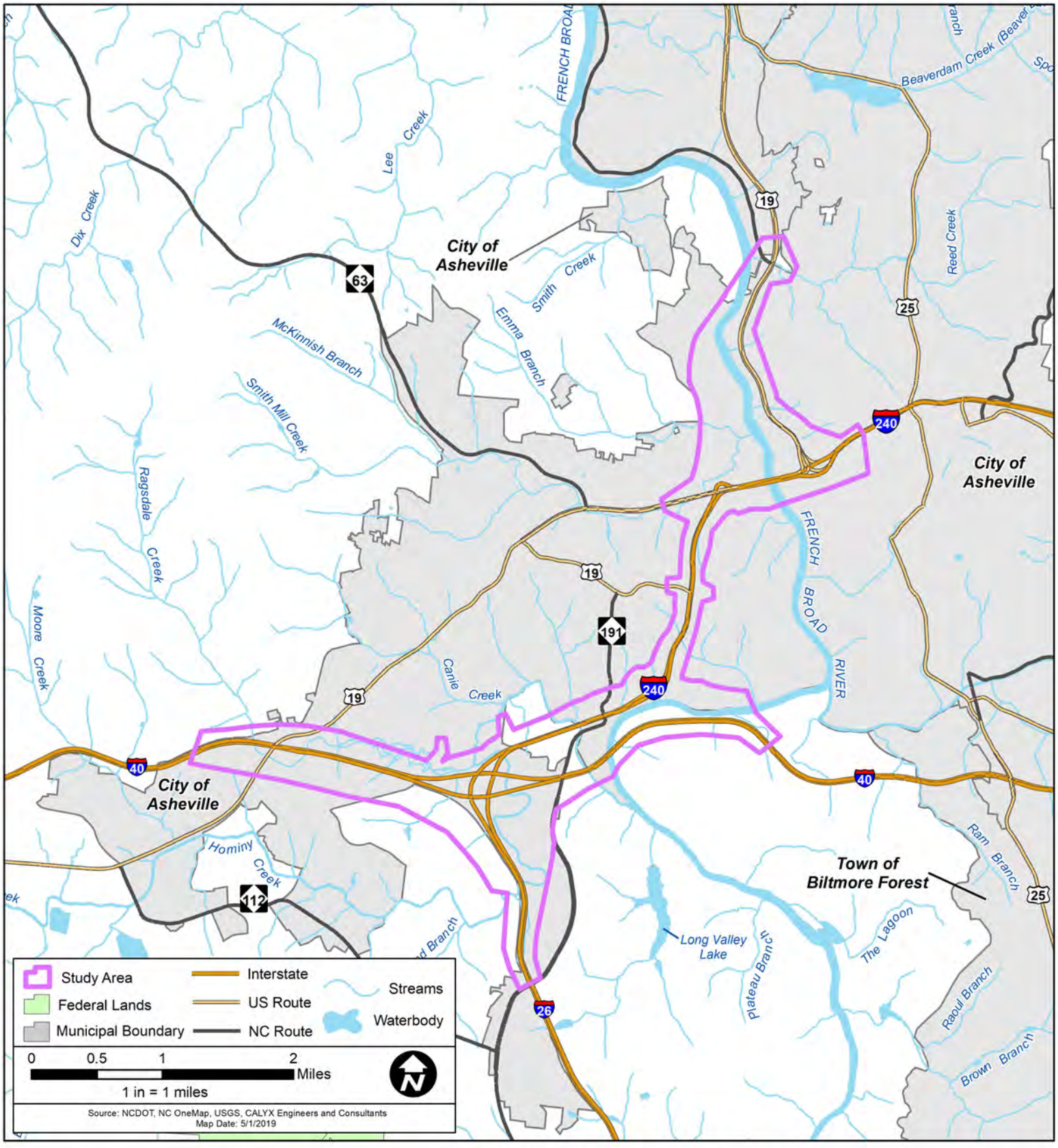
APPENDIX A. FIGURES



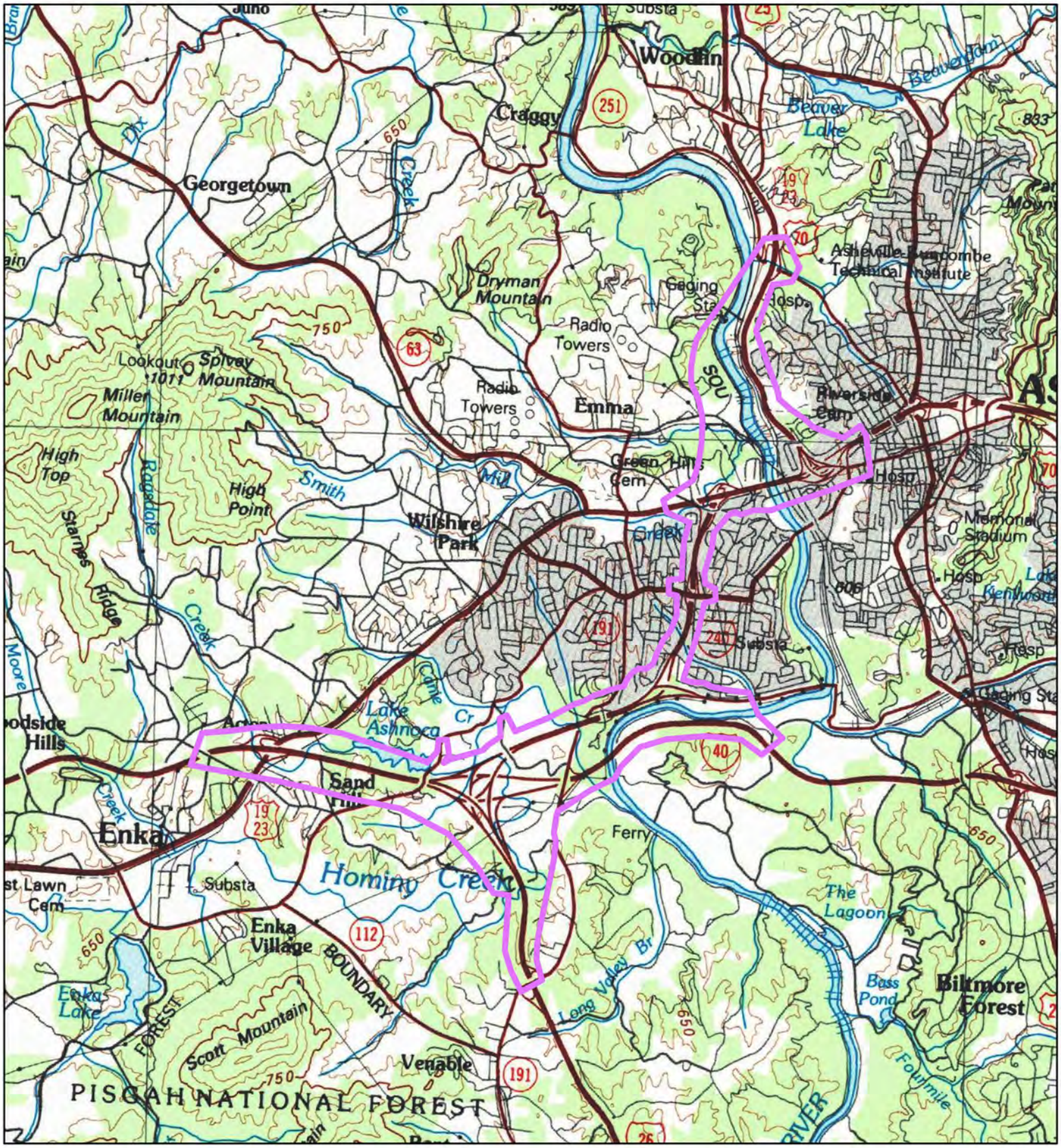
NORTH CAROLINA
DEPARTMENT OF TRANSPORTATION

I-26 Asheville Connector

TIP Project I-2513

Buncombe County, NC

Figure 1 - Project Vicinity



NORTH CAROLINA
DEPARTMENT OF TRANSPORTATION

I-26 Asheville Connector

TIP Project I-2513

Buncombe County, NC

Legend

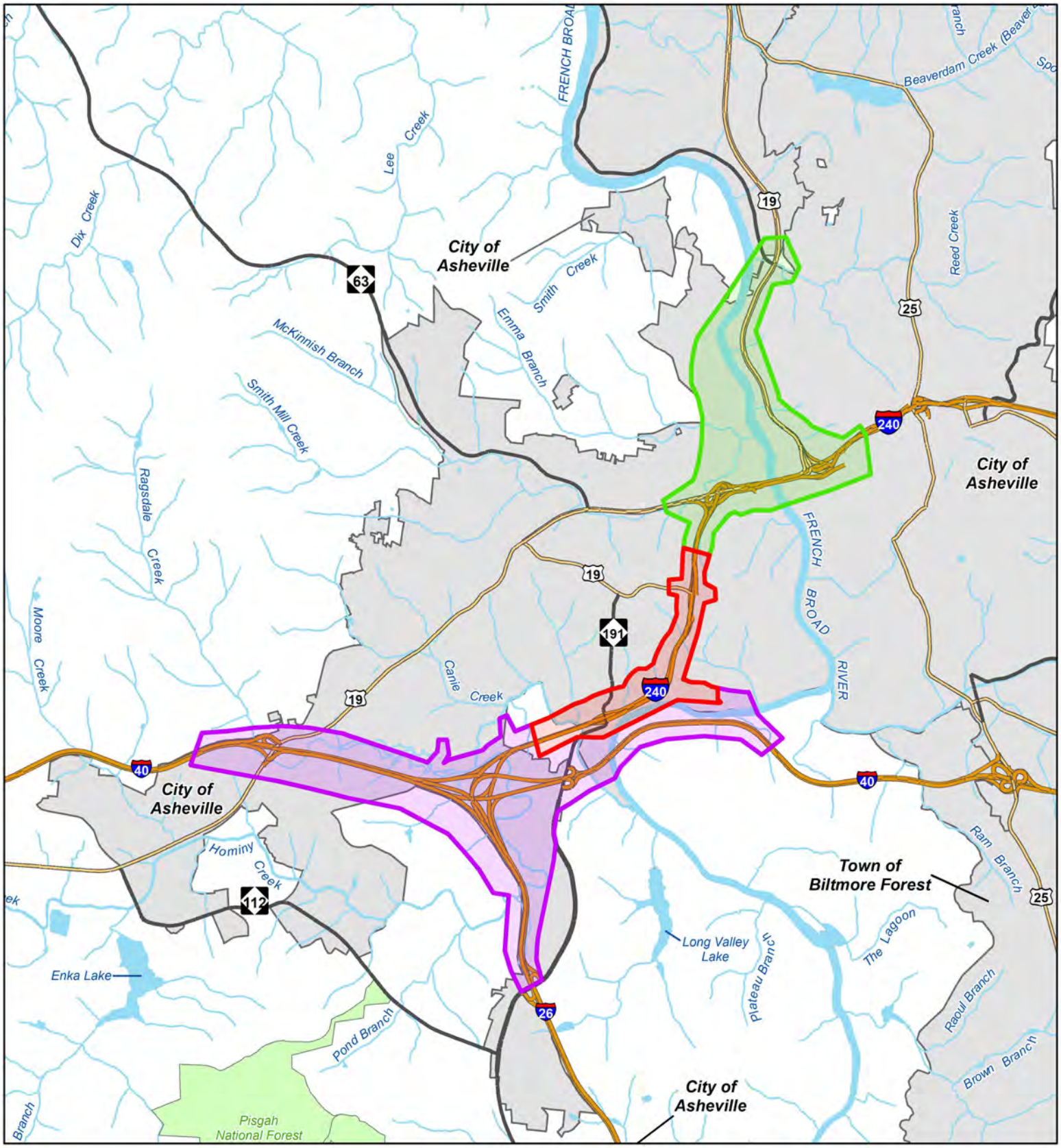
Study Area

0 0.5 1 2 Miles

1 in = 1 mile

Figure 2 - Landscape Position

Source: NC OneMap, CALYX Engineers and Consultants
Map Date: 1/14/2019



NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

I-26 Asheville Connector

TIP Project I-2513

Buncombe County, NC

Legend

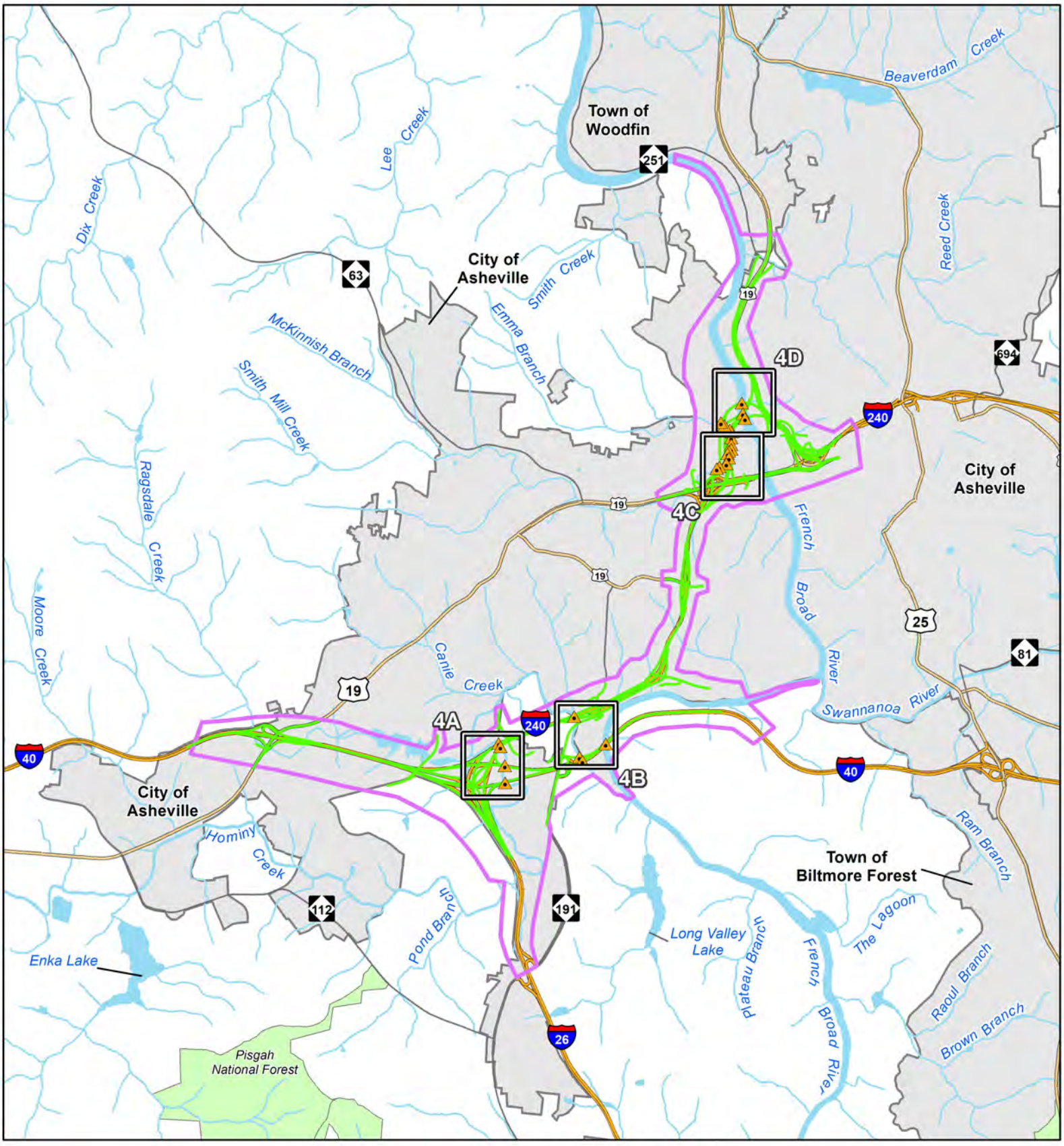
- Section A
- Section B
- Section C
- Interstate
- US Route
- NC Route
- Federal Lands
- Streams
- Waterbody

0 0.5 1 2 Miles

1 in = 1 mile

Figure 3
Project Study Area and Sections

Source: NCDOT, NC OneMap, USGS, CALYX Engineers and Consultants
Map Date: 1/14/2019



NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

I-26 Asheville Connector

TIP Project I-2513

Buncombe County, NC

Legend

- Crossing Location
- Map Tile
- Action Area
- Detailed Study Alternative
- Federal Land
- Municipal Boundary
- Waterbody
- Stream
- Interstate
- US Route
- NC Route
- Major Road

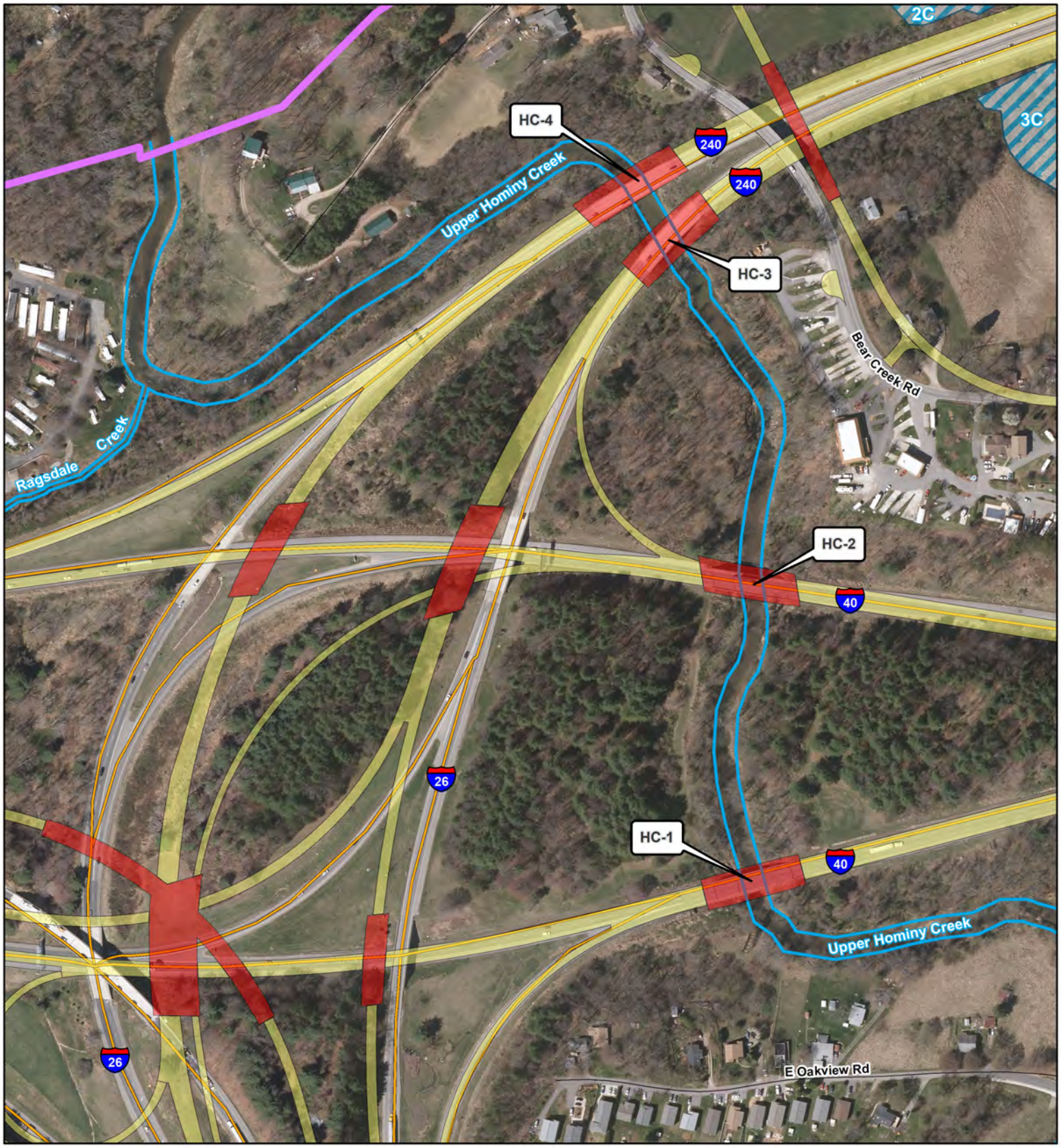
0 0.5 1 2 Miles

1 in = 1 miles

Figure 4

Crossing Locations Overview

Source: NC OneMap, CALYX Engineers and Consultants
Map Date: 5/2/2019



NORTH CAROLINA
DEPARTMENT OF TRANSPORTATION

I-26 Asheville Connector

TIP Project I-2513

Buncombe County, NC

Legend

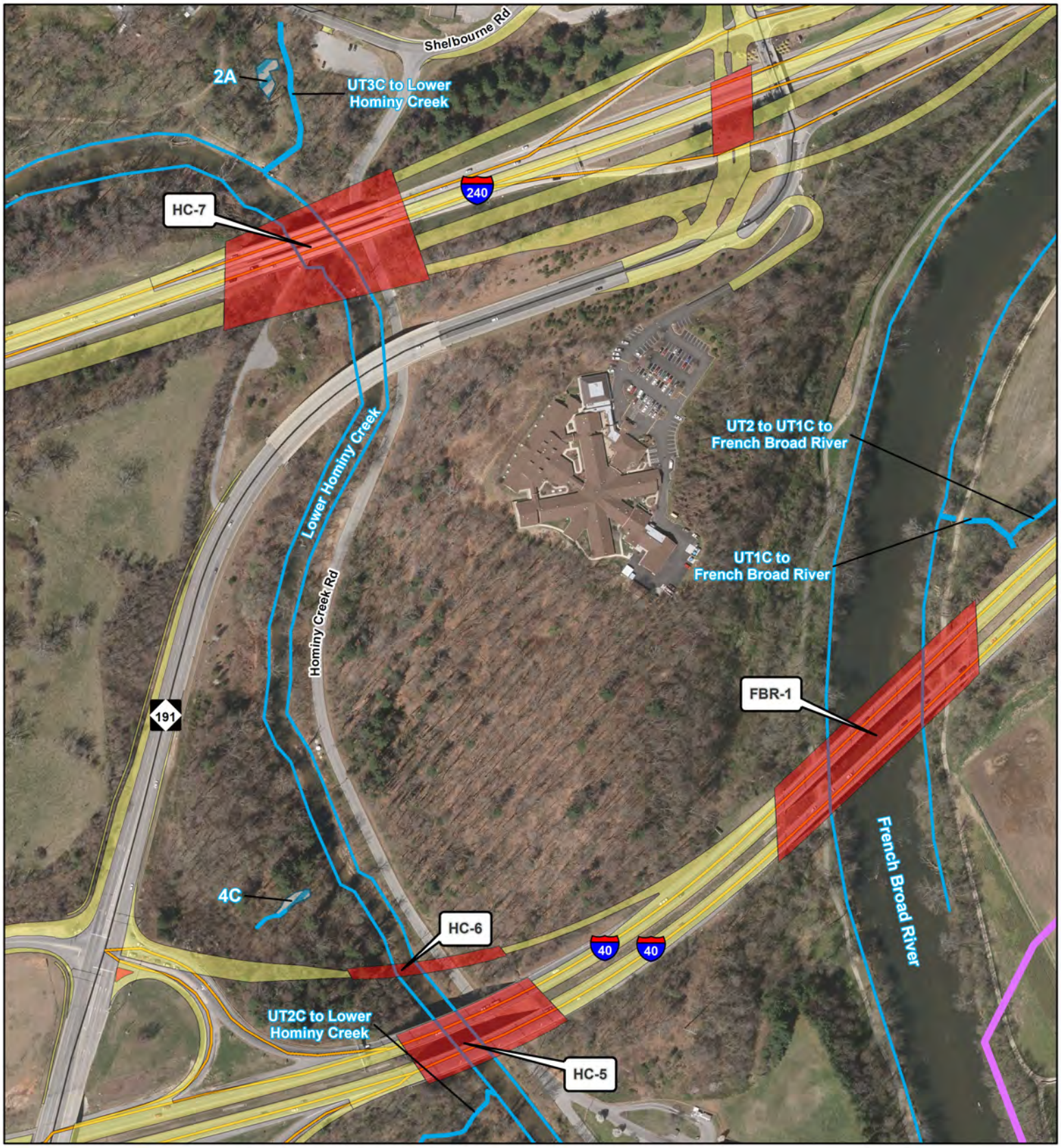
- Study Area
- HC-1 Crossing
- Proposed Bridge
- Proposed Roadway
- Delineated Wetland
- Delineated Stream
- Interstate
- US Route
- NC Route
- Major Road
- Local Road

