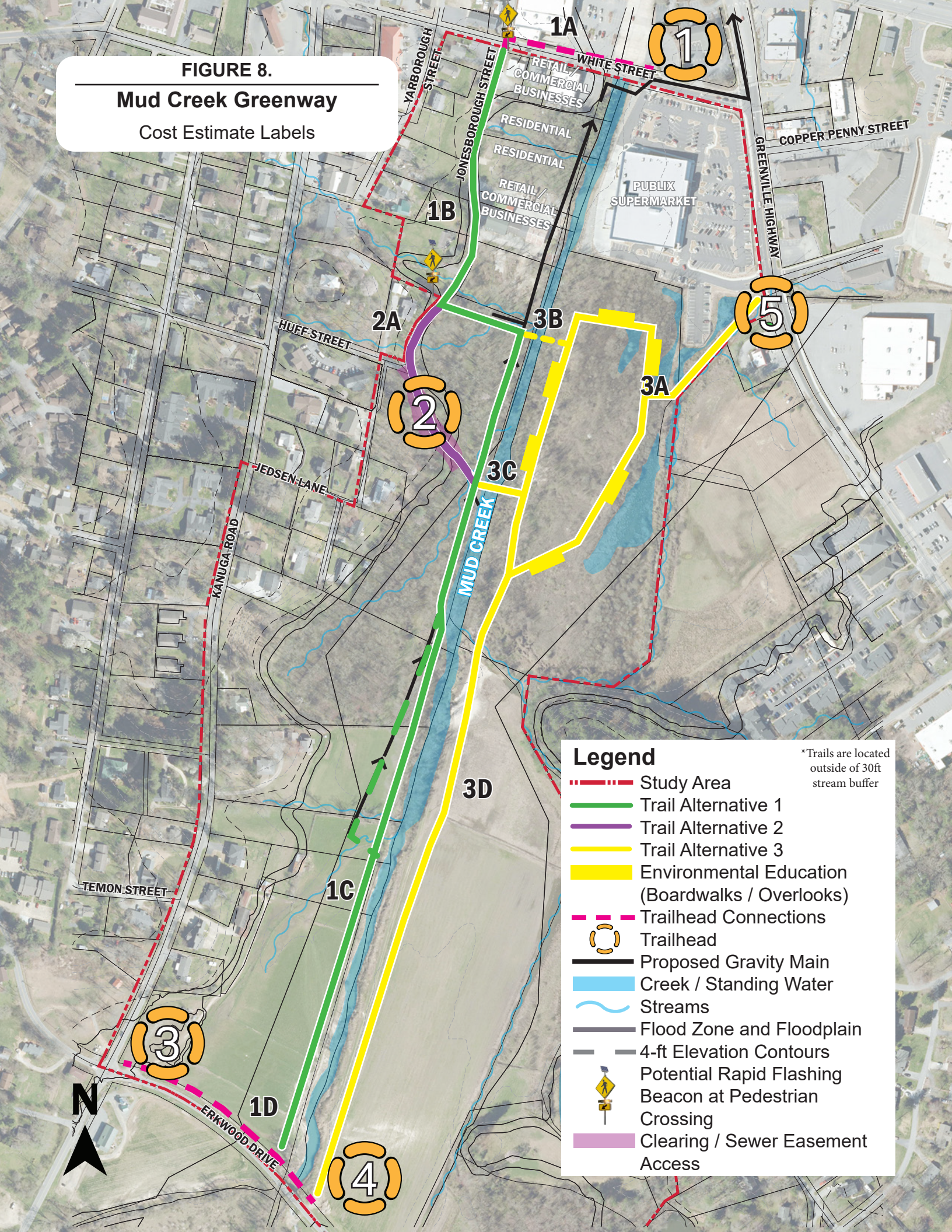


FIGURE 8.
Mud Creek Greenway
Cost Estimate Labels
1A
1
WHITE STREET
YARBOROUGH STREET
JONESBOROUGH STREET
RETAIL / COMMERCIAL BUSINESSES
RESIDENTIAL
RESIDENTIAL
RETAIL / COMMERCIAL BUSINESSES
COPPER PENNY STREET
GREENVILLE HIGHWAY
PUBLIX SUPERMARKET
1B
2A
3B
5
HUFF STREET
2
3A
JEDSEN LANE
3C
KANUGA ROAD
MUD CREEK
3D
TEMON STREET
1C
3
N
1D
ERKWOOD DRIVE
4
Legend
*Trails are located outside of 30ft stream buffer
Study Area
Trail Alternative 1
Trail Alternative 2
Trail Alternative 3
Environmental Education (Boardwalks / Overlooks)
Trailhead Connections
Trailhead
Proposed Gravity Main
Creek / Standing Water
Streams
Flood Zone and Floodplain
4-ft Elevation Contours
Potential Rapid Flashing Beacon at Pedestrian Crossing
Clearing / Sewer Easement Access

4.6 Renderings

Conceptual renderings for the proposed trailheads and multi-use paths are provided on the following pages. These renderings are subject to change based on final survey and design.

Elevated boardwalk examples are provided below and on the following page. These are examples that could be implemented for Alternative 3. Specific design criteria are detailed below:

- Helical piles could be used to elevate the boardwalks over the wetlands.
- The boardwalks would be 12' wide clear for bicycle and pedestrian use that matches the greenway multi-use paths.
- Fall preventative railings required in areas that exceed 30" in height with railing supports on the exterior to prevent handlebar snags (apply to the entire boardwalk).
- Railings should be 42" in height and the maximum space between on side railing shall not exceed 4" in width or at the bottom of the side railings between the decking and the railings.
- Cross slopes to not exceed 2%.
- Maximum grade shall not exceed 5% longitudinally or it is considered an ADA ramp which would trigger landings.
- All hand railings shall be sanded smooth.
- Boardwalk shall accommodate the weight of a gator vehicle for maintenance and or emergencies at minimum.

Elevated Boardwalk Examples

This page intentionally left blank

MUD CREEK GREENWAY
TRAILHEAD CONCEPTUAL RENDERING

DISCLAIMER: THIS DISPLAY IS FOR CONCEPTUAL RENDERING ONLY, SUBJECT TO CHANGE BASED ON FINAL SURVEY AND DESIGN. USERS OF THIS INFORMATION SHOULD REVIEW OR CONSULT THE PRIMARY INFORMATION AND DATA SOURCES TO ASCERTAIN THE USABILITY OF THE INFORMATION.

This page intentionally left blank

MUD CREEK GREENWAY
MULTI-MODAL PATH CONCEPTUAL RENDERING I - Jonesborough Street

DISCLAIMER: THIS DISPLAY IS FOR CONCEPTUAL RENDERING ONLY, SUBJECT TO CHANGE BASED ON FINAL SURVEY AND DESIGN. USERS OF THIS INFORMATION SHOULD REVIEW OR CONSULT THE PRIMARY INFORMATION AND DATA SOURCES TO ASCERTAIN THE USABILITY OF THE INFORMATION.

This page intentionally left blank

MUD CREEK GREENWAY
MULTI-MODAL PATH CONCEPTUAL RENDERING II

DISCLAIMER: THIS DISPLAY IS FOR CONCEPTUAL RENDERING ONLY, SUBJECT TO CHANGE BASED ON FINAL SURVEY AND DESIGN. USERS OF THIS INFORMATION SHOULD REVIEW OR CONSULT THE PRIMARY INFORMATION AND DATA SOURCES TO ASCERTAIN THE USABILITY OF THE INFORMATION.

ACTION PLAN

CHAPTER 5

5.1 Action Plan Overview

The Action Plan for this Feasibility Study includes a preferred alignment and a 10-year schedule for completion that will include a phasing plan. The prioritization methodology, located below in **Table 13**, was based on design considerations and was created to rank the various alignments. The plan incorporates cost estimates, funding sources, potential teaming partners, and land acquisition methodologies. The Action Plan was modified to reflect Oversight Committee recommendations. The Action Plan also includes maps of the greenway locations, and graphic renderings of the greenway. The preferred greenway alternative includes a combination of segments from Alternative 1 and Alternative 3 (**Figure 9**).