0 150 300 600 Feet

1 in = 300 ft

Figure 4A
Crossing Locations

Source: NC OneMap, CALYX Engineers and Consultants
Map Date: 5/1/2019



NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

I-26 Asheville Connector

TIP Project I-2513

Buncombe County, NC

Legend

- Study Area
- HC-1 Crossing
- Proposed Bridge
- Proposed Roadway
- Delineated Wetland
- Delineated Stream
- Interstate
- US Route
- NC Route
- Major Road
- Local Road

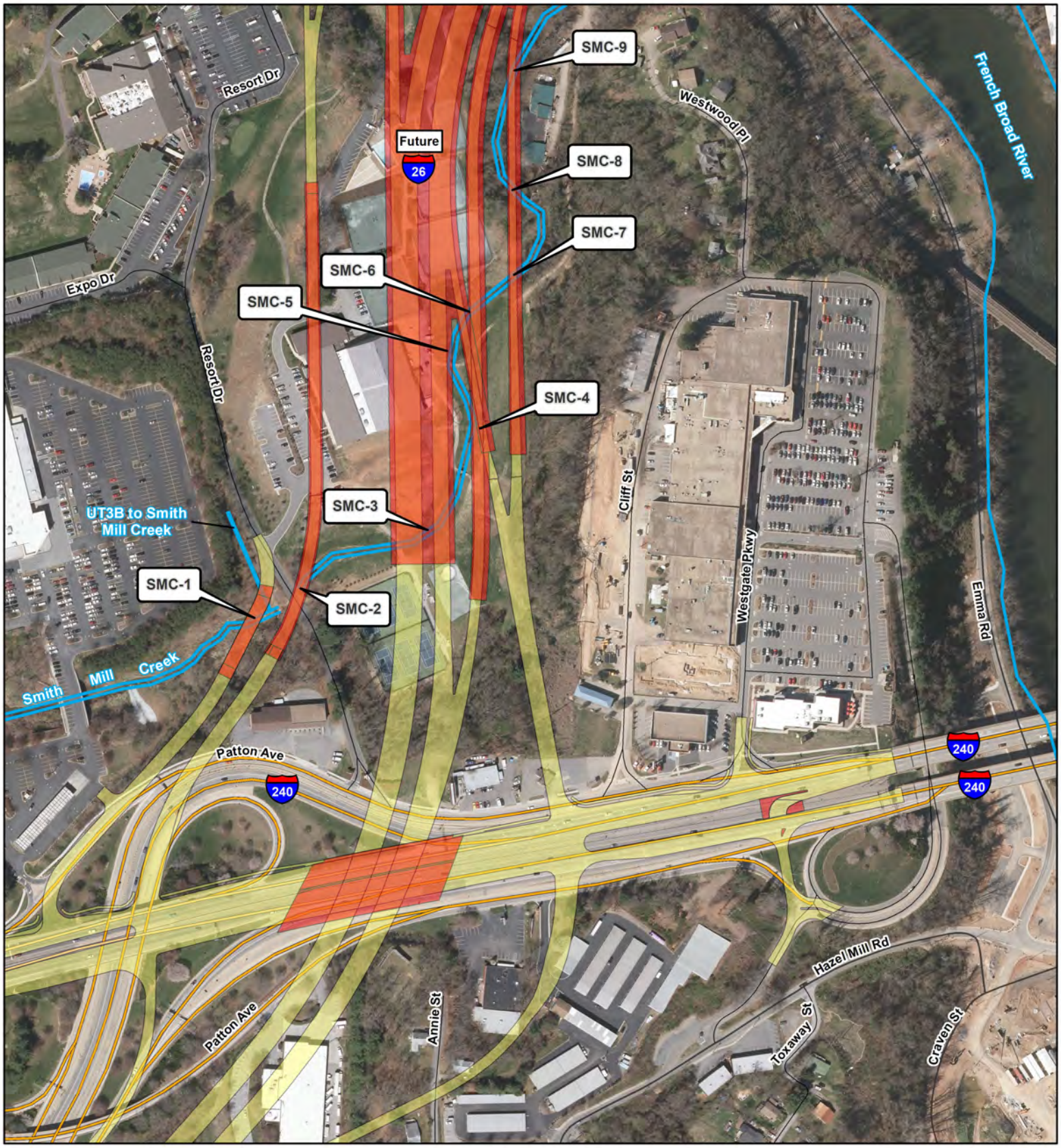
0 150 300 600 Feet

1 in = 300 ft

Figure 4B

Crossing Locations

Source: NC OneMap, CALYX Engineers and Consultants
Map Date: 5/1/2019



NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

I-26 Asheville Connector

TIP Project I-2513

Buncombe County, NC

Legend

- Study Area
- HC-1 Crossing
- Proposed Bridge
- Proposed Roadway
- Delineated Wetland
- Delineated Stream
- Interstate
- US Route
- NC Route
- Major Road
- Local Road

0 150 300 600 Feet

1 in = 300 ft

Figure 4C

Crossing Locations

Source: NC OneMap, CALYX Engineers and Consultants
Map Date: 5/1/2019

NORTH CAROLINA
DEPARTMENT OF TRANSPORTATION

I-26 Asheville Connector

TIP Project I-2513

Buncombe County, NC

Legend

- Study Area
- HC-1 Crossing
- Proposed Bridge
- Proposed Roadway
- Delineated Wetland
- Delineated Stream
- Interstate
- US Route
- NC Route
- Major Road
- Local Road

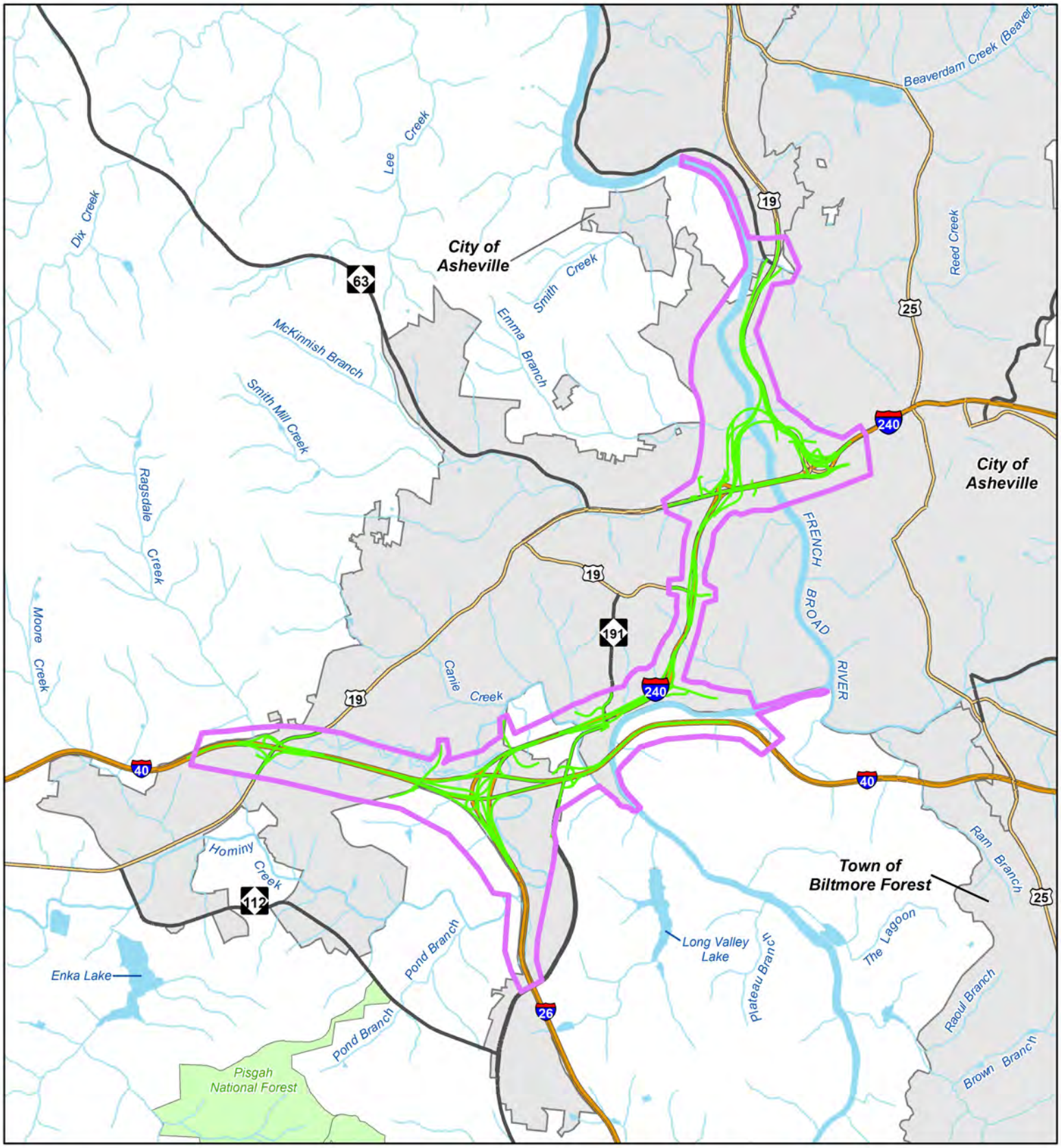
0 150 300 600 Feet

1 in = 300 ft

Figure 4D

Crossing Locations

Source: NC OneMap, CALYX Engineers and Consultants
Map Date: 5/1/2019



NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

I-26 Asheville Connector

TIP Project I-2513

Buncombe County, NC

Legend

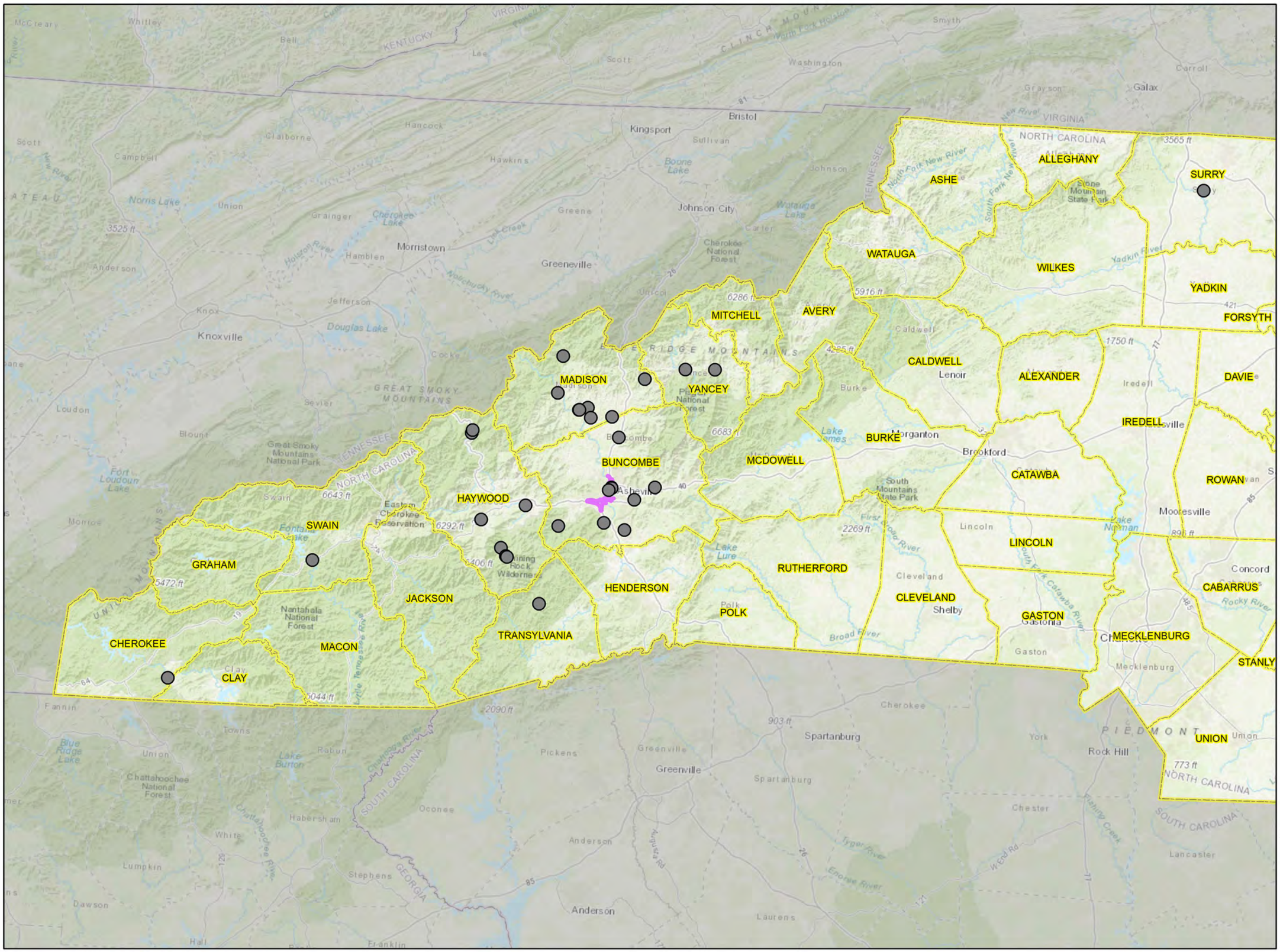
- Action Area
- Detailed Study Alternative
- Interstate
- US Route
- NC Route
- Federal Lands
- Municipal Boundary
- Streams
- Waterbody

0 0.5 1 2 Miles

1 in = 1 mile

Figure 5 - Action Area

Source: CALYX Engineers and Consultants
Map Date: 5/2/2019



Legend

- Bat Occurences
- Action Area
- County Boundary

Figure

6

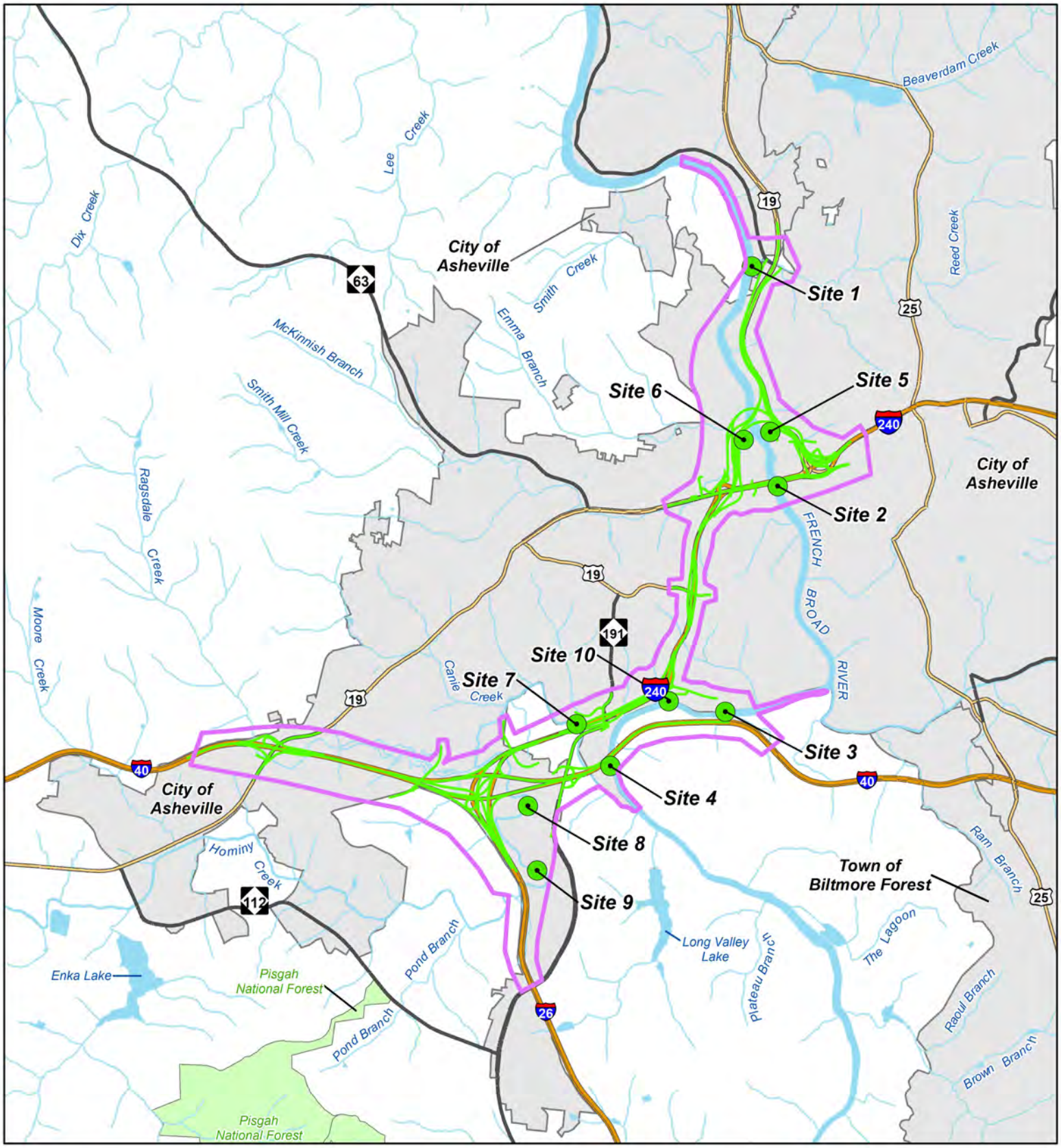
NC Gray Bat Occurrences

I-26 Asheville Connector
TIP Project I-2513

Buncombe County, NC

0 15 30
Miles
1 inch = 16.19 miles

Source: ESRI, NCDOT, CALYX Engineers and Consultants, NCNHP (Tier 2 Data; released July 2018)
Map Date: 10/11/2019



NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

I-26 Asheville Connector

TIP Project I-2513

Buncombe County, NC

Legend

- Action Area
- Acoustic Detector Location
- Detailed Study Alternative
- Interstate
- US Route
- NC Route
- Federal Lands
- Municipal Boundary
- Streams
- Waterbody

0 0.5 1 2 Miles

1 in = 1 mile

Figure 7 - Acoustic Detector Locations

Source: NC OneMap, CALYX Engineers and Consultants
Map Date: 5/2/2019

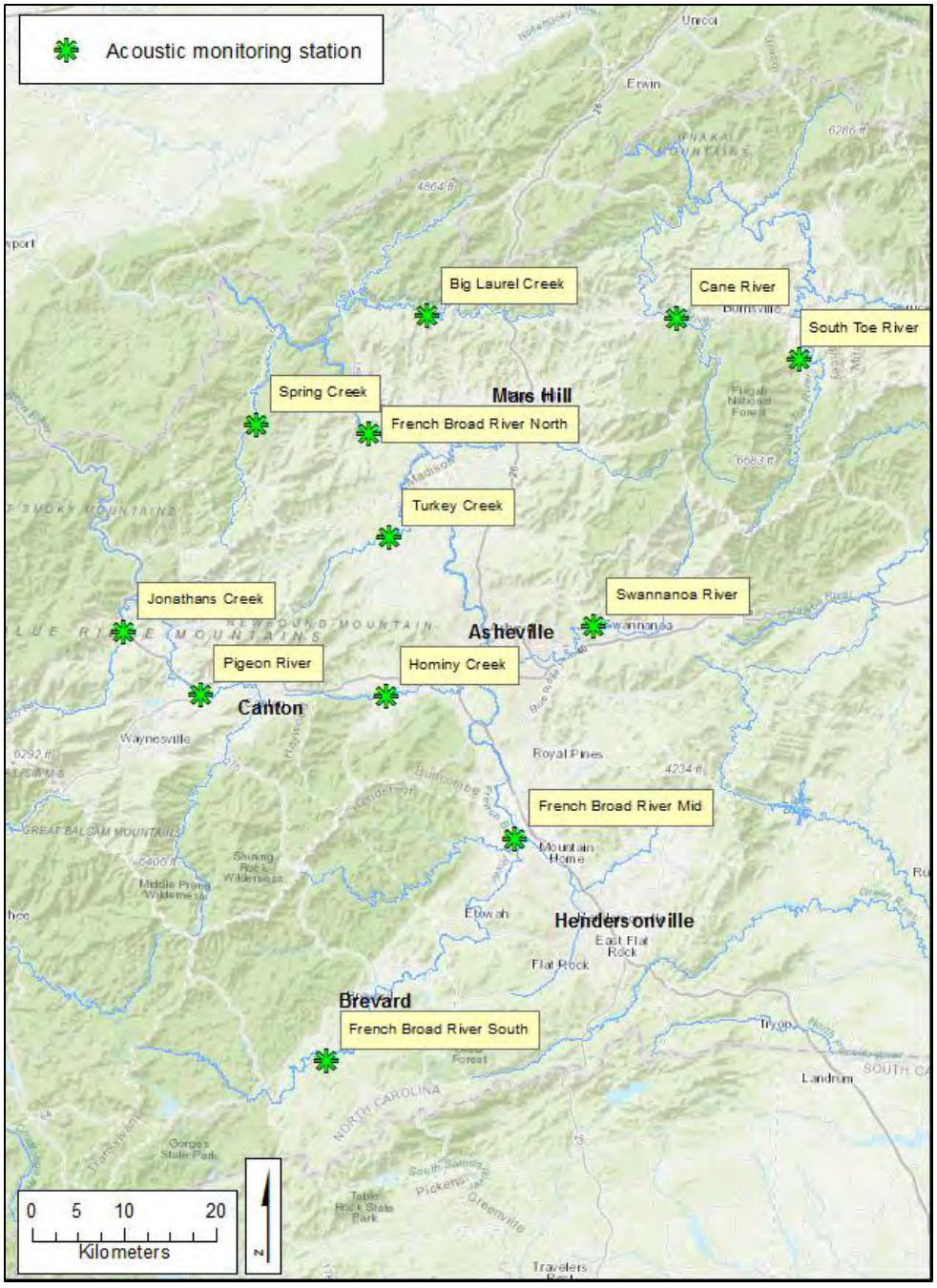
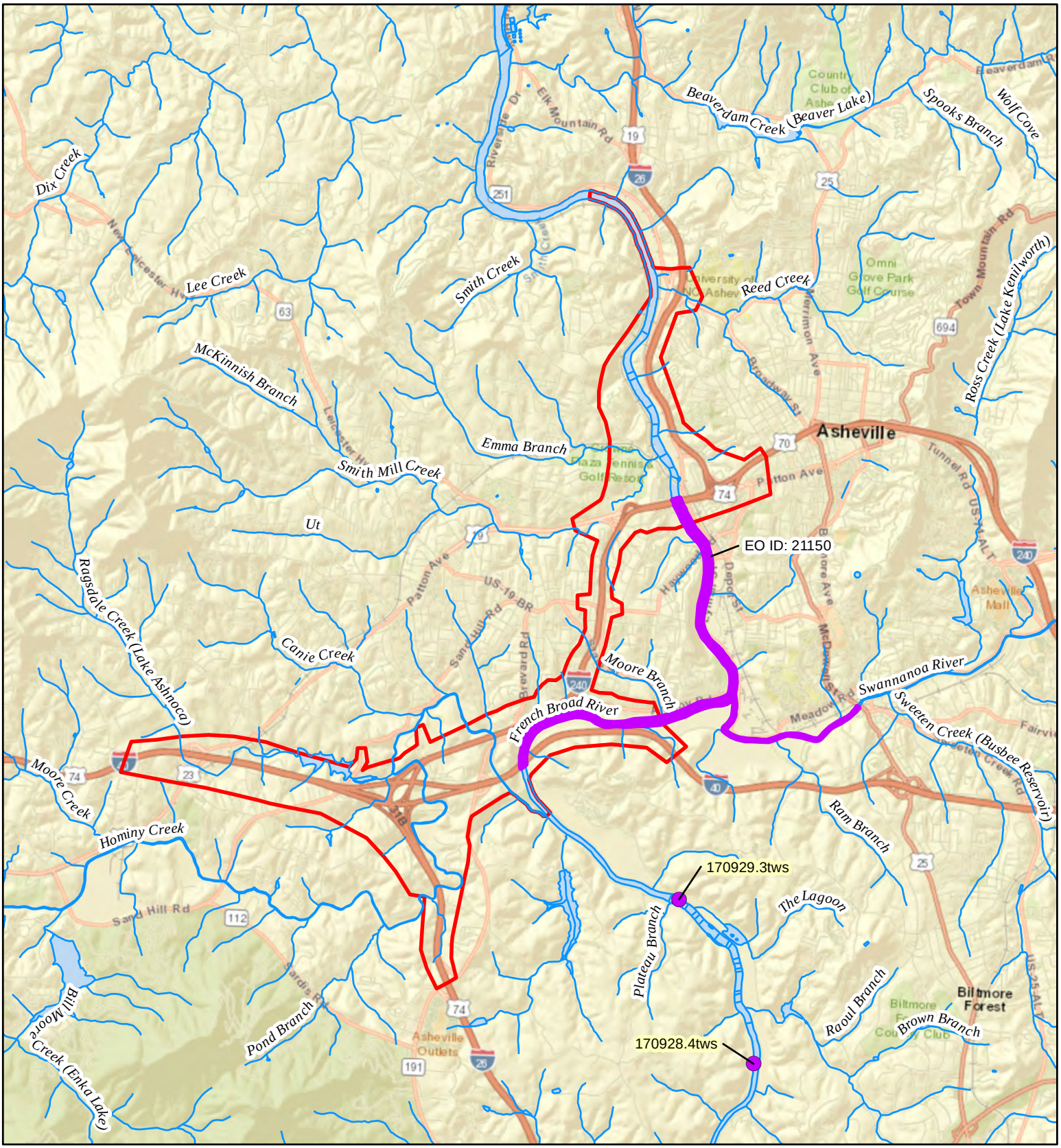


Figure 7a. (from Weber et al. 2018) ISU Acoustic monitoring station locations in the French Broad River Basin in Buncombe, Haywood, Henderson, Madison, Transylvania, and Yancey counties. We do not present data for the South Toe River station, which came online in late October.



NORTH CAROLINA
DEPARTMENT OF TRANSPORTATION

I-26 Asheville Connector

TIP Project I-2513

Buncombe County, NC

Legend

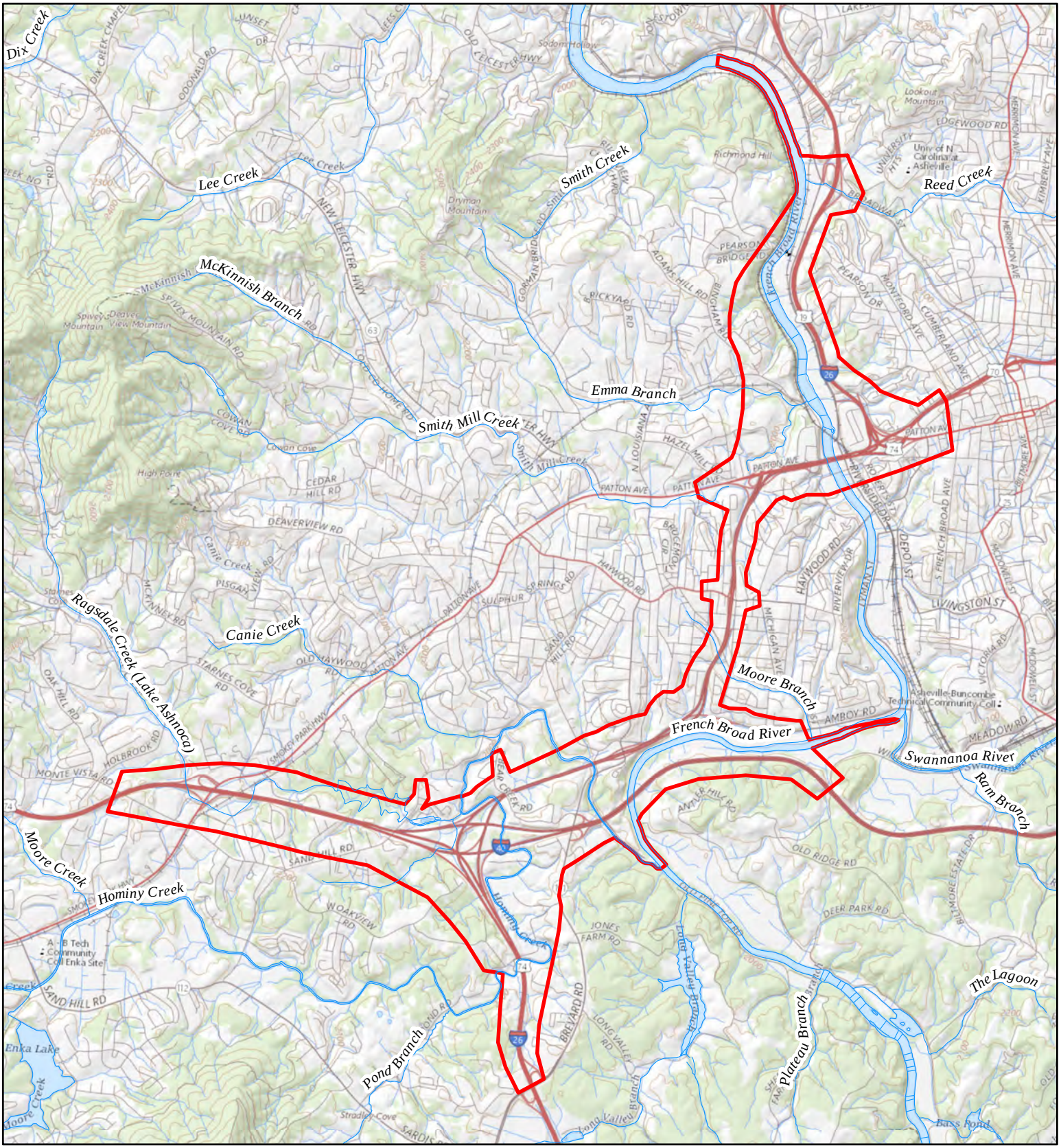
- Appalachian Elktoe Found During 2017 Surveys
- Appalachian Elktoe Element Occurrence
- French Broad River Basin Streams
- I-2513 Action

0 0.5 1 2 Miles

1 in = 1 mile

Figure 8 - Appalachian Elktoe Presence in Vicinity ofAction Area

Source: Three Oaks Engineering
Map Date: 3/8/2019



NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

I-26 Asheville Connector

TIP Project I-2513

Buncombe County, NC

Legend

French Broad River Basin Streams

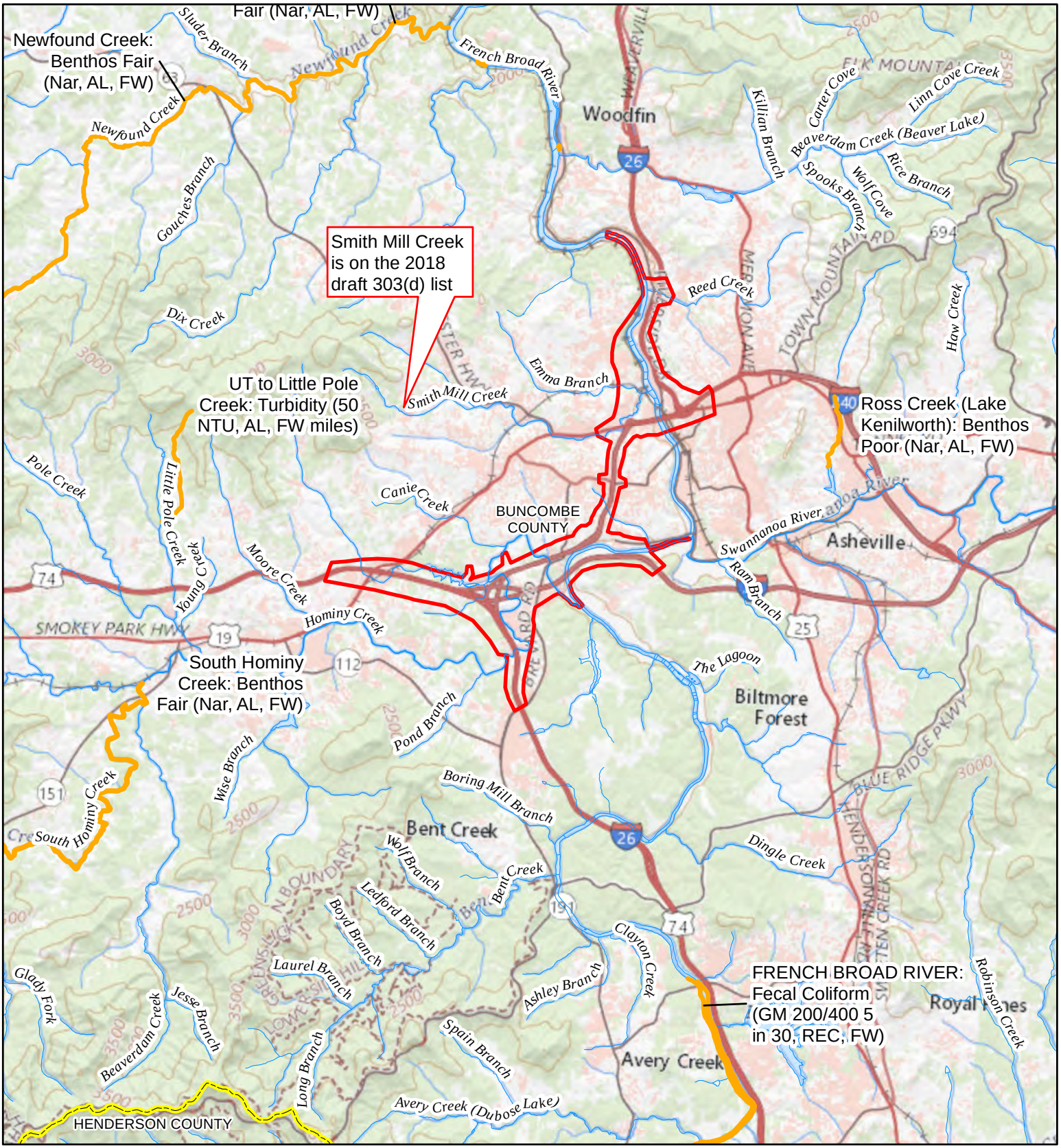
I-2513 Action Area

0 0.25 0.5 1 Miles

1 in = 1 mile

Figure 9 - Action Area Streams

Source: Three Oaks Engineering
Map Date: 3/8/2019



NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

I-26 Asheville Connector

TIP Project I-2513

Buncombe County, NC

Legend

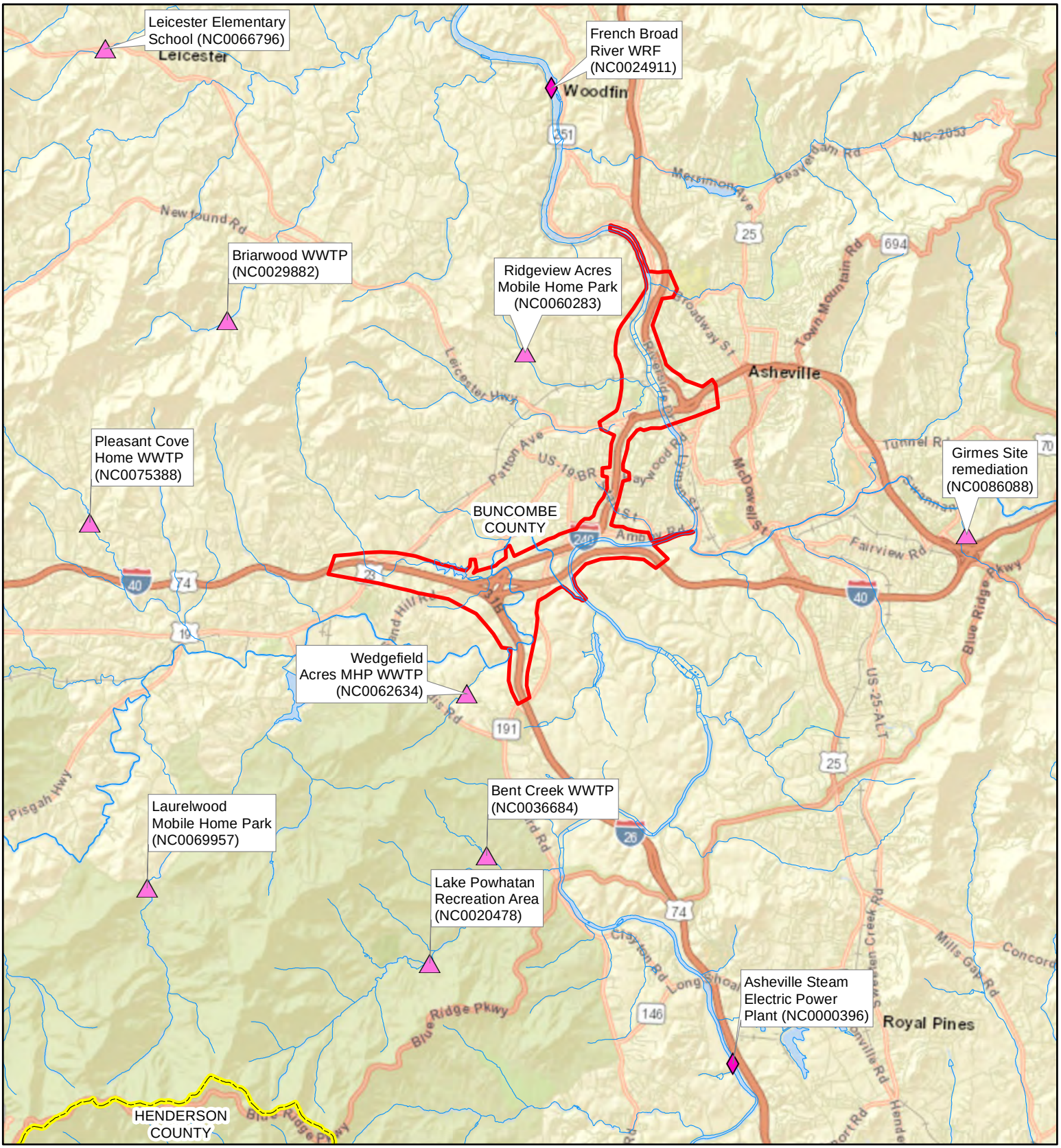
- 2016 303(d) Listed Streams
- French Broad River Basin Streams
- I-2513 Action Area
- County Boundary

0 0.75 1.5 3 Miles

1 in = 2 mile

Figure 10 - 303(d) Listed Streams

Source: Three Oaks Engineering
Map Date: 3/8/2019



NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

I-26 Asheville Connector

TIP Project I-2513

Buncombe County, NC

Legend

- Major NPDES Discharge
- Minor NPDES Discharge
- French Broad River Basin Streams
- I-2513 Action Area
- County Boundary

0 0.75 1.5 3 Miles

1 in = 2 mile

Figure 11 - National Pollutant Discharge Elimination System Discharges

Source: Three Oaks Engineering

Map Date: 3/8/2019

APPENDIX B. STRUCTURE SURVEY REPORT

FEDERALLY PROTECTED BAT SPECIES STRUCTURE SURVEY REPORT

I-26 Asheville Connector
Buncombe County, North Carolina
Federal Aid Project No. MA-NHF-26-1(53)
WBS Element No. 34165.1.1

TIP I-2513

Prepared for

The North Carolina Department of Transportation
Environmental Analysis and Permitting Unit
1598 Mail Service Center
Raleigh, NC 27699-1598
919.707.6000

September 2018

FEDERALLY PROTECTED BAT SPECIES STRUCTURE SURVEY REPORT

I-26 Asheville Connector
Buncombe County, North Carolina
Federal Aid Project No. MA-NHF-26-1(53)
WBS Element No. 34165.1.1

TIP I-2513

Prepared for

The North Carolina Department of Transportation
Environmental Analysis and Permitting Unit
1598 Mail Service Center
Raleigh, NC 27699-1598
919.707.6000

Prepared by

CALYX Engineers + Consultants
6750 Tryon Road, Cary, NC 27518
919.836.4800

September 2018

Table of Contents

1.0 PROJECT DESCRIPTION

The North Carolina Department of Transportation (NCDOT) obtained the services of CALYX Engineers and Consultants, Inc. (CALYX) to perform protected bat surveys for the proposed I-26 interstate freeway connector project. The project will connect I-26 in southwestern Asheville to US 19-23-70 in northwest Asheville (STIP Project No. I-2513) for a span of approximately 7 miles (mi.) within Buncombe County (NCDOT 2017) (Appendix A, Figure 1).

For purposes of this scope of work, the project footprint is defined as the study area to be depicted in the Final EIS, approximately 2,202 acres in total, roughly centered on the existing roadway with expansions around the major highway interchanges, and north of Patton Avenue at the French Broad River where a new bridge will be installed. Figure 2 (Appendix A) depicts the project study area.

The study area is situated in the Blue Ridge physiographic province of North Carolina. Topography in the project vicinity is characterized by gradual to steep slopes with narrow floodplains along drainage ways. Elevations range from a low of 1,980 feet (ft.) above sea level near the confluence of Hominy Creek and the French Broad River to a high of 2,150 ft. along I-240 in the central portion of the project study area. Land use within the project vicinity is characterized by residential and urban development, forest land (including a portion of Pisgah National Forest), and agriculture (NCDOT 2015).

2.0 SPECIES INFORMATION

Two bat species are currently listed by the U.S. Fish and Wildlife Service (USFWS) as occurring in Buncombe County, NC (USFWS 2018a). One additional bat species may become listed in the county in the near future.

2.1 Gray Bat

As of April 28, 1976 the USFWS listed gray bat (*Myotis grisescens;* MYGR) as “Endangered” under the Endangered Species Act. As of August 10, 2018 (date accessed), MYGR was listed as “current” in Buncombe County (USFWS 2018a). This species is known or presumed to occur in this county only during summer months.

MYGR are typically a communally roosting, cave obligate species, meaning that groups of individuals are known to utilize caves for roosting in both summer and winter. This species has been documented using bridges and culverts as roosts during summer months. (Hayes and Bingman 1964, Keeley and Tuttle 1999).

Summer maternity roosts are typically located within 1 km of a river or reservoir over which the bats forage (Tuttle 1979), and are rarely located more than 4 km away from foraging areas (Tuttle 1976a). However, individuals may travel up to 35 kilometers between prime feeding areas over lakes or rivers and occupied caves (LaVal et al. 1977, Tuttle and Stevenson 1977, Tuttle and Kennedy 2005). Forested areas along the banks of streams and lakes serve as corridors for travel and as protective feeding cover for newly volant young (Tuttle 1979, Brady et al. 1982).

A review of North Carolina Natural Heritage Program (NCHP) records (most recently updated July 2018, and viewed on August 10, 2018) indicates the nearest MYGR roost record at a location approximately 11 mi. north of the study area, and represents 40 bats observed roosting between

the expansion joints of a bridge in Madison County, NC (EO ID 37068, last observed in September 2016). The nearest MYGR mist net record represents a juvenile male captured at a creek in Buncombe County, NC (EO ID 21803, last observed in July 2003). This record is approximately seven mi. southwest of the study area. No hibernacula for this species have been documented in North Carolina (NCNHP 2018).

2.2 Northern Long-eared Bat

As of May 4, 2015 USFWS listed Northern long-eared bat (*Myotis septentrionalis;* MYSE) as "Threatened" under the Endangered Species Act. As of August 10, 2018 (date accessed), MYGR was listed as "current" in Buncombe County (USFWS 2018a). This species is known or presumed to occur in this county only during summer months.

In western North Carolina, MYSE spend winter hibernating in caves and mines. During the summer, MYSE roost singly or in colonies underneath bark, in cavities, or in crevices of both live and dead trees (typically ≥3 in. dbh). Males and non-reproductive females may also roost in cooler places, like caves and mines. This bat also has been found, rarely, roosting in structures like barns and sheds, under eaves of buildings, behind window shutters, in bridges, and in bat houses. Foraging occurs on forested hillsides and ridges, and occasionally over forest clearings, over water, and along tree-lined corridors. Mature forests may be an important habitat type for foraging (USFWS 2015).

A review of NCNHP records (most recently updated July 2018 and viewed on August 10, 2018) indicates that the nearest MYSE hibernacula record is 18 mi. away (EO ID 32137) and represents the Bat Site Preserve with multiple observations from 1980 to 2014. No known MYSE roost trees occur within 150 ft. of the project area. The nearest mist net record (EO ID 34294) is from a location approximately 5 mi. southwest of the study area, and represents multiple individuals (NCNHP 2018).

2.3 Indiana Bat

As of March 11, 1967 USFWS listed Indiana bat (*Myotis sodalis;* MYSO) as "Endangered" under the Endangered Species Act. As of August 10, 2018 (date accessed), MYSO was not listed in Buncombe County (USFWS 2018a). MYSO may be added to the list of federally protected species for Buncombe County in the near future (personal communication, Marella Buncick, USFWS). Therefore, to avoid any potential project delays, CALYX also assessed the study area for suitable MYSO habitat per the USFWS 2018 Range-wide Indiana Bat Summer Survey Guidelines (USFWS 2018b).

MYSO have different summer and winter habitat requirements. Winter habitat is in caves and abandoned mines that usually have standing water on the floor. The bats migrate to the winter habitat between September and November; they stay there with occasional periods of activity until they emerge in mid-March to early May. Hibernation only occurs in regions where winter temperatures are stable and around 40 degrees Fahrenheit. Suitable summer habitat includes roosting, foraging, and commuting areas. Summer roosting habitat includes forests and woodlots containing potential roost trees, which have exfoliating bark, cracks, or crevices in trees (alive or dying) or snags that are greater than 3 in. diameter-at-breast height (dbh). Roosting habitat may contain dense or loose aggregates of trees with variable amounts of canopy closure. (While any tree greater than 3 in. dbh has the potential to be MYSO summer roosting habitat, solid stands of 3 in. dbh and smaller trees are not considered suitable roosting habitat; suitable roosting habitat would generally consist of forest patches with larger trees also present.) Bridges are occasionally used for roosting by MYSO in the summer (USFWS 2007).

Foraging habitat consists of forested patches, wooded riparian corridors, and natural vegetation adjacent to these areas. Commuting habitat includes wooded tracts, tree-lines, wooded hedgerows, streams or other such pathways that are within or connected to roosting or foraging areas. Streams that have been stripped of their riparian vegetation do not appear to offer suitable foraging habitat. Rivers as foraging areas and as migration routes are extremely important to this species (USFWS 2007).

A review of NCNHP records (most recently updated July 2018, and viewed on August 10, 2018) indicates the nearest MYSO roost tree record at a location approximately 21 mi. west of the study area (EO ID 27984, last observed in 2008) in Haywood County, NC, and represents multiple roosting individuals. The closest mist net record (EO ID 33871, last observed in 2010) is from a location approximately 42 mi. west of the study area in Graham County, NC, and represents one adult male and one adult female. The nearest MYSO hibernacula (EO ID 17770) is recorded approximately 18 mi. southeast of the study area in Rutherford County, NC and represents multiple observations from 1980 to 1995 (NCNHP 2018).

3.0 METHODS

This section describes the methods used to perform surveys. All survey methods were developed in coordination with NCDOT, the Asheville USFWS Ecological Services Field Office and the North Carolina Wildlife Resources Commission (NCWRC).

3.1 Bridges and Culverts

Bridges (or bridge pairs) and large culverts (at least 5 ft. high and 200 ft. long) were assigned a unique identification number (CALYX ID) at the start of the study, as shown in Appendix A, Figures 3A through 3F, and Tables 1 and 2, in Section 4.1. These structures were visually inspected at least once during daylight hours by trained, experienced biologists or biological technicians.

In addition, five bridges (or pairs of bridges) that were particularly difficult to adequately check on foot were checked using a hydra lift truck; a machine typically used to conduct formal bridge safety inspections:

- I-40 over the French Broad River (CALYX ID B19)
- Haywood Road over I-26/I-240 (CALYX ID B29)
- Pearson Bridge Road over the French Broad River (CALYX ID B43)
- Haywood Road over the French Broad River (CALYX ID B52)
- Amboy Road over the French Broad River (CALYX ID B53)

Seven bridges (or pairs of bridges) were of particular concern to USFWS since they have both concrete decks and concrete beams, which are characteristics typically preferred by bats. These bridges were checked for evidence of bat use twice; once during 2017 and once during 2018.

- Oakview Road over Hominy Creek (CALYX ID B16)
- Pedestrian walkway over Hominy Creek/Hominy Creek Road (CALYX ID B24)
- Stewart Street over I-26/I-240 (CALYX ID B27)
- Sam's Club entrance bridge over Smith Mill Creek (CALYX ID 32)
- Emma Road (SR 1338) over Smith Mill Creek (CALYX ID 38)
- Craven Street over the French Broad River (CALYX ID B40)
- Southern Railroad over the French Broad River (CALYX ID B42)

Coordinates were obtained for all bridges and culverts that were surveyed. In addition, the NCDOT Bat Habitat Assessment Form for Bridges and Culverts was completed as specified in the Standard Operating Procedures (SOP): NCDOT Preliminary Bat Habitat Assessments (Structures, Caves and Mines) (NCDOT 2014) for each bridge, culvert, and structure that was surveyed. Photos were taken of any bridges, culverts, and structures that exhibited evidence of bat use.