Table 13: Prioritization Methodology Matrix

Alternatives	Alignments with Existing Plans	Natural Environment			Human Environment				Partnership Opportunities	Recreational/ Educational Opportunities	Public Support
		Topography is relatively flat	*Floodplain/ Floodzone*	*Streams and Wetlands*	*ROW*	*Major Bridges/ Infrastructure*	*Streets*	*Utilities*	*Existing Pedestrian Infrastructure*			
Alt. 1 (Mud Creek)	✓	✓	✓	✓	✓ (Affects several properties)	X	X	✓	X	✓	✓	X
Alt. 1 (White Street)	✓	✓	✓	X	✓ (Affects several properties)	X	✓	✓	✓ (Strip of sidewalk)	✓	✓	✓
Alt. 1 (Jonesborough Street)	✓	✓	✓	X	✓ (Affects several properties)	X	✓	✓	X	✓	✓	X
Alt. 1 (Erkwood Drive)	✓	✓	✓	X	✓ (Affects one property)	X	✓	✓	X	✓	✓	X
Alt. 2	✓	✓	✓	✓	✓ (Affects several properties)	X	X	✓	X	✓	✓	✓
Alt. 3	✓	✓	✓	✓	✓ (Affects two properties)	✓ (Requires boardwalk and the bridge over Mud Creek)	X	X	X	✓	✓	✓