3.2 Abandoned Structures

Structures within the project study area that appeared to be abandoned, and appeared to have potentially suitable habitat for bats would be checked on an opportunistic basis only.

3.3 Caves and Mines

USGS mapping was reviewed prior to field investigations to determine if any caves or mine are documented within three mi. of the project study area. If caves or mines were noted during field work, they are documented as part of this report.

3.4 MYSE and MYSO Habitat Assessment and Emergence Surveys

CALYX biologists assessed the study area for potentially suitable MYSE and MYSO habitat. This consisted of a general valuation of potential roosting and foraging habitat. Emergence surveys were conducted at any potential roost trees following protocols provided in the USFWS 2018 Range-wide Indiana Bat Summer Survey Guidelines (USFWS 2018b).

4.0 FINDINGS

This section describes the results of the structure surveys. Figures 3A through 3F (Appendix A) depict the project study area and other information discussed in this section.

4.1 Bridges and Culverts

A total of 51 bridges and 15 culverts were identified within the study area and checked in the field. Two bridges that were not identified within the study area were also checked (CALYX IDs B52, B53). CALYX biologists decided that it would be prudent to check these structures due to their close proximity to the project study area, and their location over large streams or rivers. Bridge and culvert surveys were performed between July 26 and September 17 in 2017, and May 31 and August 22 in 2018.

A comprehensive list of structure survey information is provided in Table 1 and Table 2, below. Data forms for each structure check are provided in Appendix B and Appendix C. CALYX ID numbers listed in Tables 1 and 2 are unique identification numbers assigned by CALYX as part of this study. NCDOT structure numbers were pulled directly from publicly available GIS data.

Bridge Checks with Hydra Lift

I-40 over French Broad River (CALYX ID B19)

This pair of bridges was checked with a hydra lift and on foot on September 16, 2017. No evidence of bat roosting was observed. There is an active colony of cliff swallows (*Petrochelidon pyrrhonota*) using this bridge. Approximately 30 nests were observed, along with a large number of pigeon droppings.

Haywood Road over I-26/I-240 (CALYX ID B29)

This bridge was checked with a hydra lift and on foot on August 23, 2017. No evidence of bat roosting was observed.

Pearson Bridge Road over French Broad River (CALYX ID B43)
This bridge was checked with a hydra lift and on foot on September 17, 2017. No evidence of bat roosting was observed.

Haywood Road over French Broad River (CALYX ID B52)
This bridge was checked with a hydra lift and on foot on September 17, 2017. No evidence of bat roosting was observed. There is an active colony of cliff swallows (*Petrochelidon pyrrhonota*) using this bridge. More than 75 nests were observed.

Amboy Road over French Broad River (CALYX ID B53)
This bridge was checked with a hydra lift and on foot on September 16, 2017. No evidence of bat roosting was observed. There is an active colony of cliff swallows using this bridge. Approximately 30 nests were observed, along with a large number of pigeon droppings.

Summary of Bridge and Culvert Check Results
No evidence of bat use was noted on any bridges. The culvert at Hill Street and Riverside Drive (CALYX ID C13) near the French Broad River is the only culvert where bats or evidence of bats was noted. The main culvert is an 8 ft. by 8 ft. concrete box culvert that is over 1000 ft. in length. The downstream end of the culvert has two smaller metal pipes attached. Multiple corrugated metal pipes of various lengths and diameters join the box culvert along its length and at its upstream end. These pipes and drop inlets provide other potential points of entry/exit for bats. CALYX biologists documented bats using the culvert roost on August 24, 2017. The bats were tentatively identified as MYGR. Biologists chose to quickly exit the culvert upon unexpectedly disturbing the bats. On September 7, 2017, USFWS and NCWRC biologists performed an emergence survey and counted a total of at least 200 bats flying from the culvert system at the downstream outlet and a culvert inlet near Houston Street. On September 13, 2017 USFWS and NCWRC biologists returned to the culvert and confirmed that MYGR were present.

Indiana State University is currently conducting a research project for NCDOT on MYGR in the French Broad River Basin. Multiple emergence counts and trapping events have occurred in association with the culvert system. Additional counts and trapping will continue later in 2018, as well as in 2019 and 2020 (personal communication, Joey Weber, Indiana State University).

Table 1. Bridge Survey Results

CALYX ID	NCDOT Structure Number	Facility on Structure	Feature Under Structure	Date Surveyed	Emergence Survey	Comment
B1	100171	Brevard Rd/NC 191	I-26	5/31/2018	Y	*Quercus* sp. snag. No bats emerged 7/25/2018
B2	N/A	Private Road	Hominy Creek	9/7/2017	N	
B3	100235 (WBL) 100238 (EBL)	I-26	Hominy Creek	5/31/2018	N	
B4	100051	Pond Rd/SR 3431	Hominy Creek	5/31/2018	N	
B5	100295	Monte Vista Rd/SR 1224	I-40	8/22/2017	Y	*Juglans nigra* or *Carya* sp. snag. No bats emerged 7/25/2018
B6	100301	I-40	Smokey Park Hwy/US23/US74A	8/22/2017	N	
B7	100313	I-40	Railroad	8/22/2017	N	
B8	100326	I-40	Sand Hill Rd/SR 3412	8/22/2017	N	
B9	100253	I-26	I-40	8/24/2017	N	
B10	100254	US 74	I-26 /I-40	8/24/2017	N	
B11	100273	I-26	I-40	9/7/2017	N	
B12	100334	I-40	Hominy Creek	9/7/2017	N	
B13	100285	I-26	I-40	9/7/2017	N	
B14	100283	I-26	I-40	9/7/2017	N	
B15	100339	I-40	Hominy Creek	9/7/2017	N	
B16^	100052	E Oakview Rd	Hominy Creek	9/7/2017, 5/31/2018	N	
B17	100194	Brevard Rd/NC 191	I-40	9/7/2017	N	
B18	100037 (WBL) 100344 (EBL)	I-40	Hominy Creek	9/7/2017	N	
B19*	100356 (WBL) 100352 (EBL)	I-40	French Broad River	9/16/2017	N	Checked on foot and with lift truck. Approximately 30 cliff swallow nests; lots of pigeon droppings.
B20	100070 (WBL) 100066 (EBL)	I-26/I-240	Hominy Creek	9/7/2017	Y	*Platanus occidentalis* snag. Emergence survey on 7/26/2018, saw one bat possibly emerge from tree. Survey repeated on 8/8/2018. Again, one bat possibly emerged from snag. Anabat SD2 recorded bat calls during time of emergence. No calls consistent with any Myotis species.
B21	100182	S Bear Creek Rd/SR 3413	I-26/I-240	9/7/2017	N	
B22	100845	Brevard Rd/NC 191	Hominy Creek	8/11/2017	Y	*Platanus occidentalis* snag. No bats emerged 7/18/18.
B23	100208 (WBL) 100206 (EBL)	I-26/I-240	Hominy Creek/Private Road	8/11/2017	Y	*Platanus occidentalis* snag. No bats emerged 7/18/18.
B24^	100216	Pedestrian Walkway	Hominy Creek	8/11/2017, 5/31/2018	Y	*Platanus occidentalis* snag. No bats emerged 7/18/18.
B25	100242	Brevard Rd/NC 191	I-26/I-240	8/23/2017	N	
B26	100521	Amboy Rd/SR 3556	I-26	8/23/2017	Y	Unidentified snags. No bats emerged 7/18/18.
B27^	N/A	Stewart St	I-26/I-240	8/23/2017, 7/4/2018	N	
B28	100274	State St	I-26/I-240	8/23/2017	N	
B29*	100336	Haywood Rd/US 19B/US 23B	I-26/I-240	8/23/2017	N	Checked on foot and with lift truck.
B30	100191	US 19/US 23	I-240	8/23/2017	N	
B31	100168	US 19/US 23/US 74A/Patton Ave	I-26/I-240	8/23/2017	N	
B32^	N/A	Sam's Club Entrance	Smith Mill Creek	8/11/2017, 7/4/2018	Y	Unidentified snag. No bats emerged 7/19/18.
B33	N/A	Private Road	Smith Mill Creek	8/11/2017	Y	*Robinia pseudoacacia* with dead branches and *Liriodendron tulipifera* snag. No bats emerged 7/17/18.
B34	N/A	Private Road	Smith Mill Creek	8/11/2017	Y	*Robinia pseudoacacia* with dead branches and *Liriodendron tulipifera* snag. No bats emerged 7/17/18.

CALYX ID	NCDOT Structure Number	Facility on Structure	Feature Under Structure	Date Surveyed	Emergence Survey	Comment
B35	N/A	Private Road	Smith Mill Creek	8/11/2017	Y	*Robinia pseudoacacia* with dead branches and *Liriodendron tulipifera* snag. No bats emerged 7/17/18.
B36	N/A	Private Road	Smith Mill Creek	7/28/2017	N	
B37	N/A	Southern Railroad	Smith Mill Creek	7/28/2017	N	
B38^	100726	Emma Rd/SR 1338	Smith Mill Creek	7/28/2017, 7/5/2018	N	
B39	100277	Southern Railroad	Smith Mill Creek, Emma Rd/SR 1338	7/28/2017	N	
B40^	100743	Craven St	French Broad River	8/11/2017, 6/1/2018	N	Metal (on south side of bridge) and concrete (on north side) guard rails (each side is different).
B41a	100322 (WBL)	I-240/I-26/Patton Ave	French Broad River	7/26/2017	N	Snags (*Platanus occidentalis, Juglans nigra, Acer negundo, Pinus* sp.) present but unsuitable habitat due to proximity to I-240, I-26, and urban development.
B41b	100323 (EBL)	I-240/I-26/Patton Ave	French Broad River	7/26/2017	N	Snags (*Platanus occidentalis, Juglans nigra, Acer negundo, Pinus* sp.) present but unsuitable habitat due to proximity to I-240, I-26, and urban development.
B42^	N/A	Southern Railroad	French Broad River	8/11/2017, 7/4/2018	N	
B43*	100278	Pearson Bridge Rd/SR 1348	French Broad River	9/17/2017	Y	Checked on foot and with lift truck. Unidentified snag. No bats emerged on 7/16/2018. Surface mine within 0.5 mi.
B44	100289 (EBL) 100284 (WBL)	I-26	Reed Creek/Broadway	7/28/2017	N	Surface mine within 0.5 mi.
B45	100281	I-26	Hill St	8/11/2017	N	
B46	100279	Atkinson St	I-26	8/11/2017	N	
B47	100001	US 70 Ramp to I-240	I-240/I-26	9/6/2017	N	
B48	100348	I-240	I-26	9/6/2017	N	
B49	100034	US 19 Ramp	I-240	9/6/2017	N	
B50	100077	Patton Ave	I-240	9/6/2017	N	
B51	N/A	Pedestrian Bridge	I-240	8/10/2017	N	
B52*	100705	Haywood Rd/SR 3548	French Broad River	9/17/2017	N	Checked on foot and with lift truck. 75+ cliff swallow nests.
B53*	100521	Amboy Rd/SR 3556	French Broad River	9/16/2017	N	Checked on foot and with lift truck. Lots of pigeon droppings. Approximately 30 cliff swallow nests.

^ bat-friendly bridge; checked in 2017 and 2018.
*** Indicates bridge checked with hydra lift**

Table 2. Culvert Survey Results

CALYX ID	NCDOT Structure Number	Facility on Structure	Feature Under Structure	Date Surveyed	Emergence Survey	Comments
C1	N/A	I-26	UT to Hominy Creek	7/17/2018	Y	Unidentified snags. No bats emerged on 7/24/2018 or 7/25/2018.
C2	100297	I-40	Ragsdale Creek	8/22/2017	N	
C3	100771	US-19/Smokey Park Hwy/US 23/US 74A	Ragsdale Creek	8/22/2017	N	
C4	100320	I-40	Ragsdale Creek	8/24/2017	N	
C5	N/A	Sand Hill Rd/SR 3412	Ragsdale Creek	8/24/2017	N	
C6	N/A	US 74/I-40	Trent Branch	8/24/2017	N	
C7	N/A	I-26/I-240	UT to French Broad River	8/24/2017	N	
C8	N/A	I-26/I-240	UT to French Broad River	8/23/2017	N	
C9	N/A	I-26/I-240	Moore Branch	8/23/2017	N	
C11	100769	US 19/US 23/US 74A/Patton Ave	Smith Mill Creek	8/23/2017	N	
C12	100774	NC 251/Broadway	Reed Creek	7/28/2017	N	Surface mine within 0.5 mi.
C13	N/A	US 19/23/Riverside Dr	UT to French Broad River	8/24/2017	Y	MYGR roosting in culvert; emergence surveys performed by USFWS and NCWRC documented over 200 bats on September 7, 2017.
C14	N/A	US 19/23/Riverside Dr	UT to French Broad River	8/24/2017	N	
C15	N/A	I-26/Riverside Dr	UT Reed Creek	8/22/2018	N	
C16	N/A	I-26	UT Hominy Creek	8/22/2018	N	

4.2 Abandoned Structures

No abandoned structures within the project study area that could provide potential roosting habitat for bats were noted during the site visits. However, Indiana State University (ISU) researchers who are conducting a study on MYGR in the area tracked one MYGR to a building near Riverside Drive and Hill Street (personal communication, Joey Weber, ISU). An adult male MYGR used this roost for six days. The structure is infrequently used by humans, and will not be demolished as part of the project construction.

4.3 Caves and Mines

No caves or mines were observed during the field surveys. According to USGS mapping, there are three surface mines located within a ½-mi. radius of the study area (USGS 2018). Seven (7) mines are mapped between one half and three mi. of the project study area (Table 3 below). Wilson Road is the only mine that is questionable in terms of production type. Aerial mapping shows the location is a residentially developed area and no obvious mine location can be seen nearby. All other mines are identified as surface mines or processing plants. No mines were investigated in the field as part of this field survey.

Table 3. Mines within Three Miles of I-2513

Mine Name	Distance from Study Area	Mine Type
Asheville Portable Plant	Between ½ and 3 mi.	Processing Plant
Bell Mine	Within ½ mi.	Surface
Biltmore Plant	Between ½ and 3 mi.	Surface
Enka Quarry	Between ½ and 3 mi.	Surface
Enka Quarry	Between ½ and 3 mi.	Surface
Grove Pit	Between ½ and 3 mi.	Surface
Harmony Mine	Within ½ mi.	Surface
Harrin's Mine	Within ½ mi.	Surface
I-40 Stockpile & Plant	Between ½ and 3 mi.	Processing Plant
Wilson Road	Between ½ and 3 mi.	Unknown

In addition, Jody Kuhne, NCDOT Regional Geological Engineer for NCDOT, stated that no caves or cave like features, nor cliff forming units or rock outcrops (which might indicate the presence of caves) were noted during the geosocial studies performed in association with this project (personal communication, August 3, 2018).

4.4 MYSE and MYSO Habitat Assessment and Emergence Surveys

Suitable summer foraging habitat for MYSE and MYSO is present within the study area in the form of wooded habitats, emergent wetlands, adjacent edges of agricultural fields, old fields and pastures. However, due to the highly disturbed, urbanized nature of the study area, the habitat is considered poor, and it is unlikely that MYSE or MYSO would utilize these areas.

Potential roost trees were identified within the study area at several locations. Emergence surveys were performed at all the sites between July 16, 2018 and August 8. 2018, and Emergence Survey Datasheets are included in Appendix D. With the exception of one snag associated with B20, no bats were seen flying from potential roosts during emergence surveys. The snag associated with B20 was surveyed twice. The tree is situated in an area that is difficult to view at dusk. During the first survey, a bat potentially flew from the tree. The survey was repeated and another bat potentially flew from the tree. An ANABAT SD2 acoustic detector was

used during the second survey, and bat calls were recorded. None of the calls were consistent with any *Myotis* species.

4.5 Summary of Findings

After checking all potential bat roost sites located within (or in some cases, immediately adjacent to) the project study area, only one site was identified as a bat roost; the culvert near Hill Street and Riverside Drive near the French Broad River (CALYX ID C13).

The majority of the proposed road widening will occur within existing NCDOT right of way, including the existing median. These areas contain little to no woody vegetation. Areas outside the existing right of way that may require clearing include existing interchanges, and other urbanized areas which are already cleared of most woody vegetation.

Habitat for MYGR

Only one structure within the study area showed evidence of bat use. Furthermore, no underground mines are present within three mi. of the study area. Therefore, the only suitable roosting habitat for MYGR is the Hill Street culvert. Foraging and commuting habitat is present along the French Broad River and Hominy Creek.

Habitat for MYSE

Only one structure within the study area showed evidence of bat use. Furthermore, no underground mines are present within three mi. of the study area. Therefore, the only suitable winter roosting habitat for MYSE is the Hill Street culvert. However, this culvert was checked in December 2017 and no bats were present.

Although no MYSE roost tree surveys were conducted for this project, it is highly unlikely that MYSE would choose to roost in trees within the wooded areas immediately adjacent to NCDOT right of way due to elevated levels of disturbance caused by light and noise from passing vehicles. Likewise, wooded areas associated with commercial and residential development would also be subject to high levels of disturbance from general human activity, including light and noise. Overall, roosting, foraging, and commuting habitat for MYSE is poor.

Habitat for MYSO

Only one structure within the study area showed evidence of bat use. Furthermore, no underground mines are present within three mi. of the study area. Therefore, the only suitable winter roosting habitat for MYSO is the Hill Street culvert. However, this culvert was checked in December 2017 and no bats were present.

Potential MYSO roost tree surveys were conducted for this project. No MYSO were noted emerging from any of the trees. Furthermore, it is highly unlikely that MYSO would choose to roost in trees within the wooded areas immediately adjacent to NCDOT right of way due to elevated levels of disturbance caused by light and noise from passing vehicles. Likewise, wooded areas associated with commercial and residential development would also be subject to high levels of disturbance from general human activity, including light and noise. Overall, roosting, foraging, and commuting habitat for MYSO is poor.

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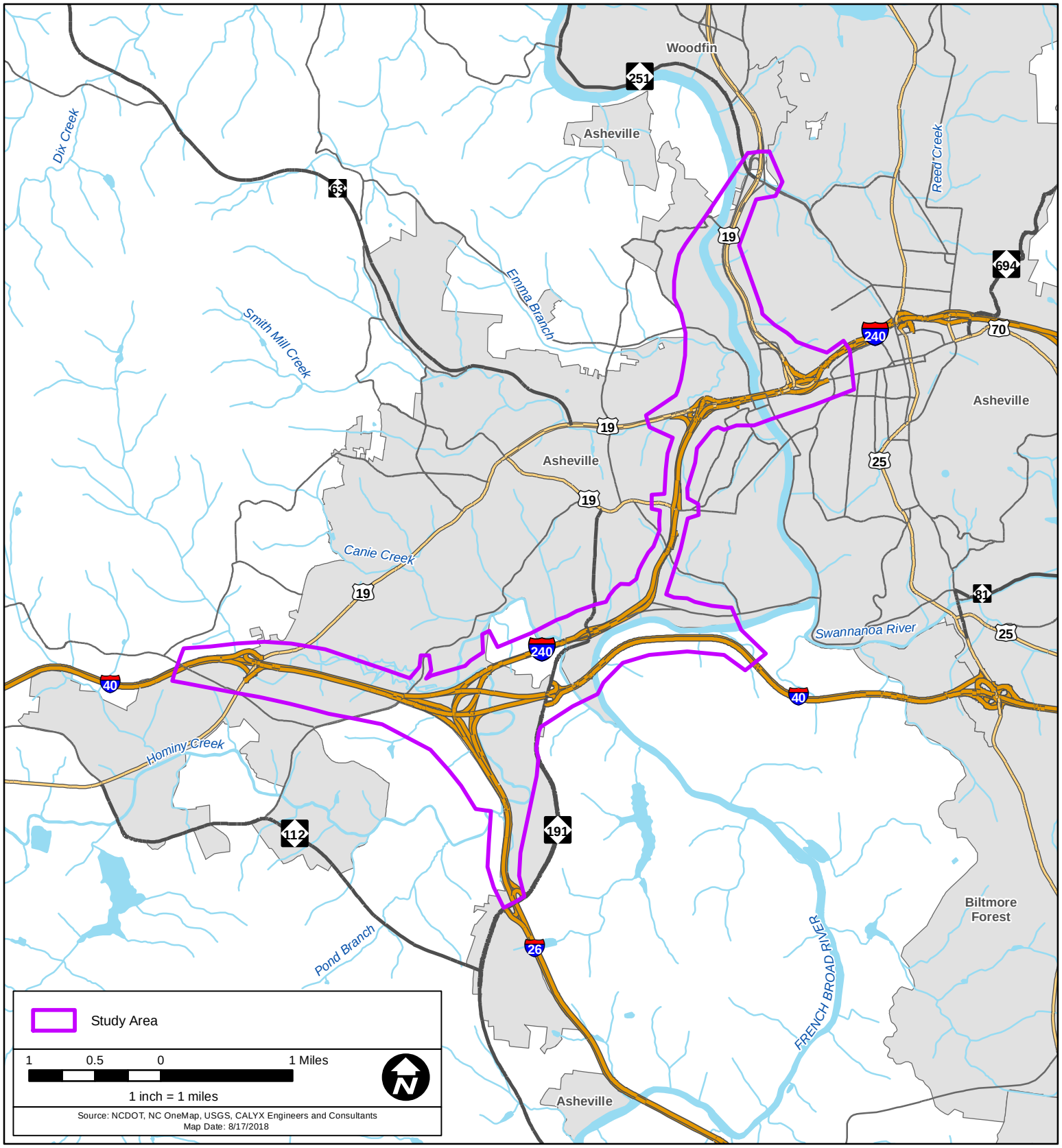
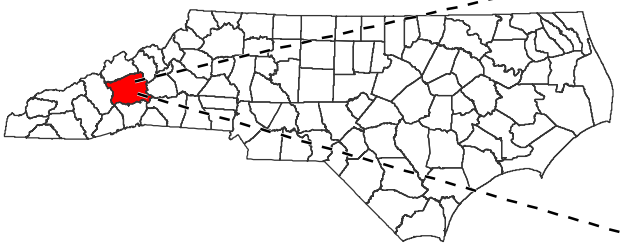
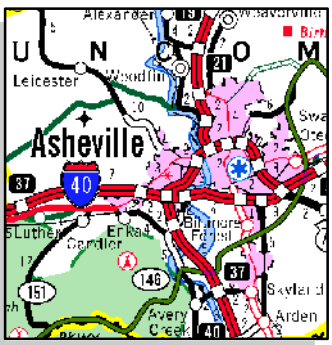
Appendix A: Figures







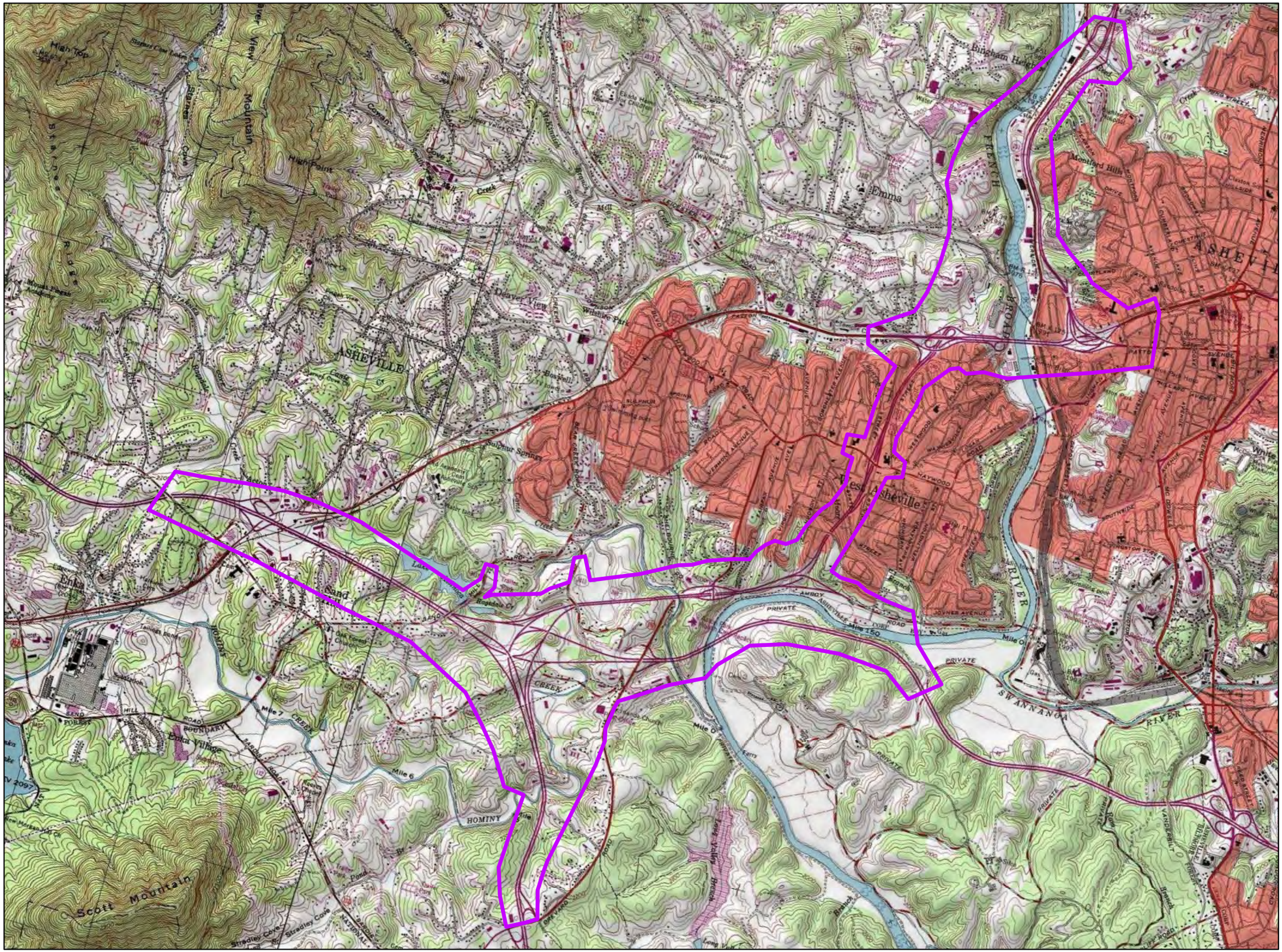
NORTH CAROLINA
DEPARTMENT OF TRANSPORTATION

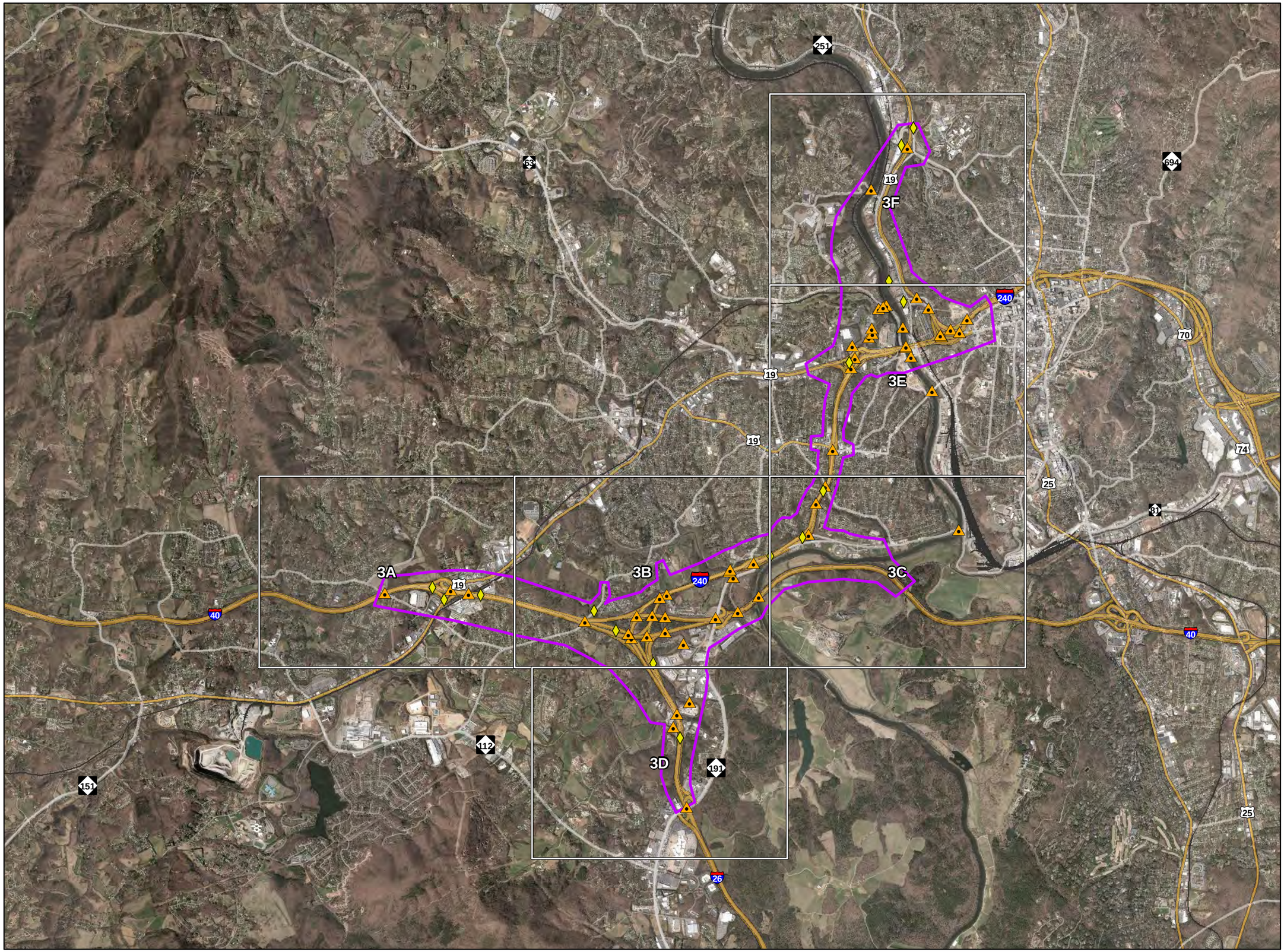
I-26 Asheville Connector

TIP Project I-2513

Buncombe County, NC

Figure 1 - Project Vicinity


ASHEVILLE
Emma
Biltmore Park
Delaver View
Bingham Heights
Montford Hills
Enka
Enka Village
Sand Hill
Scott Mountain
Mile 6
Mile 7
Mile 150
HOMINY CREEK
SWANNANOA RIVER
FRENCH BROAD RIVER
PRIVATE
Legend
StudyArea
Figure
2
Project Footprint
I-26 Asheville Connector
TIP Project I-2513
Buncombe County, NC
Map Date: 8/17/2018
0.5 0.25 0 0.5
Miles
1 inch = 0.5 miles
This Exhibit is for planning purposes only and information shown hereon does not meet The Standards of Practice for Land Surveying in North Carolina (21 NCAC 56.1600). The Exhibit was compiled from available information obtained from the sources listed below. Streams and Wetlands: All features located in the field were recorded using a mapping grade Trimble GeoXT or GeoXH GPS receiver with supposed sub-meter accuracy.
Sources: ESRI, Calyx Engineers and Consultants



Legend

- Bridge
- Culvert
- Railroad
- Map Tile
- StudyArea

Figure 3

Structure Locations Overview

I-26 Asheville Connector

TIP Project I-2513

Buncombe County, NC

Map Date: 8/17/2018

0.75 0.375 0 0.75

Miles

1 inch = 0.75 miles

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Sources: NCDEQ, NCDOT, Calyx Engineers and Consultants

Aerial Photography: NCDOT

Legend

- Bridge
- Culvert
- Railroad
- NCDEQ 24K Stream
- NCDEQ 24K Waterbody
- StudyArea

Figure 3A

Structure Locations

I-26 Asheville Connector

TIP Project I-2513

Buncombe County, NC

Map Date: 8/22/2018

800 400 0 800

Feet

1 inch = 800 feet

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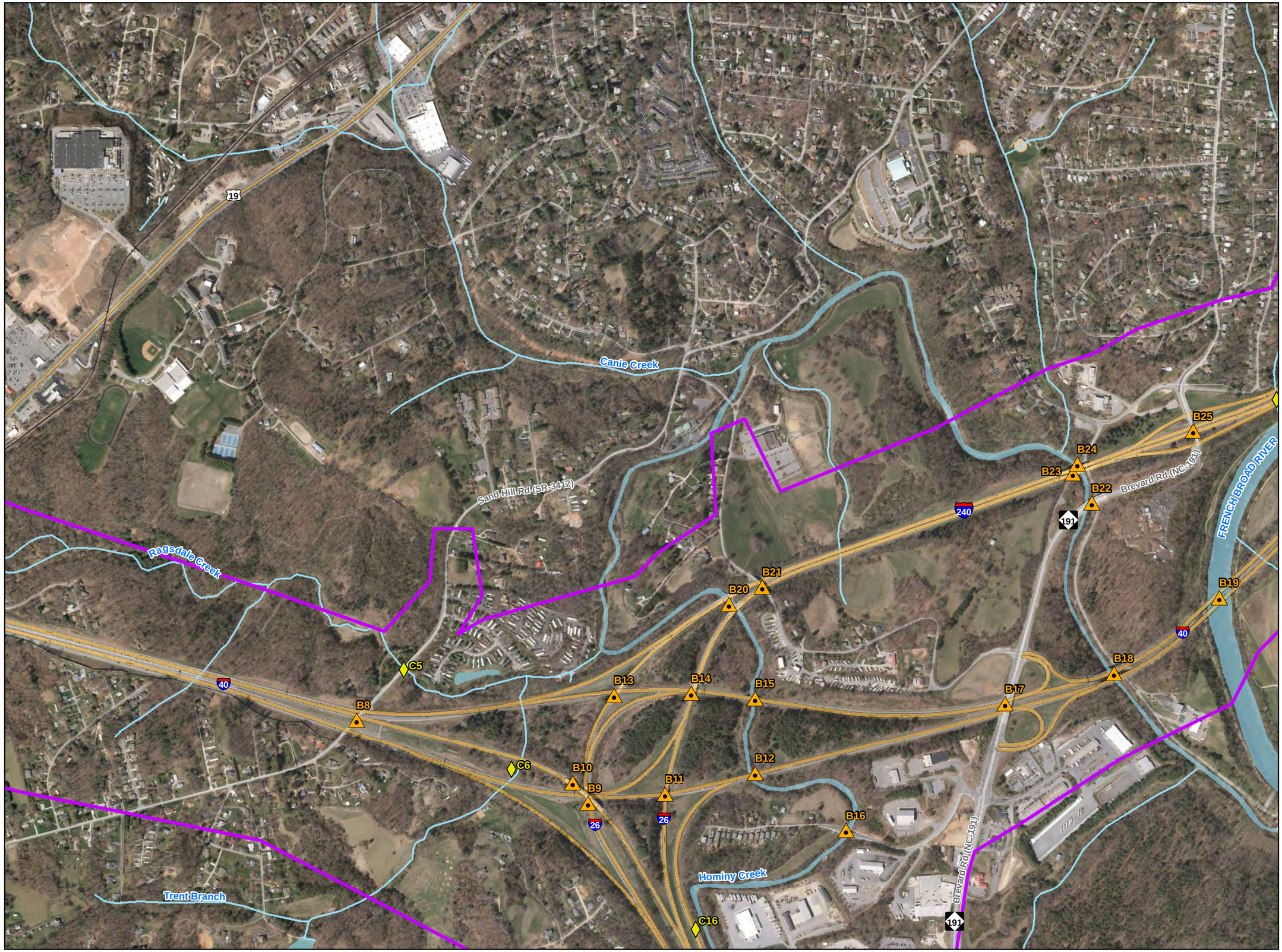
Sources: NCDEQ, NCDOT, Calyx Engineers and Consultants

Aerial Photography: NCDOT



Legend

- Bridge
- Culvert
- Railroad
- NCDEQ 24K Stream
- NCDEQ 24K Waterbody
- StudyArea

Figure 3B

Structure Locations

I-26 Asheville Connector

TIP Project I-2513

Buncombe County, NC

Map Date: 8/22/2018

800 400 0 800

Feet

1 inch = 800 feet

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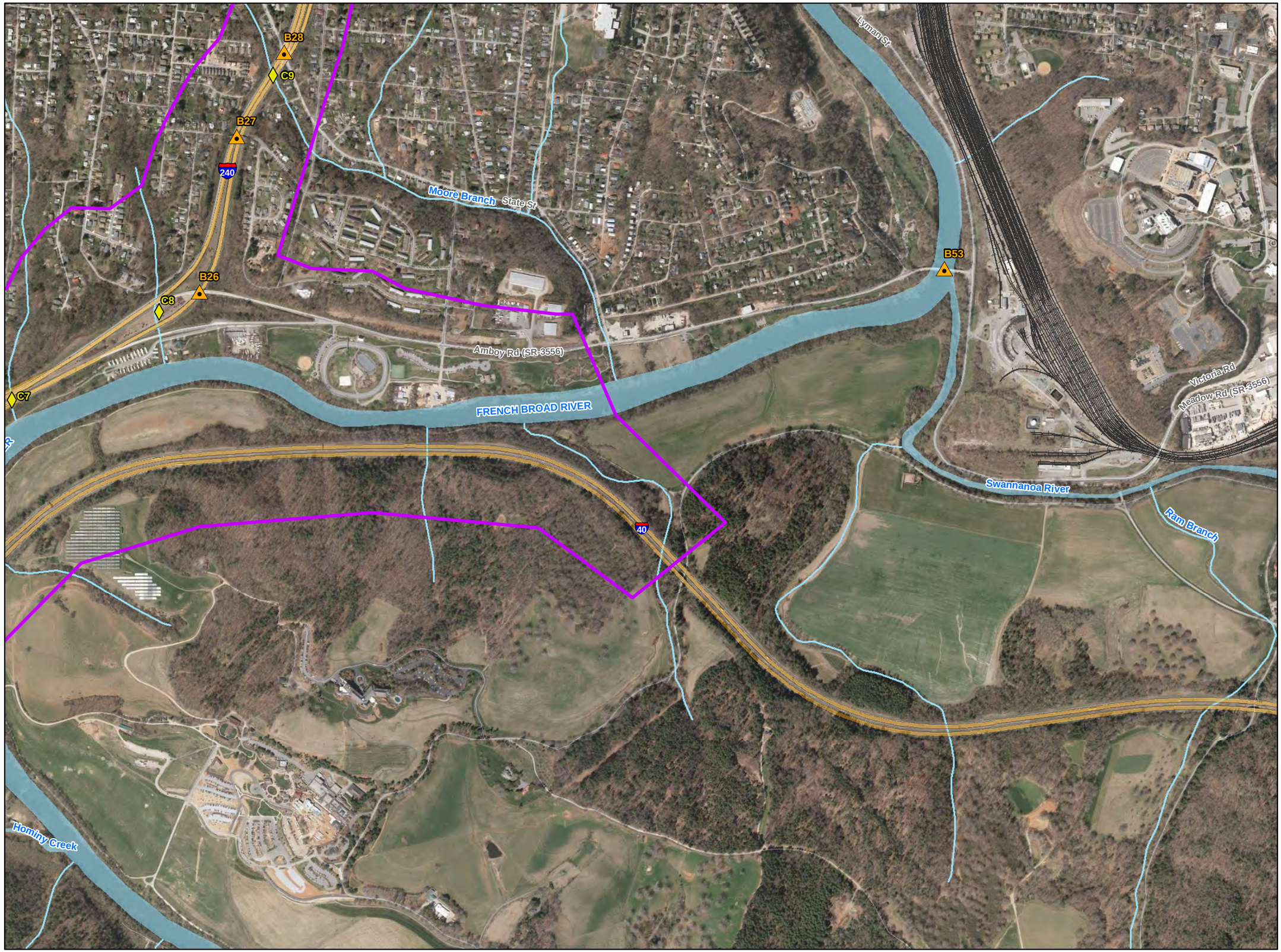
Aerial Photography: NCDOT



Legend

- Bridge
- Culvert
- Railroad
- NCDEQ 24K Stream
- NCDEQ 24K Waterbody
- StudyArea

Figure 3C

Structure Locations

I-26 Asheville Connector

TIP Project I-2513

Buncombe County, NC

Map Date: 8/22/2018

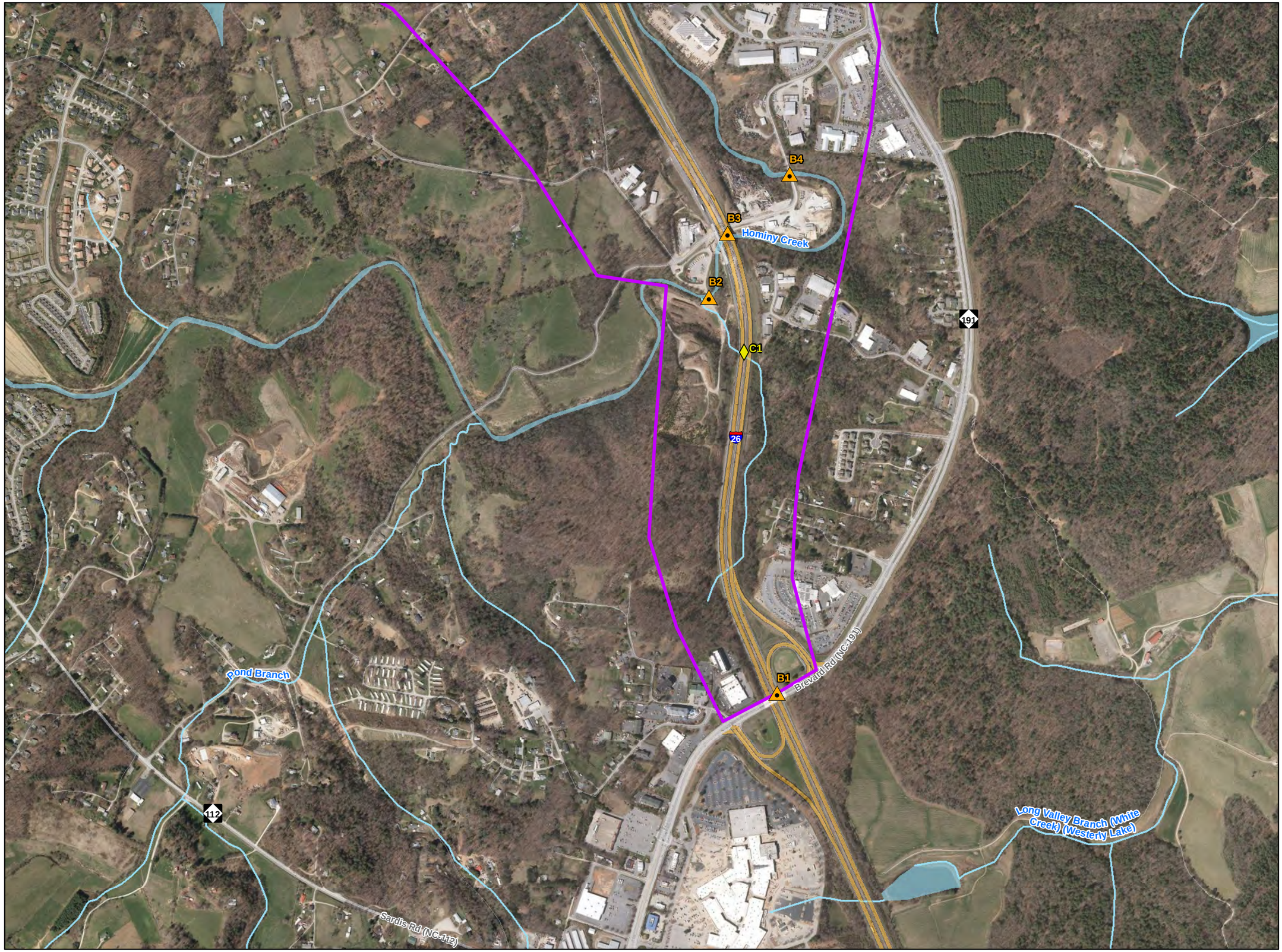
800 400 0 800

Feet

1 inch = 800 feet

Sources: NCDEQ, NCDOT, Calyx Engineers and Consultants

Aerial Photography: NCDOT



Legend

- Bridge
- Culvert
- Railroad
- NCDEQ 24K Stream
- NCDEQ 24K Waterbody
- StudyArea

Figure 3D

Structure Locations

I-26 Asheville Connector

TIP Project I-2513

Buncombe County, NC

Map Date: 8/22/2018

800 400 0 800

Feet

1 inch = 800 feet

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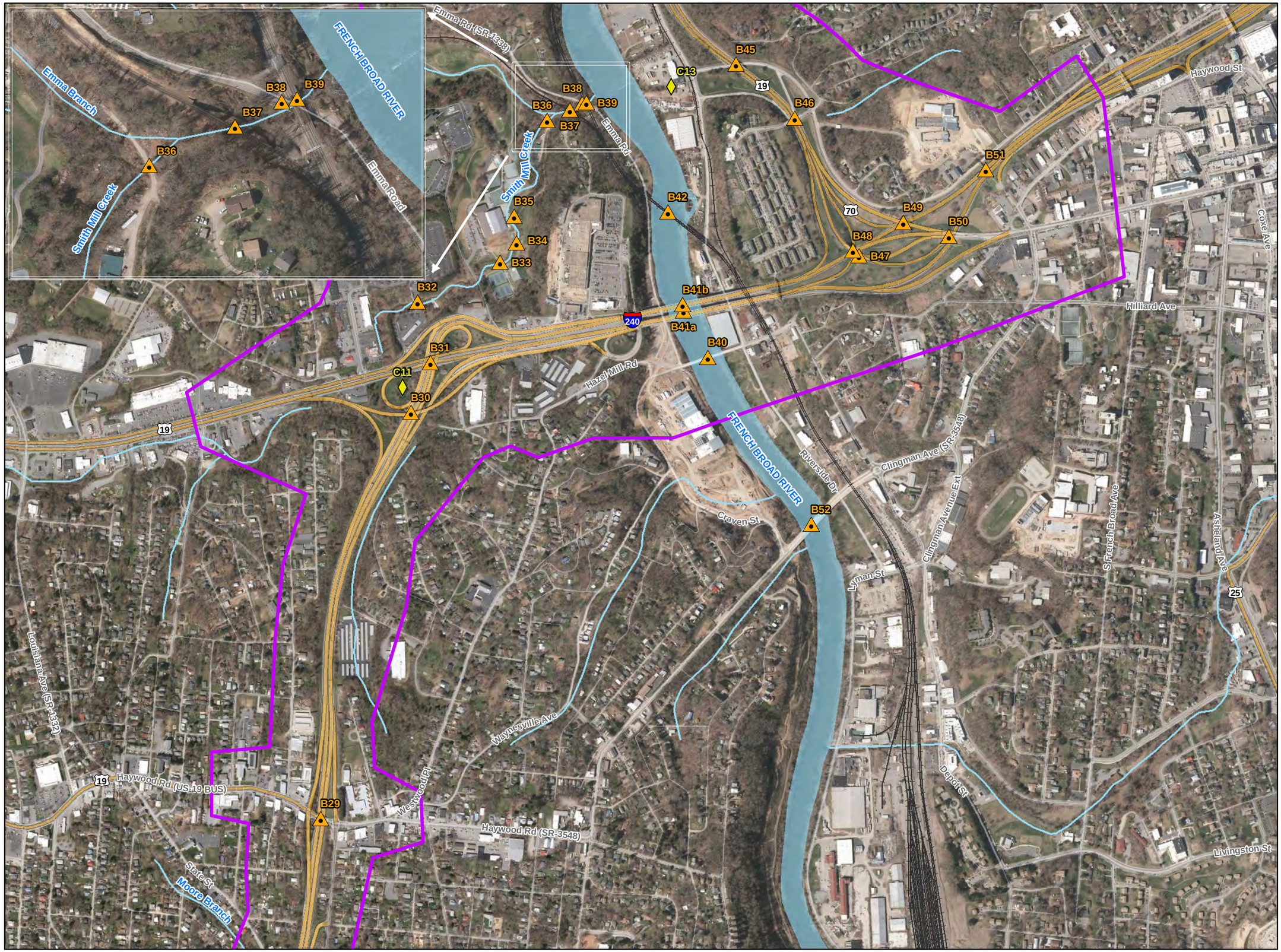
Sources: NCDEQ, NCDOT, Calyx Engineers and Consultants