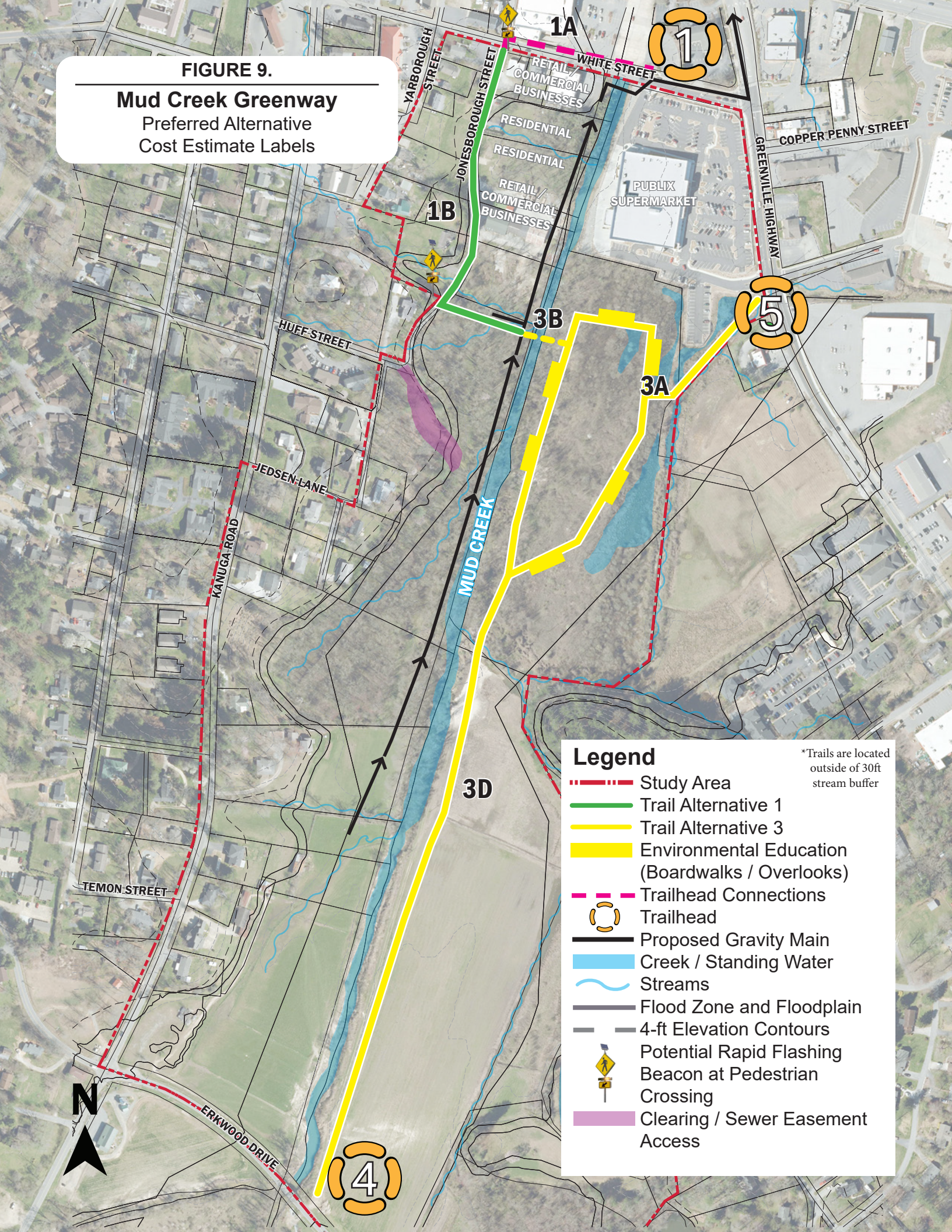


FIGURE 9.
Mud Creek Greenway
Preferred Alternative
Cost Estimate Labels
1A
1
WHITE STREET
YARBOROUGH STREET
JONESBOROUGH STREET
RETAIL / COMMERCIAL BUSINESSES
RESIDENTIAL
RESIDENTIAL
RETAIL / COMMERCIAL BUSINESSES
COPPER PENNY STREET
GREENVILLE HIGHWAY
PUBLIX SUPERMARKET
1B
3B
5
HUFF STREET
3A
JEDSEN LANE
KANUGA ROAD
MUD CREEK
3D
TEMON STREET
ERKWOOD DRIVE
4
N
Legend
*Trails are located outside of 30ft stream buffer
Study Area
Trail Alternative 1
Trail Alternative 3
Environmental Education (Boardwalks / Overlooks)
Trailhead Connections
Trailhead
Proposed Gravity Main
Creek / Standing Water
Streams
Flood Zone and Floodplain
4-ft Elevation Contours
Potential Rapid Flashing Beacon at Pedestrian Crossing
Clearing / Sewer Easement Access

5.1.1 Summary of the Cost Estimate

The cost estimate for the preferred greenway alternative is provided in **Table 14** below. The preferred greenway alternative includes a combination of segments from Alternative 1 and Alternative 3. The cost estimate includes fees for design, ROW, utilities, and construction. Costs are based on bike lanes that are 5ft wide on White Street and 12ft wide multi-use paths.