Aerial Photography: NCDOT



Legend

- Bridge
- Culvert
- Railroad
- NCDEQ 24K Stream
- NCDEQ 24K Waterbody
- StudyArea

Figure
3E

Structure Locations

I-26 Asheville Connector

TIP Project I-2513

Buncombe County, NC

Map Date: 8/17/2018

800 400 0 800

Feet

1 inch = 800 feet

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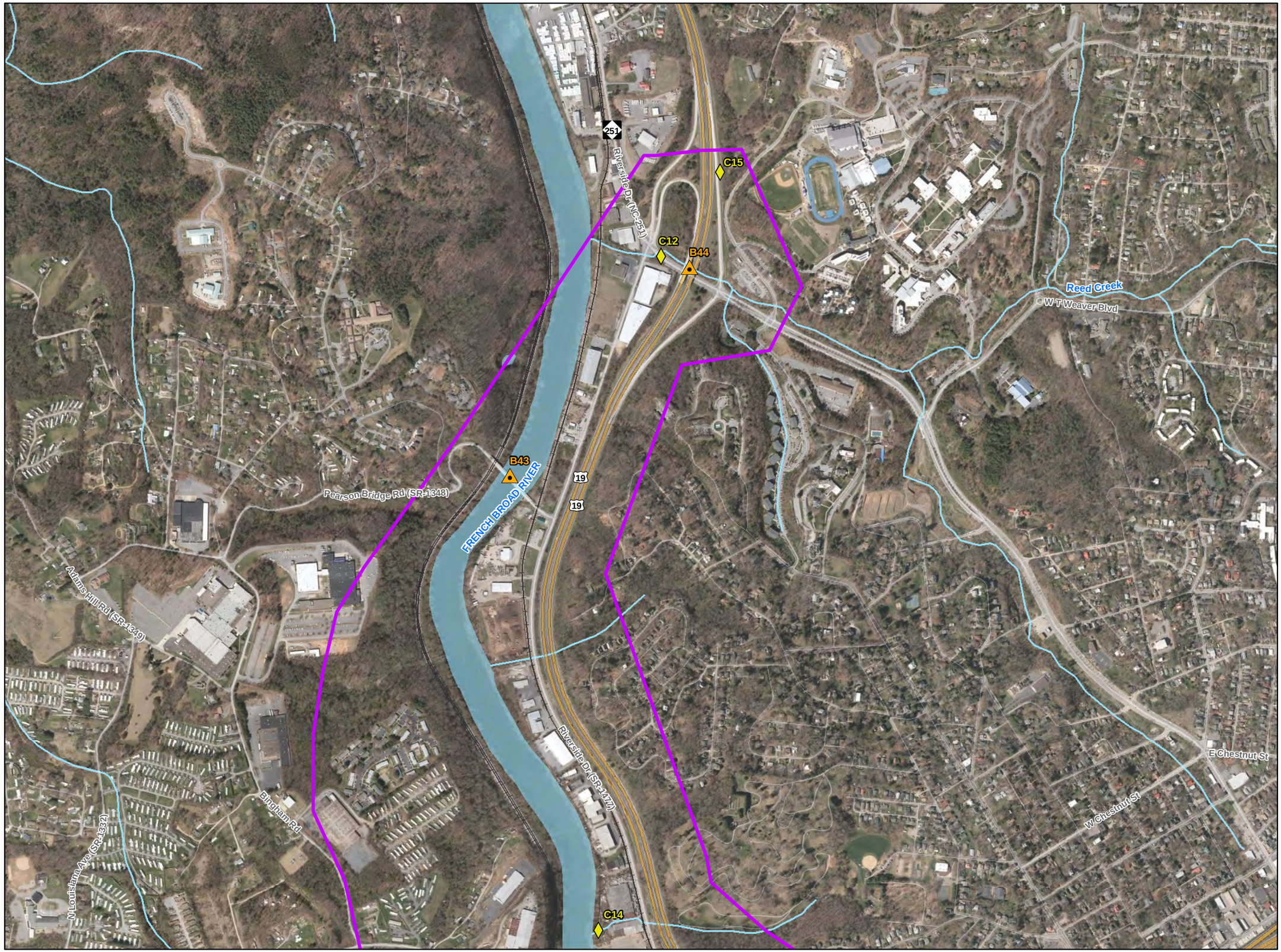
Sources: NCDEQ, NCDOT, Calyx Engineers and Consultants

Aerial Photography: NCDOT



Legend

- Bridge
- Culvert
- Railroad
- NCDEQ 24K Stream
- NCDEQ 24K Waterbody
- StudyArea

Figure 3F

Structure Locations

I-26 Asheville Connector

TIP Project I-2513

Buncombe County, NC

Map Date: 8/22/2018

800 400 0 800

Feet

1 inch = 800 feet

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Sources: NCDEQ, NCDOT, Calyx Engineers and Consultants

Aerial Photography: NCDOT

Appendix B: Bridge Habitat Assessment Forms

PAGES INTENTIONALLY REMOVED

Appendix C: Culvert Habitat Assessment Forms

PAGES INTENTIONALLY REMOVED

Appendix D: Emergence Survey Datasheets

PAGES INTENTIONALLY REMOVED

APPENDIX C. ACOUSTIC SURVEY REPORT

FEDERALLY PROTECTED BAT SPECIES
ACOUSTIC SURVEY REPORT

I-26 Asheville Connector
Buncombe County, North Carolina
Federal Aid Project No. MA-NHF-26-1(53)
WBS Element No. 34165.1.1

TIP I-2513

Prepared for

The North Carolina Department of Transportation
Environmental Analysis Unit
1598 Mail Service Center
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FEDERALLY PROTECTED BAT SPECIES ACOUSTIC SURVEY REPORT

I-26 Asheville Connector
Buncombe County, North Carolina
Federal Aid Project No. MA-NHF-26-1(53)
WBS Element No. 34165.1.1

TIP I-2513

Prepared for

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1.0 PROJECT DESCRIPTION

The North Carolina Department of Transportation (NCDOT) obtained the services of CALYX Engineers and Consultants, Inc. (CALYX), an NV5 company, to perform acoustic surveys for gray bats (*Myotis grisescens*; MYGR) for the proposed I-26 interstate freeway connector project. The project will connect I-26 in southwest Asheville to US 19/23/70 in northwest Asheville (STIP Project No. I-2513) for a span of approximately 7 miles (mi), within Buncombe County (NCDOT 2017).

For purposes of this scope of work, the project footprint is defined as the study area to be depicted in the Final Environmental Impact Statement (EIS); Approximately 2,202 acres in total, roughly centered on the existing roadway with expansions around the major highway interchanges, and north of Patton Avenue at the French Broad River where a new bridge will be installed. Figure 1 (Appendix A) depicts the project vicinity, detailed study alternatives, and study area.

The study area is situated in the Blue Ridge physiographic province of North Carolina. Topography in the project vicinity is characterized by gradual to steep slopes with narrow floodplains along drainage ways. Elevations range from a low of 1,980 feet (ft) above sea level near the confluence of Hominy Creek and the French Broad River to a high of 2,150 ft along I-240 in the central portion of the project study area. Land use within the project vicinity is characterized by residential and urban development, forested land (including a portion of Pisgah National Forest), and agriculture (NCDOT 2015). The project study area and its landscape position is illustrated in Figure 2, located in Appendix A.

2.0 SPECIES INFORMATION

As of April 28, 1976 the U.S. Fish and Wildlife Service (USFWS) listed MYGR as “Endangered” under the Endangered Species Act. As of February 20, 2019 (date accessed), MYGR was listed as “current” in Buncombe County (USFWS 2019). This species is known, or presumed to occur, in Buncombe County only during summer months. Although northern long-eared bats (*Myotis septentrionalis;* MYSE) are also listed, acoustic surveys focused on MYGR.

2.1 Nearby Records

North Carolina Natural Heritage Program (NCNHP) records (most recently updated January 22, 2019, and viewed on February 20, 2019) confirm presence in six western North Carolina counties: Buncombe, Haywood, Madison, Swain, Transylvania, and Yancey. In addition, another occurrence that has not yet been incorporated into the NCNHP database includes a record at the Cherokee/Clay County line. Records in North Carolina represent mist-net captures, NC State Laboratory of Public Health records, and summer roost locations. There are no known MYGR hibernacula located in North Carolina (NCNHP 2019). Based on surveys of bridges and culverts conducted by CALYX in 2017, a MYGR roost is known from the study area.

2.2 Natural History

MYGR are typically a communally roosting, cave obligate species, meaning that groups of individuals are known to utilize caves for roosting in both summer and winter. This species has been documented using bridges and culverts as roosts during summer months (Hayes and Bingman 1964, Keeley and Tuttle 1999).

Summer maternity roosts are typically located within 0.62 mi of a river or reservoir over which the bats forage (Tuttle 1979), and are rarely located more than 2.49 mi away from foraging areas

(Tuttle 1976). However, individuals may travel up to 21.75 mi between prime feeding areas over lakes or rivers and occupied caves (LaVal et al. 1977, Tuttle and Stevenson 1977, Tuttle and Kennedy 2005). Forested areas along the banks of streams and lakes serve as corridors for travel and as protective feeding cover for newly volant young (Tuttle 1979, Brady et al. 1982).

3.0 ACOUSTIC SURVEY METHODS

All survey methods were developed in coordination with NCDOT, the Asheville USFWS Ecological Services Field Office, and the North Carolina Wildlife Resources Commission (NCWRC). MYGR were known to be present within the project vicinity, so acoustic surveys were not designed to determine presence/absence. Alternatively, acoustic surveys served the purpose of determining areas of highest MYGR activity, and seasonal patterns of activity, if possible.

Qualifications of CALYX biologists who performed the work for this project are included in Appendix C.

3.1 Detector Locations

With regard to bat acoustic analysis, “clutter” is defined as anything that serves as a surface to reflect sound. This could be anything from grass, leaves, tree limbs, and water, to a human body, bridge, or even the detector itself. Bats produce differing echolocation calls depending on the type and amount of clutter. MYGR typically forage in areas of low clutter, over large streams and rivers. Low clutter detector locations typically produce recordings with longer call sequences where the individual pulses are complete, lower in slope, lower in frequency, and less likely to be confused with other species (which are more distinct), and therefore, increasing the chances of correct identification. Therefore, the project goal was to choose detector locations in these areas, with low amounts of clutter near the microphone.

Detectors were deployed to try to determine, without telemetry, bat movement and presence that would potentially be affected by the project. Based on the location of known roosts within and adjacent to the project study area, the results of telemetry work conducted by NCWRC, and because MYGR typically use large streams and rivers for foraging and commuting, most of the acoustic detector sites were established at strategic locations along the French Broad River and Hominy Creek. In 2017, four detector sites were established in the highest quality MYGR foraging/commuting habitat within the study area at locations along the French Broad River. An additional detector was added at the MYGR culvert roost location (discovered in late summer 2017) to monitor MYGR activity there. Although placing a detector at a roost is not ideal in terms of collecting calls that are generally more ideal for call identification (i.e. search phase calls/pulses recorded in open areas), a detector was placed at the roost in an attempt to record calls made by bats travelling specifically to/from the culvert, rather than commuting or feeding along the adjacent French Broad River. Although the banks of the UT were heavily vegetated, an effort was made to point the microphone toward an area that had the least amount of clutter. The detector was placed approximately 20 ft. downstream from the culvert outlet.

In 2018, five additional detector locations were added, mainly to provide coverage to Hominy Creek and Smith Mill Creek/Emma Branch. Figure 3 and Figures 3A-3E, located in Appendix A, show the overall detector locations within the project study area and more specific locations of the ten detector sites, respectively. As requested by USFWS, a detector was deployed at the French Broad River crossing of I-26 south of Asheville, which is associated with the I-26 widening Project (STIP No. I-4400/I-4700) and was monitored with acoustic equipment in 2017. This site

(known as Site 11) was monitored again throughout the 2018 field season, and is shown on the inset of Figure 3.

3.2 Acoustic Equipment

The sites were monitored using Titley Scientific AnaBat Express passive monitoring devices using the latest firmware version (V5506L (3/1/2018), V5507H (6/28/18), and V5507I (7/12/2018)) with weatherproof directional microphones. Equipment failure occurred at a few sites, and was remedied by promptly replacing the faulty detector or reinstalling the firmware, as needed. All acoustic equipment and deployment techniques met the requirements outlined in the USFWS 2017 Range-wide Indiana Bat Summer Survey Guidelines (USFWS 2017) and the USFWS 2018 Range-wide Indiana Bat Summer Survey Guidelines (USFWS 2018). All detectors were serviced by Titley Scientific or purchased brand new during the spring of 2017 and 2018. Specific information about the detectors utilized at each site is presented in the acoustic survey data forms in Appendix D.

3.3 Detector Placement and Setup

The exact physical location, height, and orientation of the microphones were determined in the field by a qualified CALYX biologist and all sites were located using a handheld GPS unit. Detectors that were located near roadways were placed as far away from vehicles as possible while still utilizing forest edge habitat. In these cases, CALYX biologists placed the detectors in locations and orientations that would minimize noise from passing vehicles. This was accomplished by orienting microphones away from traffic, placing microphones downslope at a lower elevation than passing cars, or using other landscape features to block traffic noise. In general, the microphones were elevated a minimum of 12 feet from the ground or water surface to avoid the possibility of sound echoing off those surfaces toward the microphone. Microphone height was adjusted on a site by site basis, depending on height and thickness of understory vegetation.

Detectors were programmed to record nightly beginning 30 minutes prior to sunset and recording until 30 minutes after sunrise. Medium microphone sensitivity settings and data division ratios of 16 were chosen. Upon deployment of any detector, verification was made that the detector was functioning properly by performing a test of the system per the latest AnaBat Express Bat Detector User Manual [Version 1.5 (2/2/15), Version 1.6 (5/18/2018), Version 1.7 (7/12/2018), Version 1.8 (8/24/2018)] (Titley Scientific 2018). Photographs and site-specific information for each detector site and setup are recorded on the acoustic survey data forms presented in Appendix D.

3.4 Deployment Schedule

Detectors were deployed permanently at each site until MYGR activity trailed off for the season. Detectors were only removed from a site to prevent equipment damage from flood events. In the case of a malfunctioning detector, the detector was immediately replaced with another detector.

Acoustic surveys began on March 3 at Site 5, on April 5 at Sites 1-4 and 7-10, and on April 19 at Site 6. In total, 289 weeks of acoustic data were collected from the 10 different locations established throughout the project study area. In addition to those 10 detectors, another detector was deployed at Site 11 on March 3, which collected a total of 32 weeks of acoustic data. Acoustic surveys ended on October 31 at Site 11, on November 7 at Sites 1-4 and Sites 6-10, and on November 21 at Site 5.

3.5 Acoustic Analysis – Autoclassifier

All call files were processed with Bat Call Identification (BCID) Eastern USA Version 2.7d, a USFWS approved automated identification program. Default species filters were applied. At the

request of USFWS, filter settings were changed as follows: Minimum Percentage of Pulses for Species ID set to 70% and Discriminant Probability for Species ID set to 0.35. Using these conservative filter settings added even greater reliability to the identification of MYGR calls and discounted the need for manual vetting. Species identification per file, identification summary (including maximum likelihood estimate MLE) per week, and hourly breakdown per species were generated by BCID.

4.0 RESULTS

CALYX biologists visited the project site each week to download data, replace batteries, and perform detector maintenance. CALYX analyzed acoustic data as efficiently as possible to determine "real time" results, and periodically provided updates to NCDOT, NCWRC, and USFWS.

Table 1, below, shows the 2018 deployment sites and schedule, including each site's general location, deployment start date, and deployment duration. Also included is each site's total number of bat calls and number of MYGR calls. Table 2, located in Appendix B, includes both the 2017 and 2018 deployment schedule and results. Although Sites 1-5 were established in 2017, not enough data was collected in 2017 to determine any significant trends; only 2018's full season of data will be used in the data analysis. Site 11 is included as a basis for comparison in some discussions that follow. Notice that bat activity in general, and MYGR activity in particular, is exponentially higher at Site 11 than at any of the sites located within the project study area.

Table 1: 2018 Deployment Schedule & Results

Detector Site #	Site Name	Associated Waterbody	2018			
			Date Deployed	Approx. # Weeks Deployed*	Total # Bat Calls*	Total # MYGR Calls*
1	Grainger	French Broad River	20180405	30 Weeks	20,020	573
2	Smoky Park Bridge	French Broad River	20180405	29 Weeks	18,134	799
3	Carrier Park	French Broad River	20180503	25 Weeks	8,194	58
4	I-40 and Greenway	French Broad River	20180405	29 Weeks	3,877	146
5	Culvert	UT French Broad River	20180301	34 Weeks	14,804	4,711
6	Smith Mill Creek	Smith Mill Creek	20180419	28 Weeks	13,835	132
7	Hominy Creek and I-240	Hominy Creek	20180405	30 Weeks	8,574	15
8	Oakview Road	Hominy Creek	20180405	26 Weeks	3,925	26
9	Pond Road	Hominy Creek	20180405	28 Weeks	6,519	206
10	Outdoor Center	French Broad River	20180405	30 Weeks	19,952	704
11	I-26 Bridge	French Broad River	20180301	32 Weeks	51,497	26,009

*Excluding weeks with less than 6 full nights of data (due to detector malfunctions and/or severe flooding)

Refer to the acoustic survey data forms in Appendix D for each site's detailed results (weekly total calls, weekly MYGR calls, number of nights recorded, etc.).

4.1 Data Analysis

Surveying for bats using acoustic methods can be challenging for a variety of reasons. Acoustic detectors are limited in their ability to detect and record bats, distinguish bat calls from other sounds, and withstand environmental factors. Acoustic analysis software is also limited in its ability to distinguish bat calls from other sounds, and to correctly identify bats to the species level.

In addition to a variety of environmental and technical factors that may interfere with the software's ability to identify the species, individual bats may change their calls depending on their activity and specific location within their environment. There is no method to identify bat species acoustically with 100% accuracy. In fact, it is impossible to be definitive about *Myotis* species identification (and in some cases other North American bat species), unless the bat is in hand. It can only be concluded that a given call sequence from an individual bat may likely be attributable to a particular species based on comparison with a known call sequence from a bat flying in a similar situation.

That said, it is possible to definitively identify high quality calls to the genus *Myotis*, and MYGR are one of the more readily identifiable species of *Myotis* based on calls. In addition, we can feel more confident about identification when conservative filter settings are used during the automated identification process, as is the case in this study. The use of conservative filter settings is particularly useful in situations like the culvert roost, where an abundance of calls are recorded, but many calls may not be search phase calls.

In order to minimize the many challenges inherent to species identification based on acoustic data, CALYX biologists were diligent about monitoring site conditions, detector setups, detector function, and subsequent data collected to ensure that call files of the best possible quality were recorded. Only weeks with 6 or 7 full nights of data were included in the data analysis in order to compose a standard week of data.

A major flood event occurred on May 30. Flooding was too severe at Sites 1-4, 6-7, and 10 to physically access the detectors. They were left to record as long as possible before their batteries died. The detectors were serviced on June 5, once the floodwaters receded. It was possible to reach detectors at Site 5 and Site 11 on May 30. Site 5 was redeployed on June 1 and Site 11 was redeployed on June 5. Detectors at Site 8 and Site 9 malfunctioned during the flooding. In summary, data was either lost or not able to be recorded at most detectors for at least a portion of the time period between May 30 and June 5.

To avoid equipment damage caused by Hurricane Florence, all of the detectors were preemptively removed on September 12, resulting in one missing night of data. The detectors were redeployed on September 20, after floodwaters receded, resulting in an additional week of missing data.

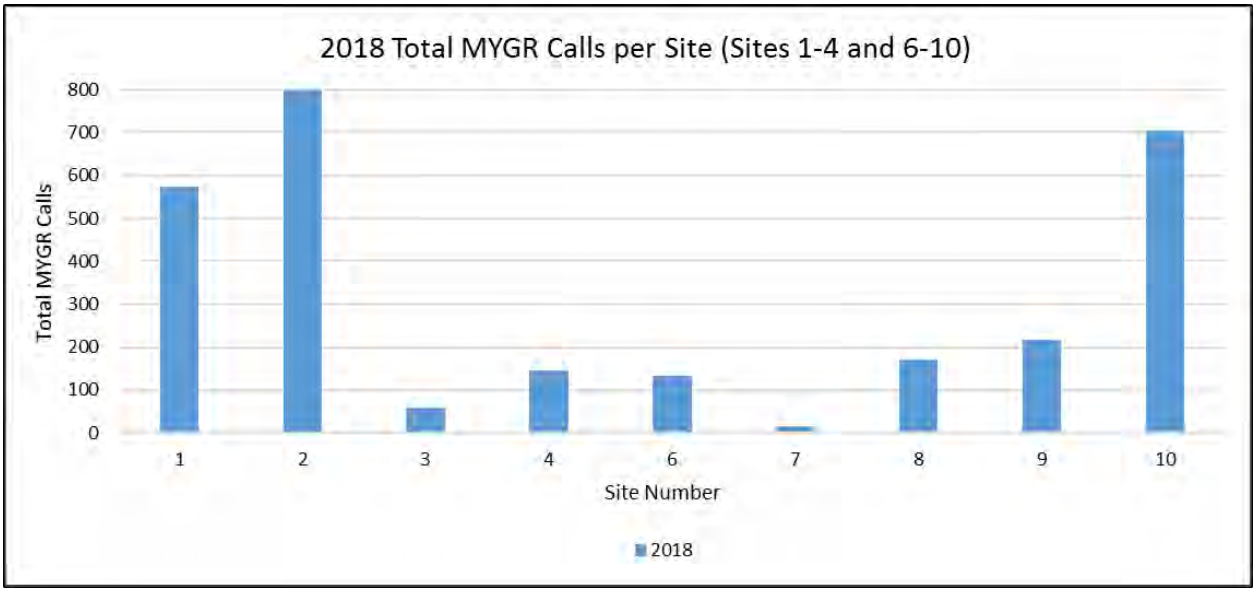
Additional flooding occurred on October 11, preventing the scheduled maintenance to occur on detectors at Sites 1-5, all of which are along the French Broad River. Without replacement batteries, only two full nights of data were recorded at the affected sites during that week of data collection.

After processing all recorded call files through BCID Eastern USA, MYGR calls were identified at all of the 10 detector sites within the study area. In addition to Site 5, which was a known MYGR roost, Sites 1, 2, and 10 produced the largest number of MYGR calls. Looking at total number of MYGR calls, Site 1 recorded 573, Site 2 recorded 799, and Site 10 recorded 704 MYGR calls. It is important to note that Sites 1, 2, and 10 were all located adjacent to the French Broad River. Chart 1, below, shows the total number of MYGR calls at each site. Site 5, with 4,711 total MYGR calls for the season, was not included since it is such a strong outlier, and resulted a presentation that made differences in call totals difficult to discern.

It should be noted that while sites 1, 2, and 10 along the French Broad River produced the highest number of calls, aside from the culvert roost site, other sites along the river produced numbers of calls similar to, or in some cases lower than sites along smaller waterways. The fewest MYGR

calls were recorded at Site 7 where Hominy Creek flows under I-240, and adjacent to a secondary road and greenway trail. Noise, light, and human activity at this location may have an influence on bat activity, especially when coupled with the smaller size of the stream where less prey may be available.

Chart 1



It is important to discern differences in activity at the various detector locations based on the reproductive cycle of MYGR in the area. Although the exact time frames are not known when MYGR in the area are pregnant, give birth, or when pups become volant, some generalizations were made for purposes of data analysis. Therefore, reproductive phases were assigned the following timeframes: pre-lactating/pregnant (beginning when MYGR emerge from hibernation through the third week of June), lactating (last week of June through the third week of July), and post lactating, when pups are volant and feeding on their own (last week of July through the time when MYGR begin hibernation).

Charts that show total MYGR calls for each detector location, overlaid on demarcations of reproductive seasons, are included in Figures 3A through 3E in Appendix A, to provide a visual representation of activity within each phase of the MYGR reproductive cycle at each detector location. For all sites, there is a general trend toward increased activity as pups become volant in late summer/early fall. This makes sense because more individual bats are present on the landscape during this time. Seasonal activity patterns may be less meaningful at detector locations where total numbers of calls were lower overall, such as sites 3, 7, and 8.