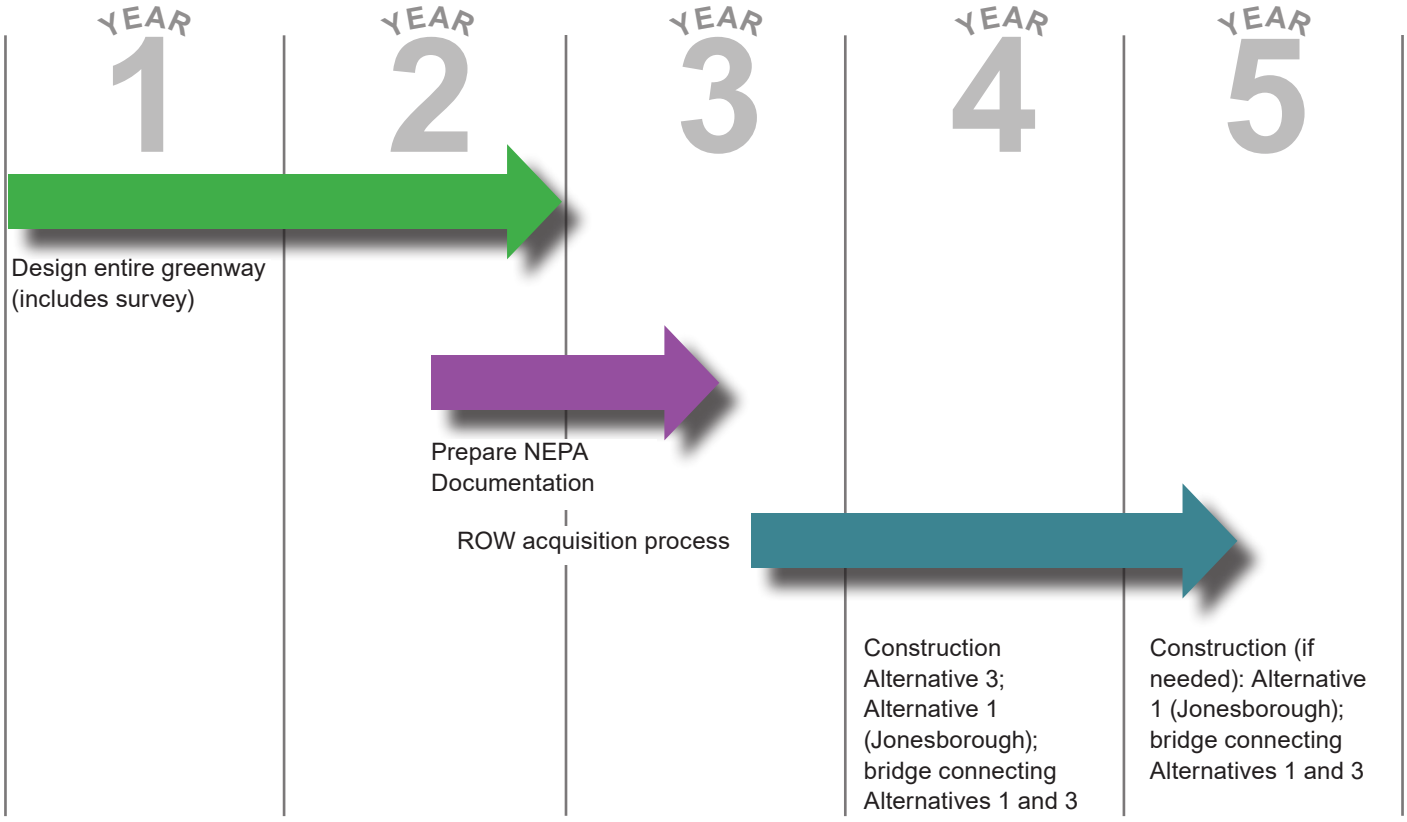
Table 14: Cost Estimation Tool Inputs

Recommendation (Based on Segments)	Description	Length (ft)	Design	ROW	Utilities	Construction	Total Cost
Alternative 1A	2 marked crosswalks and 1 flashing beacon on White Street	N/A	$15,000	$5,000	$5,000	$85,000	$110,000
Alternative 1A	Bike lanes on both sides of White Street	330	$90,000	$5,000	$10,000	$85,000	$190,000
Alternative 1B	1 marked crosswalk and 1 flashing beacon + multi-use path on Jonesborough	738	$125,000	$10,000	$20,000	$470,000	$625,000
Alternative 3A (3D was incorporated into the cost for 3A)	Boardwalk (does not include bridges) + segment to Publix + Multi-use extension south along Mud Creek	4,215	$395,000	$10,000	$75,000	$2,215,000	$2,695,000
Alternative 3B	Bridge	124	$90,000	$5,000	$5,000	$65,000	$165,000
				Grand Total			**$3,785,000**

5.1.2 Phasing Plan

Recommendations to phase the implementation based on design considerations, alignment analysis, funding availability, ROW acquisition, and connectivity, as well as future land use are provided in the proposed timeline below.

It will take two years to design the entire greenway (includes surveying). Between years 2 and 3 NEPA documentation will be prepared. Between years 3 and 5, ROW acquisition will begin, followed by construction. Construction could be broken down by the greenway sections (Alternative 3, Jonesborough Street, and the bridge over Mud Creek between the two alternatives.



5.1.3 Funding Sources

There are several opportunities for the County to acquire funding support for the project. Examples include, but are not limited to, the Surface Transportation Block Grant - Direct Attributable (STBG-DA - previously known as Surface Transportation Program), the Transportation Alternatives Program (TAP), and the Henderson County Tourism Development Authority (TDA). Each funding source is described further below.

Surface Transportation Block Grant - Direct Attributable (STBG-DA) – STBG-DA is a federal-aid transportation program, administered by the FHWA, which provides funding used by MPOs for transportation improvement projects.

Transportation Alternatives Program (TAP) – TAP is a federal-aid transportation program that provides funding for programs and projects defined as transportation alternatives, including on- and off-road pedestrian and bicycle facilities, infrastructure projects for improving non-driver access to public transportation and enhanced mobility, community improvement activities, and environmental mitigation, trails that serve a transportation purpose, and safe routes to school projects.

Henderson County Tourism Development Authority (TDA) – The North Carolina legislation originally established Henderson County's Tourism Development Authority (TDA) to promote the County as a travel destination. More specifically, the group oversees the expenditure of occupancy taxes collected. TDA has successfully reserved excess revenues that can be put towards the development of tourism-related projects. In addition, funds may be set aside to allocate towards new greenway trails and connections throughout Henderson County.

5.1.4 Coordination Opportunities

The project will require support from surrounding groups to help move the greenway forward. Henderson County should consider partnering with the following groups (described below):

- Blue Ridge Bicycle Club
- Carolina Thread Trail
- City of Hendersonville
- Conserving Carolina
- North Carolina Department of Environmental Quality (NC DEQ)
- North Carolina Department of Transportation
- RiverLink
- MountainTrue
- French Broad River Metropolitan Organization
- United States Army Corps of Engineers (USACE)

Blue Ridge Bicycle Club – The Blue Ridge Bicycle Club is a 501(c)3 non-profit and its mission is to promote healthy and fun lifestyles through cycling in Western North Carolina. The club provides funding for mini grants to support the bicycle-related projects of other groups, matching funds for groups developing bike and greenway plans, and money to support the purchase of land for greenways.

Carolina Thread Trail - The Carolina Thread Trail is led by the Catawba Lands Conservancy and its mission is to strengthen the region by promoting economic development, education, better health, and land conservation.

City of Hendersonville – A large parcel, east of Mud Creek, may be selected for the greenway. This parcel is owned by the City of Hendersonville. The City of Hendersonville was influential in the extension of the Oklawaha Greenway form Patton Park to Berkley Mils Park in 2016. Like the recommendations provided in this report, the City obtained easements for the greenway in tandem with sewer easements for the greenway Oklawaha Greenway extension.

Conserving Carolina – Conserving Carolina is non-profit conservation organization located in Hendersonville. This group has protected over 45,000 acres of land and created numerous preserves and trails. Private landowners seek help acquiring conservation easements through this group to protect their land in perpetuity.

North Carolina Department of Environmental Quality – NCDEQ is the lead stewardship agency for the protection of North Carolina's environmental resources. This agency put together the **North Carolina Conservation Planning Tool (http://portal.ncdenr.org/web/cpt/other-planning-efforts)** which provides information on current conservation planning work being done statewide, regional, or at the local level.

North Carolina Department of Transportation Division 14 – NCDOT has been an important partner for transportation projects cost sharing, especially when pedestrian and bicycle facilities are required as part of their projects. Some of the projects being developed by NCDOT in the study area will have a direct impact on the Mud Creek Greenway. The project on White Street in particular, will require pedestrian and bicycle facilities to connect to some of the proposed trailheads and eventually with the Ecusta Trail.

RiverLink - RiverLink, a non-profit, is a headquartered in Asheville and promotes the environmental and economic vitality of the French Broad River and its watershed. RiverLink also educates over 3,000 students a year, as well as the public-at-large, about the importance of the French Broad River watershed. This group could be fundamental in spearheading the environmental education efforts for the greenway alignment with the boardwalk.

MountainTrue – MountainTrue is a an environmental and conservation organization that has an office located in Hendersonville. The group is supportive of connections between humans in the natural environment. MountainTrue promotes community engagement, policy and project advocacy, and on-the-ground projects.

French Broad River Metropolitan Organization (FBRMPO) – The FBRMPO currently serves over 414,000 people across 21 municipalities and is a partnership between local and state government. It provides transportation planning support in urbanized areas and meets planning requirements established by federal authorizing legislation for transportation funding. Another major task of the FBRMPO is to prepare long range transportation plans with a minimum 20-year horizon. Additional tasks include developing an annual planning work program and assistance in prioritization of projects to be included in the State Transportation Improvement Program (NCDOT's funding for a 10-year period).

United States Army Corps of Engineers – Engagement with the USACE will be required if final greenway design alignments interfere with wetlands. Permits will be required if alignments are not located outside of the minimum 30 ft stream buffer.

5.1.5 Land Acquisition Strategies

The Henderson County Greenway Master Plan outlines several preferred methods of procurement for the acquisition of public lands and easements. These methods include fee simple, option agreements, easements, right of first refusal, remainder interest/Life estate, donation, and purchase/leaseback. the preferred methodology for land acquisition. Henderson County's view on each method is provided below.

"**Fee Simple** - Fee simple ownership is the full title to the land and the entire "bundle" of property rights including the right to possess land, to use land, or to sell land. A greenway system manager may obtain property outright through purchase, donation, or a combination of the two called a bargain purchase in which the land is sold for less than the full market value. The land can also be sold or donated through installments where multiple payments are made in different years, which may provide tax benefits to the landowner.

Option - An option agreement provides that the owner will sell the property at some agreed upon time in the future. An option does not commit the greenway manager to buy the property, but it does commit the owner to sell if the greenway manager chooses to buy.

Right of First Refusal - An agreement where the landowner commits to make the greenway manager aware when the property will be put up for sale and gives the greenway manager the right to purchase the property before it is made available to others. It does not commit the landowner to sell the property nor the greenway manager to buy it.

Easement - A legal agreement between a landowner and a third-party, usually a non-profit or government agency, that permanently provides for construction and maintenance of a greenway through the landowner's property and for the public's right to use the greenway. Full title to the land is not conveyed, only the specific property rights granted in the easement agreement, therefore, the easement value is less than the full property value. A greenway easement is like an easement for utilities.