Looking at weekly totals for the entire 2018 recording season, across all detector sites (Chart 2, below), the number of MYGR calls increased substantially during the last two weeks of July. This aligns with the trends observed at individual detector sites. It is important to note that variation in number of calls from week to week could potentially be affected by local weather conditions. Rain, high winds, or unusually cool temperatures can all affect bats' ability or desire to forage. Extreme weather events that affected recording are indicated on relevant charts. Furthermore, MYGR may utilize waterways for foraging based on prey availability, so if insect numbers drop for a particular period of time, that may be reflected in overall number of calls for that period.

Chart 2

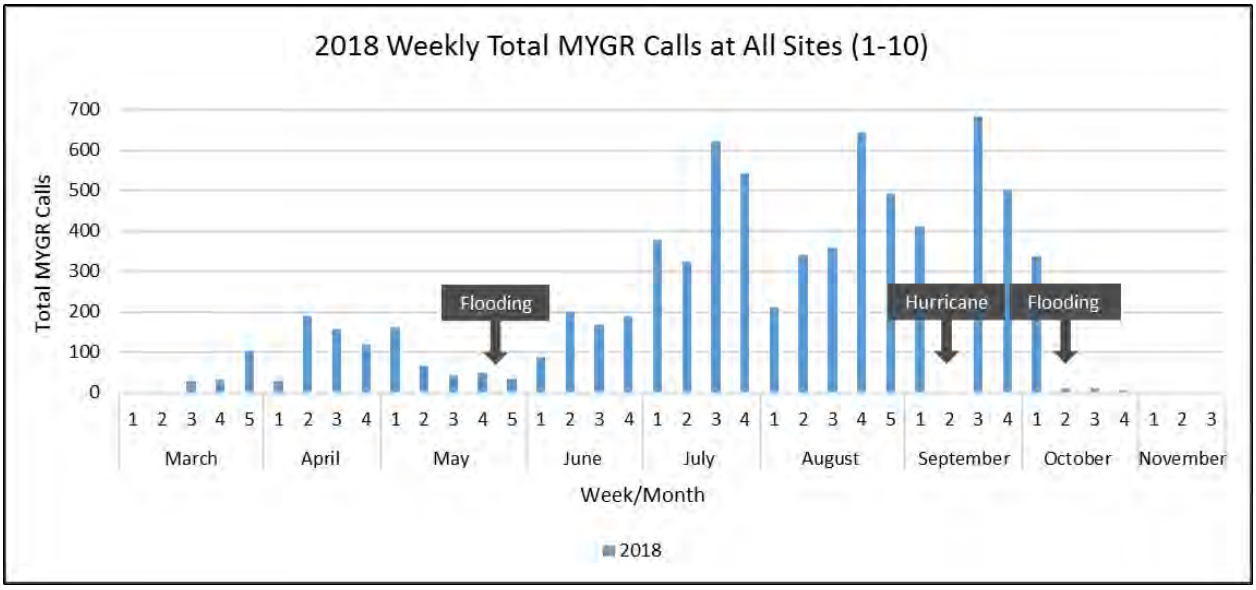
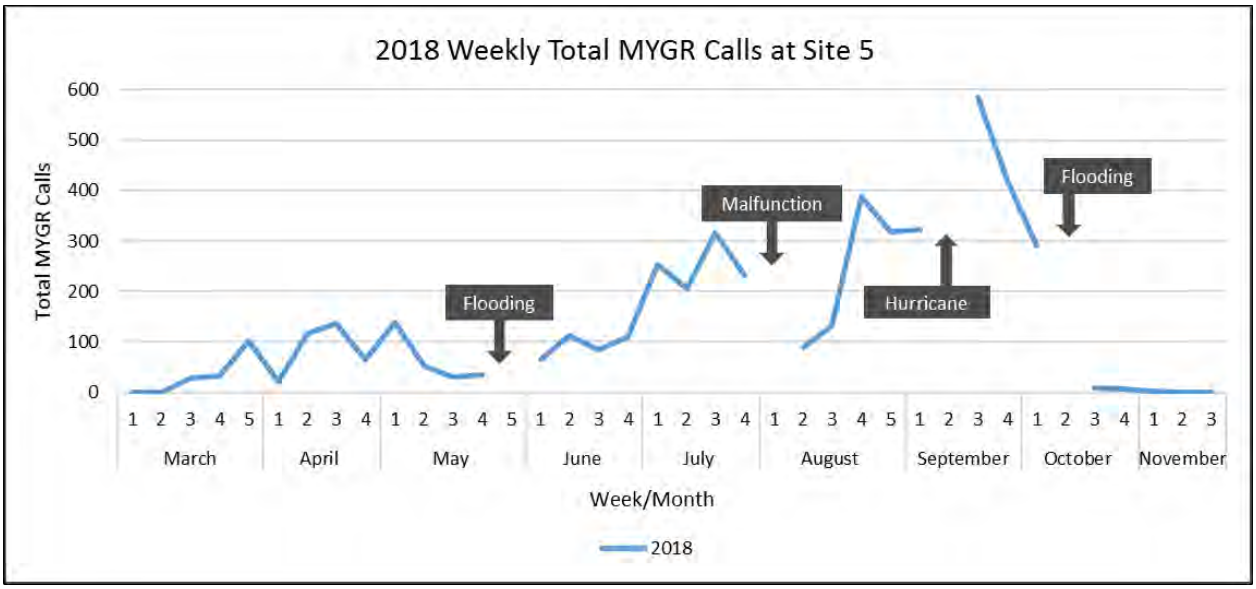


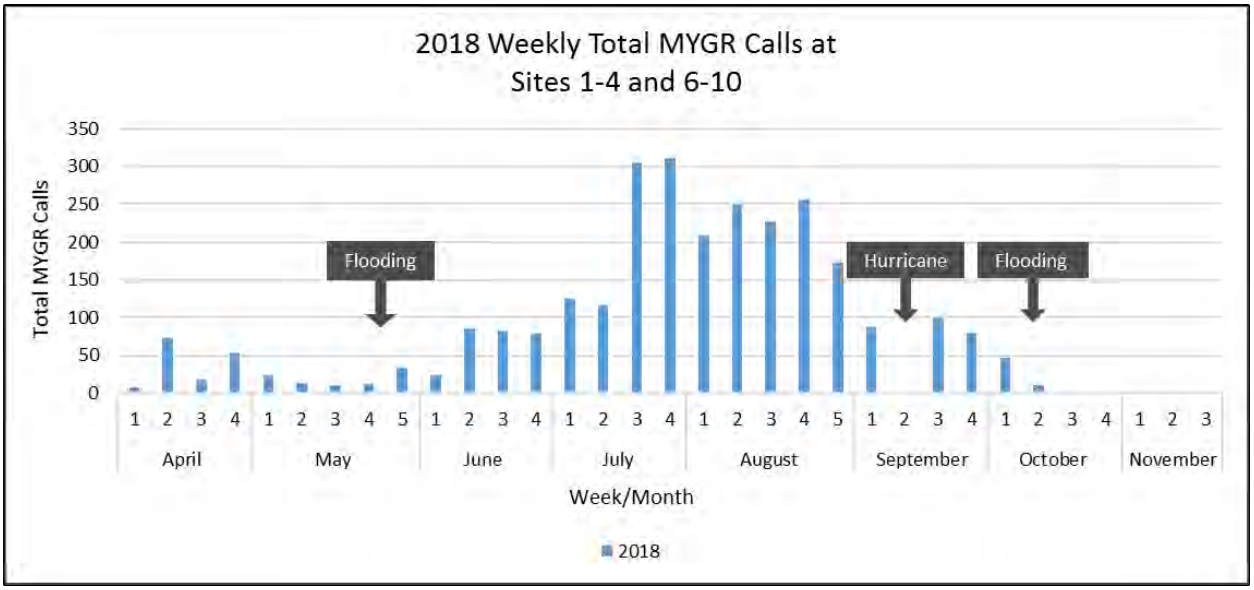
Chart 3, below, details the total number of MYGR calls per week specifically at Site 5, the MYGR culvert roost. Detector malfunctions and extreme weather events are displayed to explain gaps in the data. There is a general trend of increasing activity throughout the season. There is a drop in calls around the beginning of August simultaneous with the detector malfunctioning.

Chart 3



Removing the call data for Site 5, where the MYGR culvert roost is located, potentially gives a better representation of what occurred at the more traditional detector locations, not associated with known MYGR roosts, and more likely to be representative of activity at foraging and commuting locations. Chart 4, below, shows the weekly total number of MYGR calls at only Sites 1-4 and Sites 6-10. MYGR activity peaks the last two weeks of July and steadily declines through the end of the 2018 season. After the first week in October, the number of MYGR calls drops dramatically as the last of the MYGR leave the area and move toward their winter roosts.

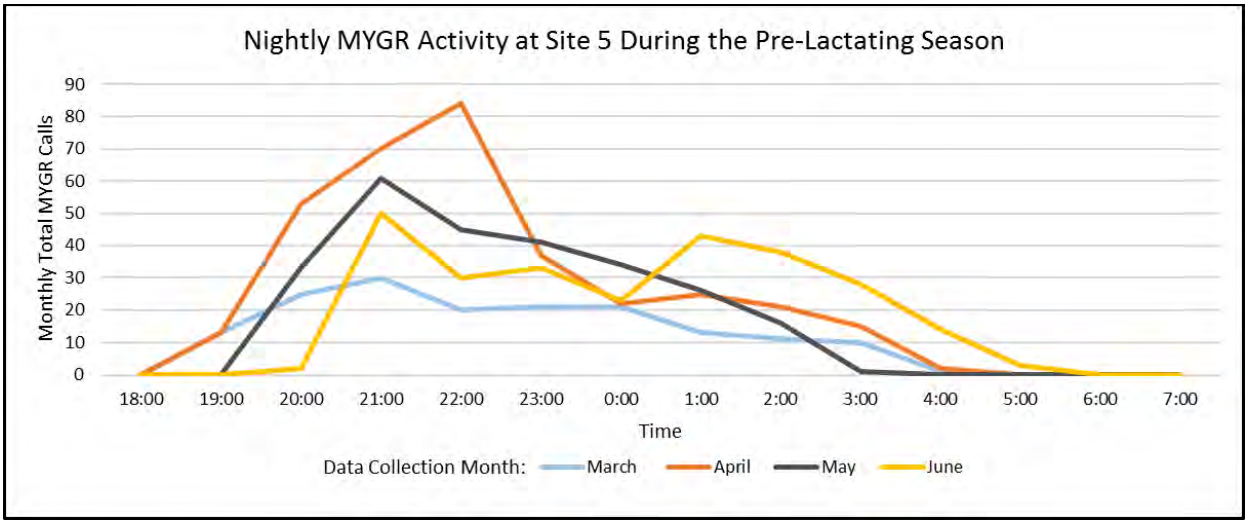
Chart 4



4.2 Nightly Activity at the Culvert Roost

BCID creates an output file that indicates the number of calls, per species, per hour for each week of data collection. The number of calls per week were summed to provide the total number of MYGR calls per hour for each month in each of the three reproductive periods throughout the summer. The following three charts provide a visual representation of seasonal MYGR activity at Site 5, the culvert roost, based on traditional phases of MYGR reproduction. Total number of MYGR calls were analyzed. Chart 5 shows activity during the pre-lactating period (when females are pregnant; typically through the third week of June), Chart 6 shows activity during the lactating period (when females are nursing pups; typically between the last week of June and the third week of July), and Chart 7 shows activity during the post-lactating period (when pups are volant and feeding on their own; typically beginning the last week of July).

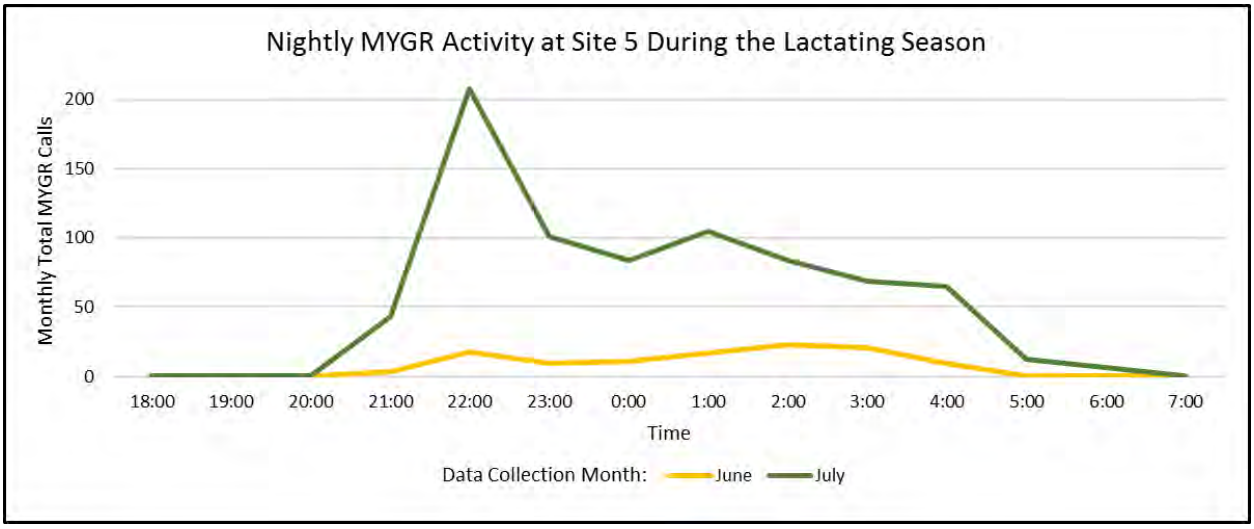
Chart 5



Based on the results of this analysis, it appears that, during the pre-lactating season, MYGR activity peaks after sunset between 21:00 and 22:00. Activity then decreases as the night

progresses. The total number of MYGR calls per hour for each of the pre-lactating season months is much lower compared to the total number of MYGR calls per hour in the lactating and post-lactating time periods.

Chart 6



The lactating season, the shortest of the three time periods, occurs only in June and July. The month of June had far fewer calls than July, making it difficult to see a significant trend. It does seem that there is a peak around 22:00 and then again at 02:00. The data from July shows a peak in activity at 22:00 before activity declines as the night progresses.

Chart 7

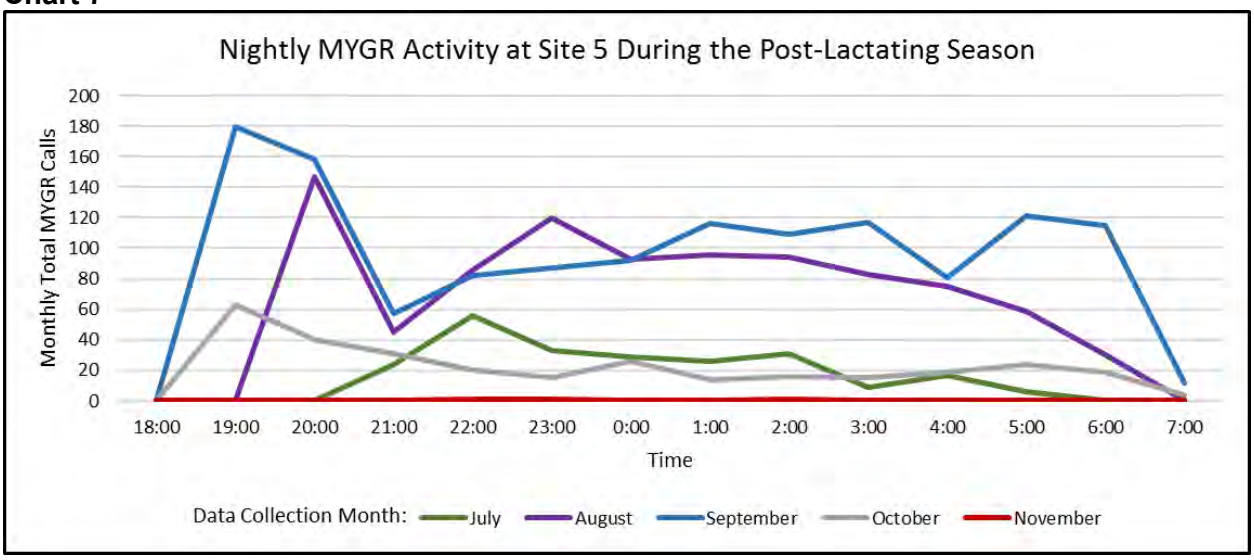
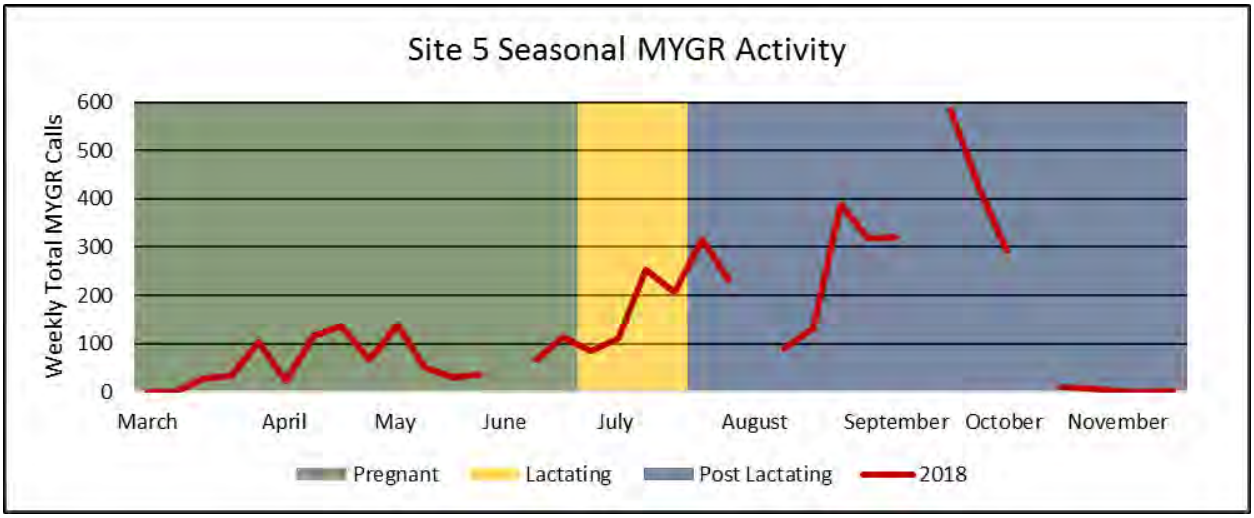


Chart 7, above, shows the activity throughout the night once pups became volant. There is high activity between 19:00 and 20:00, which is around time of sunset. It is important to note that the activity in the post-lactating season differs from the activity in the pre-lactating and lactating seasons. The activity in the post-lactating season does not decrease as the night progresses as it does in the pre-lactating and lactating seasons. Instead, activity stays relatively constant until 05:00 and 06:00 before dropping off, generally around sunrise.

Chart 8, below, shows the relationship between number of MYGR calls recorded and the main time periods. There is activity while gray bats are pregnant, but the number of MYGR calls starts to increase while females are lactating. There is a fall in recorded calls after pups become volant, but the number of calls increases to a maximum of 584 MYGR calls.

Chart 8

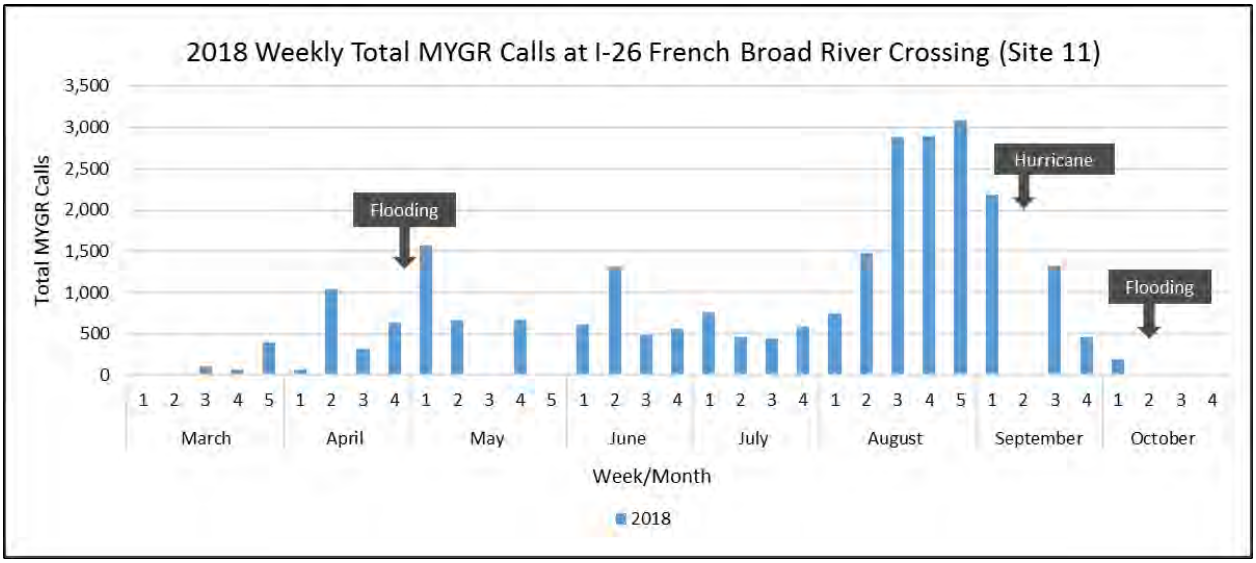


4.3 Comparative Data from Site 11

As part of the effects analysis associated with the widening of I-26 (NCDOT STIP Nos. I-4400/I*4700), an acoustic detector was placed at the I-26 crossing of the French Broad River (approximately 3 miles south of the I-40/I-240 interchange). A large amount of MYGR activity was documented at this location (Site 11) in 2017, and USFWS requested that additional monitoring continue at this location during 2018. The detector at Site 11 recorded an exponentially higher number of MYGR calls than any of the sites in the I-2513 study area. Site specific information is located on Site 11's acoustic survey data form in Appendix D. Information regarding the total number of MYGR calls recorded in 2017 and 2018 can be found in Table 2, Appendix B.

Chart 9, below, shows the total number of MYGR calls identified by BCID at Site 11 by week. Unlike sites 1-10, which had a significant increase in total MYGR calls during the last two weeks in July, peak MYGR activity at Site 11 occurred a few weeks later in mid to late August. This peak is later than the traditional time when pups become volant, and may be related to insect activity specific to the location. Unlike sites within the I-2513 study area, activity at Site 11 started to decrease at the beginning of September.

Chart 9



4.4 Summary

After analyzing the data, it is clear that the number of calls recorded at each site varies greatly. Site 5 produced the highest number of MYGR calls, as expected. The sites with the next highest number of calls, Sites 1, 2, and 10 were all located along the French Broad River. Not all sites along the river experienced the same level of activity. Site 3, located downstream from Site 10, recorded the second lowest number of MYGR calls out of all the sites.

Although there were slight differences, the overall trends in seasonal activity coincided with one another. The height of bat activity generally occurred from the end of July, when pups became volant, through the end of August. In September bat activity begins to decline as MYGR leave the area for their winter roosts, and few bats remain on the landscape after the beginning of October.

Looking more closely at nightly data, specifically at Site 5 during the post-lactating period, there is no specific time of night when MYGR activity slows down. During the pre-lactating and lactating periods, there is a clear trend in activity. However, the total number of calls during these two periods are lower than the number of calls during the post-lactating period.

MYGR calls were first recorded at Site 5 the third week of March and were recorded throughout the season until the first week of November. At Sites 1-4 and Sites 6-10, MYGR calls were recorded the first week of April when the detectors were deployed.

Call data from Site 11 reflects a significantly higher amount of MYGR activity than at any of the sites within the I-2513 study area. However, general trends of activity at Site 11 mirror those seen at Sites 1-10.