Remainder Interest/Life Estate - A landowner may sell or donate the land but retain the right for the landowner or other specific people to live on or otherwise use the property during their lifetimes.

Donation - This is an option for a property owner to donate an easement or property for greenway purposes. Property or easement donations would qualify for tax benefits.

Purchase/Lease Back - Land can be sold or donated well in advance of its need for a greenway. In these situations, it may be possible to lease or rent the land back to its previous owner until it is needed."

While there are several methods of procurement listed in the Greenway Master Plan, Henderson County favors donations and easements over the additional methods listed above. The County would like for property owners to willingly patriciate in the project through land donations. The existing sewer easement with a new future alignment could also help accommodate the land acquisition needs for the project.

If federal funds are used for design and construction, the land acquisition process will need to comply with the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (Uniform Act), in case the county decides to purchase ROW.

5.1.6 Maintenance

Recommendations on greenway maintenance solutions, including cost, resources, and the equipment and materials needed to maintain the greenway are provided in this section. Best practice solutions for the greenway maintenance are based on AECOM's previous experiences.

Several materials should be considered for the greenway:

- Treated wood for the elevated boardwalk
- Recycled plastic material for the bridges
- Pavement striping on on-road connections
- Concrete on off-road connections
- Pressure treated wood used for railings and posts
- Helical piers made from stainless steel

- Wayfinding and educational signage
- Install LED and foot lighting to increase safety measures

Maintenance of a greenway is a critical but often overlooked component of the overall success of a greenway project. A well-maintained path will increase perceptions of safety, increase the number of users, reduce liability concerns, and decrease the occurrence of more costly remedial projects. The maintenance program for the Mud Creek greenway shall involve the following:

Regular inspections to check for:

- Structural deterioration such as cracks, vertical separation, spalling, etc.
- Damage to any amenity/facility resulting from weather-related event.

Vegetation maintenance

- Maintain 8 feet of vertical clearance and 2 feet of horizontal clearance from pavement
- Remove small weeds and trees from trail surface.
- Maintain designed sight distances at intersections.
- Remove potentially hazardous overhanging branches.
- Avoid over trimming vegetation. Over trimmed vegetation makes the corridor less inviting for pedestrians, which in turn decreases safety for all users.
- Avoid overwatering near the path – excess water may travel laterally beneath the pavement surface, weakening its structural integrity.

Drainage maintenance

- Clear debris from any drainage devices to maintain functionality. Conduct routinely, but also at specific times such as after the leaves drop and after storms.
- During routine maintenance, check for structural deficiencies to drainage structures or damage.
- Ensure positive drainage along the entirety of the trail.

Structure maintenance

- Clean trail stations and toilets daily.
- Repaint buildings and trail markings every five years, renovate buildings every ten to twenty years, and resurface trail every ten years.
- Inspect bridges, tunnels, walls, fences, and any other vertical barriers annually.

Sign maintenance

- Periodically review all signs and markings for degradation.
- Clean signs regularly to maintain visibility.
- Replace and repair as needed.

As the project moves into design, these maintenance items shall be specifically delineated in a Maintenance Manual to be distributed to the staff responsible for the maintenance of the greenway. If the greenway is to be maintained by multiple agencies, a Memorandum of Understanding shall be developed that clarifies the responsibilities of each of the agencies that will be involved in the maintenance. In addition, the jurisdictions should consider instituting a "Friends of the Mud Creek Greenway" volunteer program to engage the community in the maintenance and long-term stewardship of the path. By implementing these best management practices, the Mud Creek Greenway will be a treasured amenity for the people of Henderson, North Carolina for years to come.

Table 15 provides a detailed list of assumed maintenance and operational costs that will be associated with the preferred greenway alignment. The annual cost per mile is provided next to each maintenance activity. The costs provided in the table are based on planning-level estimates and may be subject to change.

Table 15: Maintenance and Operations Cost Estimations

Maintenance Activity*	Frequency			Annual Cost/Mile
	Weeks	*Months*	*Year***	
MOWING & TRIMMING	30			$200
HAND TOOL SWEEPING		9		$120
MACHINE SWEEPING		4		$165
WEED CONTROL & PEST MANAGEMENT		4		$30
TRASH COLLECTION & DISPOSAL		12		$40
TRAIL EDGE TRASH & DEBRIS CLEAN-UP		3		$30
DRAINAGE CHANNEL & CULVERT CLEANING		4		$30
GENERAL MAINTENANCE OF TRAILHEADS		4		$20
TRAILHEAD PLANTING & LANDSCAPING		4		$5
TRAILHEAD IRRIGATION OF NEW PLANT MATERIAL		4		$5
LEAF REMOVAL		5		$120
TREE PRUNING		3		$50
TREE REMOVAL		2		$75
SITE FURNISHING MAINTENANCE / REPAIR / REPLACEMENT		6		$125
ASPHALT PATCHING / POTHOLE REPAIR			1	$75
ASPHALT CRACK SEALING			1	$50
ASPHALT REPAVING / OVERLAY (EVERY 10 YRS)			0.1	$425
GRAFFITI REMOVAL			1	$100
BRIDGE, UNDERPASS, CROSSING INSPECTIONS (EVERY 5 YRS/BRIDGE-18)			0.2	$1,800
GENERAL BRIDGE MAINTENANCE			1	$600
TRAIL SECURITY & PATROL	24			$100
EXPENSES & OVERHEAD				
NEW EQUIPMENT PURCHASES				$500
DESIGNATED GREENWAY STAFF (1 FTE** @ $30,000/15 MI)				$2,000
			SUBTOTAL/MILE	$6,665
			LENGTH (MILE)	1.05
			SUBTOTAL	**$6,998**
BOARDWALK				
ANNUAL BOARDWALK FEES ($7/LF, $16,898/5 YEARS)****			1	$3,380
			TOTAL	**$10,378**

* ESTIMATED COSTS INCLUDE EXISTING EQUIPMENT & FUEL
** FTE = FULL-TIME EMPLOYEE
*** ANNUAL COSTS WILL GROW 2-3% EACH YEAR
**** BOARDWALK COSTS DO NOT INCLUDE FLOODING EVENTS

Cost estimates above are planning-level estimates.

Sources

American Planning Association. City Parks Forum Briefing Papers 3: How Cities Use Parks for Economic Development: https://www.naturewithin.info/Policy/APA_econ.pdf

American Planning Association (Novemeber 2017). GHS Swamp Rabbit Trail Selected as the "People's Choice" Great Place Designee. Retreived from: https://www.planning.org/newsreleases/2017/nov08a/

Apple Country Public Transit: https://www.hendersoncountync.gov/planning/page/apple-country-public-transit

Ecusta Rail Trail Planning Study and Economic Impact Analysis: http://frenchbroadrivermpo.org/wp-content/uploads/2019/09/EcustaRailTrail_FinalReport_Ch1.pdf

Environmental Protection Agency (EPA). Nonpoint Source Success Story North Carolina Projects Reduce Impacts of Agriculture and Stormwater on Lower Mud Creek (2019): https://nepis.epa.gov/Exe

French Broad River MPO's Metropolitan Transportation Plan (2015-2040): http://frenchbroadrivermpo.org/mtp/

Henderson County Greenway Master Plan (April 2019): https://www.hendersoncountync.gov/greenway-network/page/greenway-master-plan

Henderson County, NC, Economic Development. The Partnership: https://gohendersoncountync.org/who-we-are/community-profile/#Demographics

Hendersonville Bicycle Plan (2017): https://connect.ncdot.gov/municipalities/PlanningGrants/Documents/Hendersonville%20Bicycle%20Plan.pdf

Mecklenburg County Greenway Master Plan (2008-2018). Appendix C: Funding Sources: https://www.mecknc.gov/ParkandRec/Greenways/Documents/CFunding.pdf

U.S. Census Bureau (2014-2018). Age by Language Spoken at Home by Ability to Speak English for the Population 5 Years and Over. American Community Survey 5-year Estimates (2014-2018), Table B16004.

U.S. Census Bureau (2014-2018). Race. American Community Survey 5-year Estimates (2014-2018), Table B02001.

U.S. Census Bureau (2014-2018). Hispanic or Latino Origin by Race. American Community Survey 5-year Estimates (2014-2018), Table B03002.

U.S. Census Bureau (2014-2018). Sex by Age. American Community Survey 5-year Estimates (2014-2018), Table B01001.

U.S. Census Bureau (2014-2018). Tenure by Vehicles Available. American Community Survey 5-year Estimates (2014-2018), Table B25044.

AECOM

MUD CREEK GREENWAY FEASIBILITY STUDY