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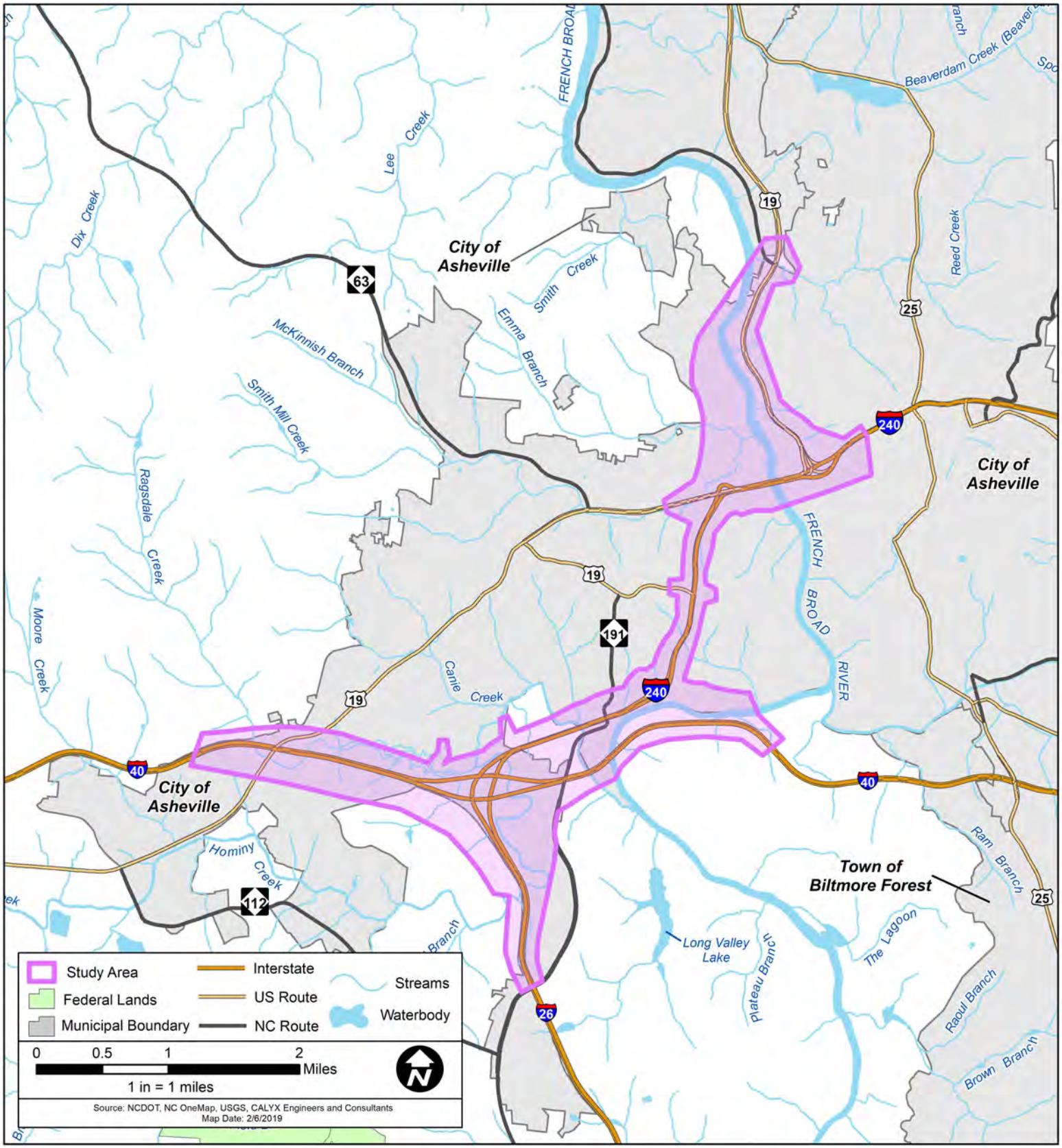
United States Fish and Wildlife Service (USFWS). 2019. Endangered and Threatened Species and Species of Concern by County for North Carolina http://www.fws.gov/raleigh/species/cntylist/nc_counties.html (Accessed February 20, 2019)

Appendix A

Figures



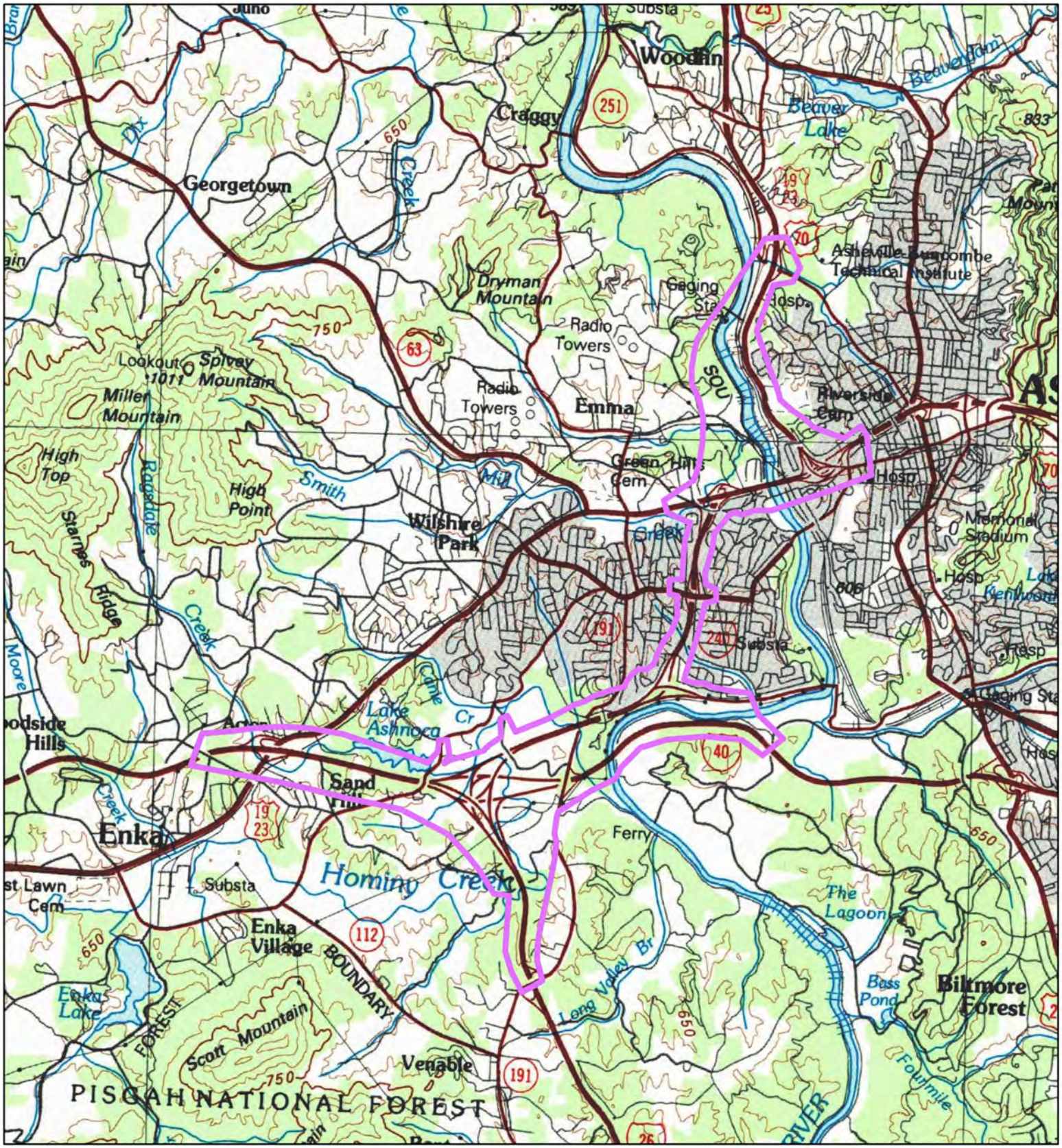
NORTH CAROLINA
DEPARTMENT OF TRANSPORTATION

I-26 Asheville Connector

TIP Project I-2513

Buncombe County, NC

Figure 1 - Project Vicinity



Legend

Study Area

NORTH CAROLINA
DEPARTMENT OF TRANSPORTATION

0 0.5 1 2 Miles

1 in = 1 mile

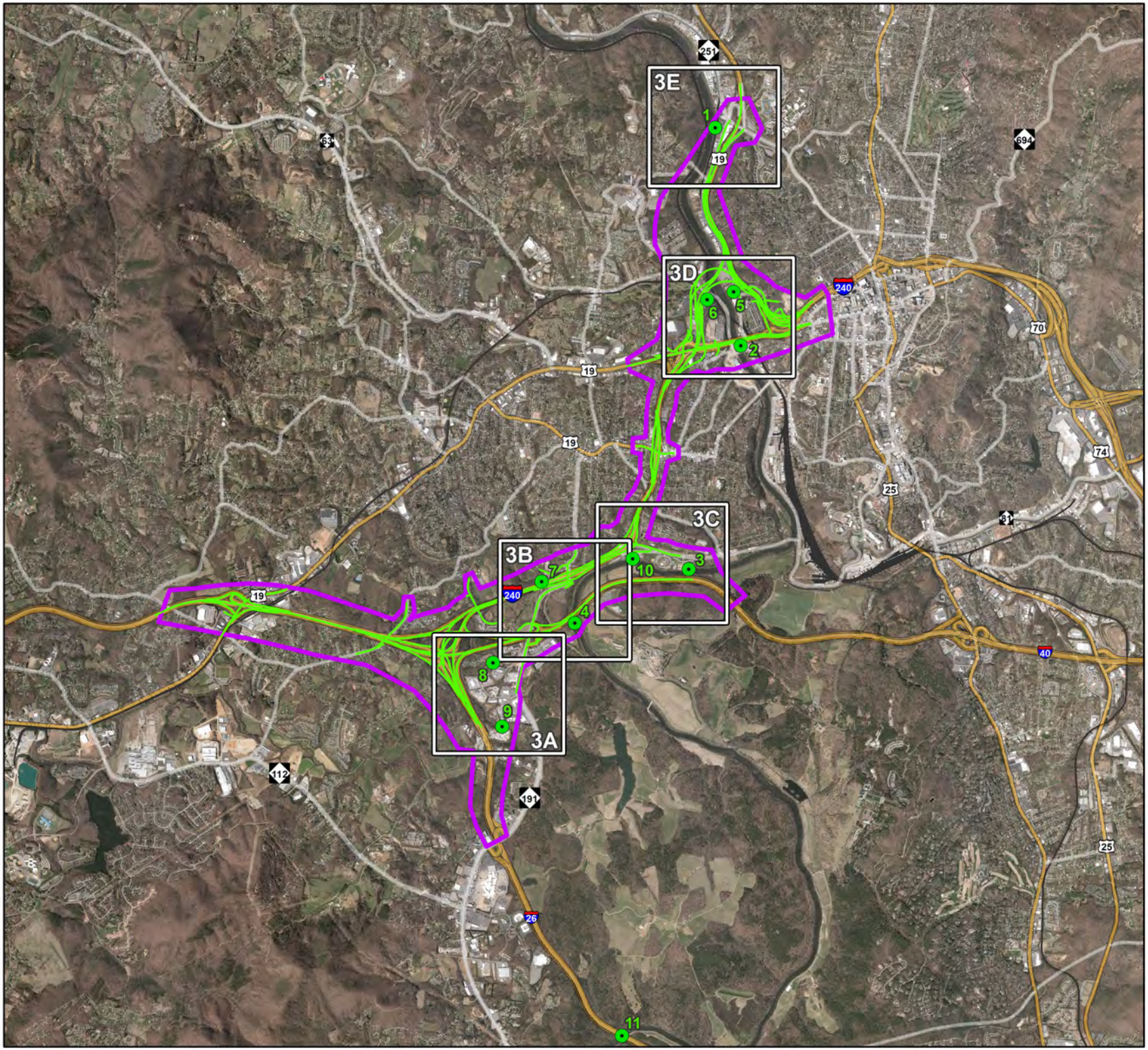
I-26 Asheville Connector

TIP Project I-2513

Buncombe County, NC

Figure 2 - Landscape Position

Source: NC OneMap, CALYX Engineers and Consultants
Map Date: 2/25/2019



Legend

- Map Tile
- Study Area
- Detector Locations
- Detailed Study Alternative

Figure 3

Acoustic Detector Locations Overview

I-26 Asheville Connector

TIP Project I-2513

Buncombe County, NC

Map Date: 3/4/2019

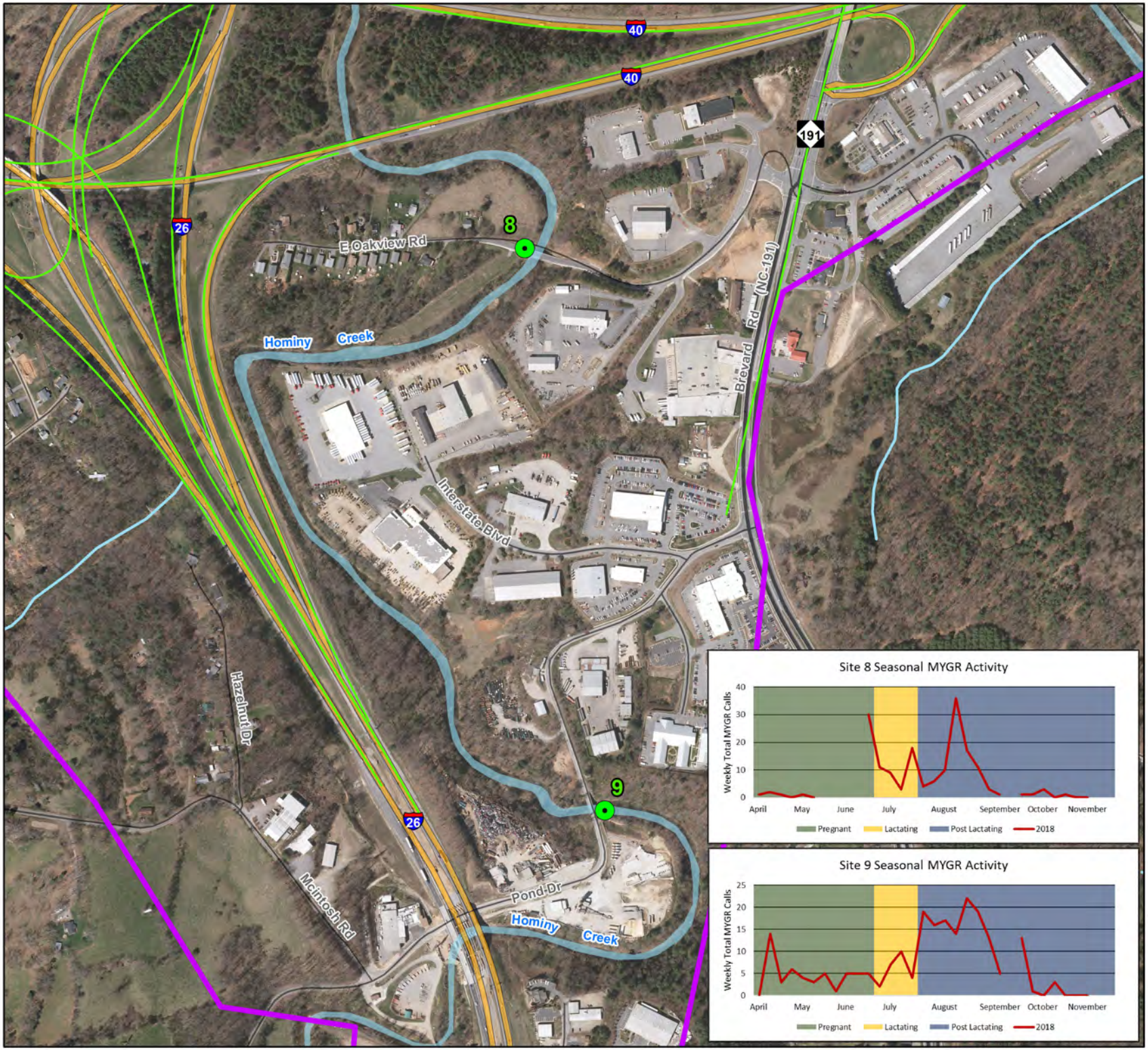
0 0.5 1 Miles

1 inch = 1 mile

This Exhibit is for planning purposes only and information shown hereon does not meet The Standards of Practice for Land Surveying in North Carolina (21 NCAC 56.1600). The Exhibit was compiled from available information obtained from the sources listed below. Streams and Wetlands: All features located in the field were recorded using a mapping grade Trimble GeoXT

Sources: NCDEQ, NCDOT, Calyx Engineers and Consultants

Aerial Photography: NC OneMap



Legend

- Study Area
- Detector Locations
- Detailed Study Alternative
- NCDEQ 24K Stream
- NCDEQ 24K Waterbody

Figure 3A

Acoustic Detector Locations

I-26 Asheville Connector

TIP Project I-2513

Buncombe County, NC

Map Date: 2/26/2019

0 300 600 Feet

1 inch = 600 feet

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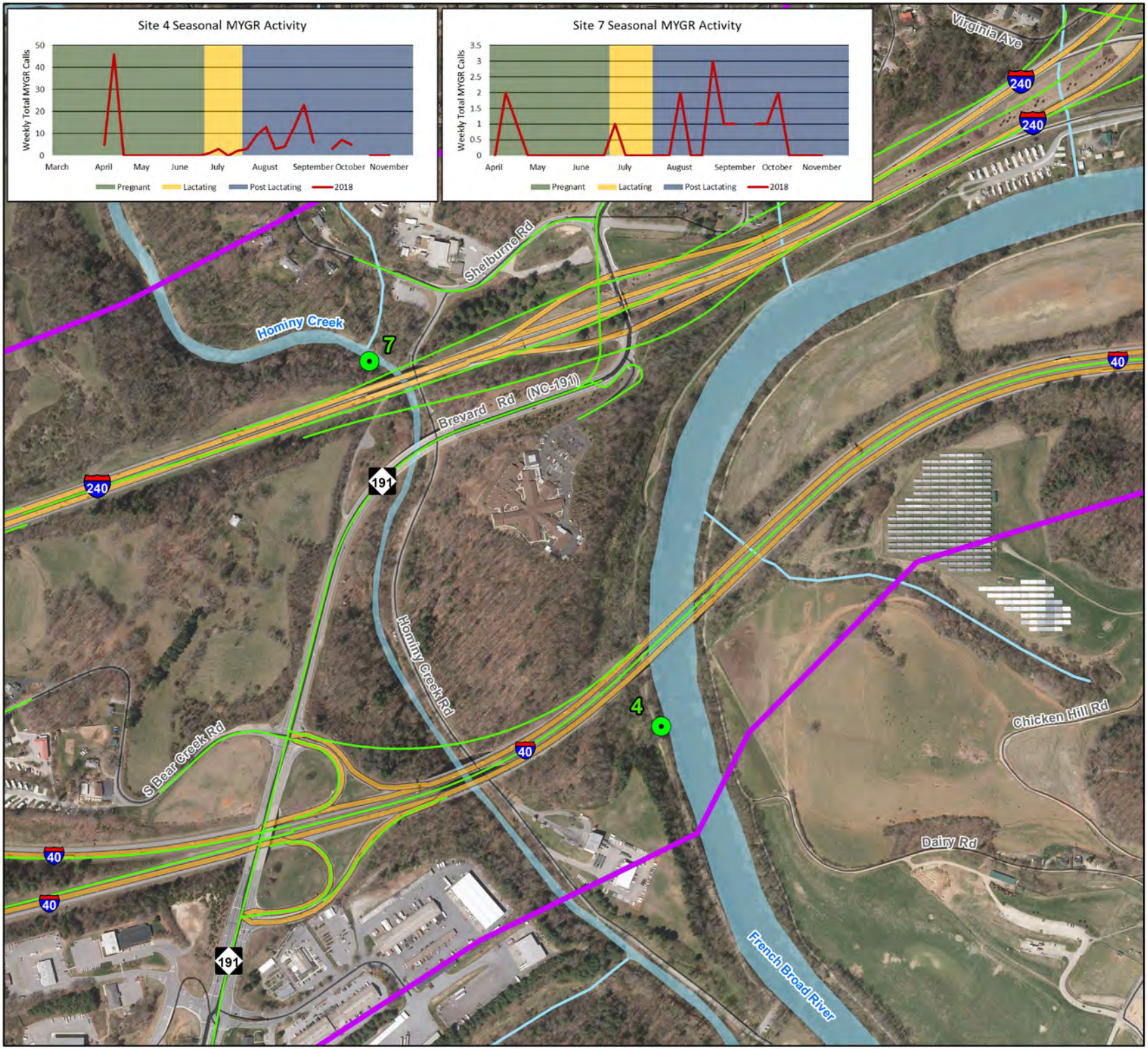
Sources: NCDEQ, NCDOT, Calyx Engineers and Consultants

Aerial Photography: NC OneMap



Legend

- Study Area
- Detector Locations
- Detailed Study Alternative
- NCDEQ 24K Stream
- NCDEQ 24K Waterbody

Figure 3B

Acoustic Detector Locations

I-26 Asheville Connector

TIP Project I-2513

Buncombe County, NC

Map Date: 2/26/2019

0 300 600 Feet

1 inch = 600 feet

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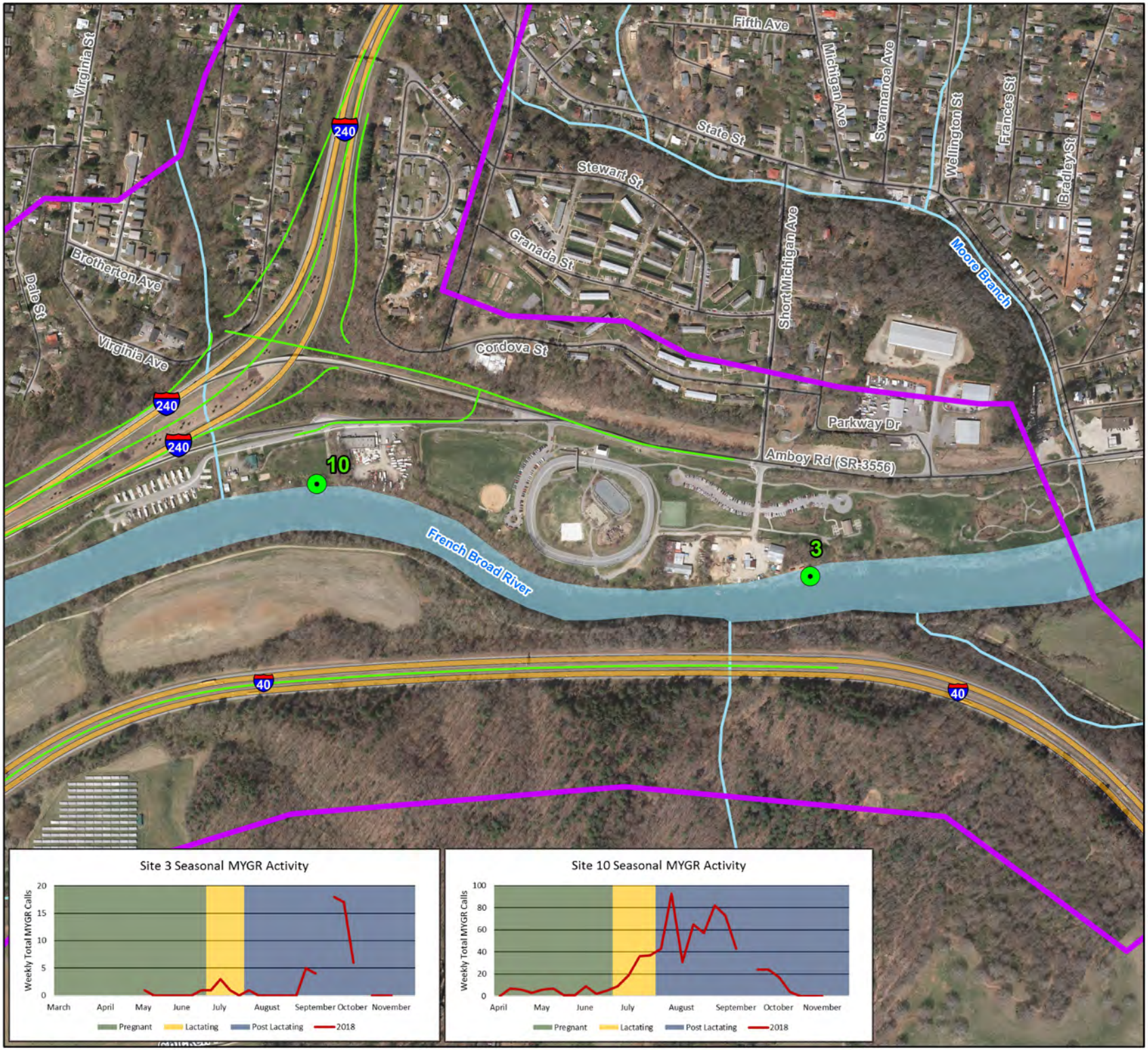
Sources: NCDEQ, NCDOT, Calyx Engineers and Consultants

Aerial Photography: NC OneMap



Legend

- Study Area
- Detector Locations
- Detailed Study Alternative
- NCDEQ 24K Stream
- NCDEQ 24K Waterbody

Figure 3C

Acoustic Detector Locations

I-26 Asheville Connector

TIP Project I-2513

Buncombe County, NC

Map Date: 2/26/2019

0 300 600 Feet

1 inch = 600 feet

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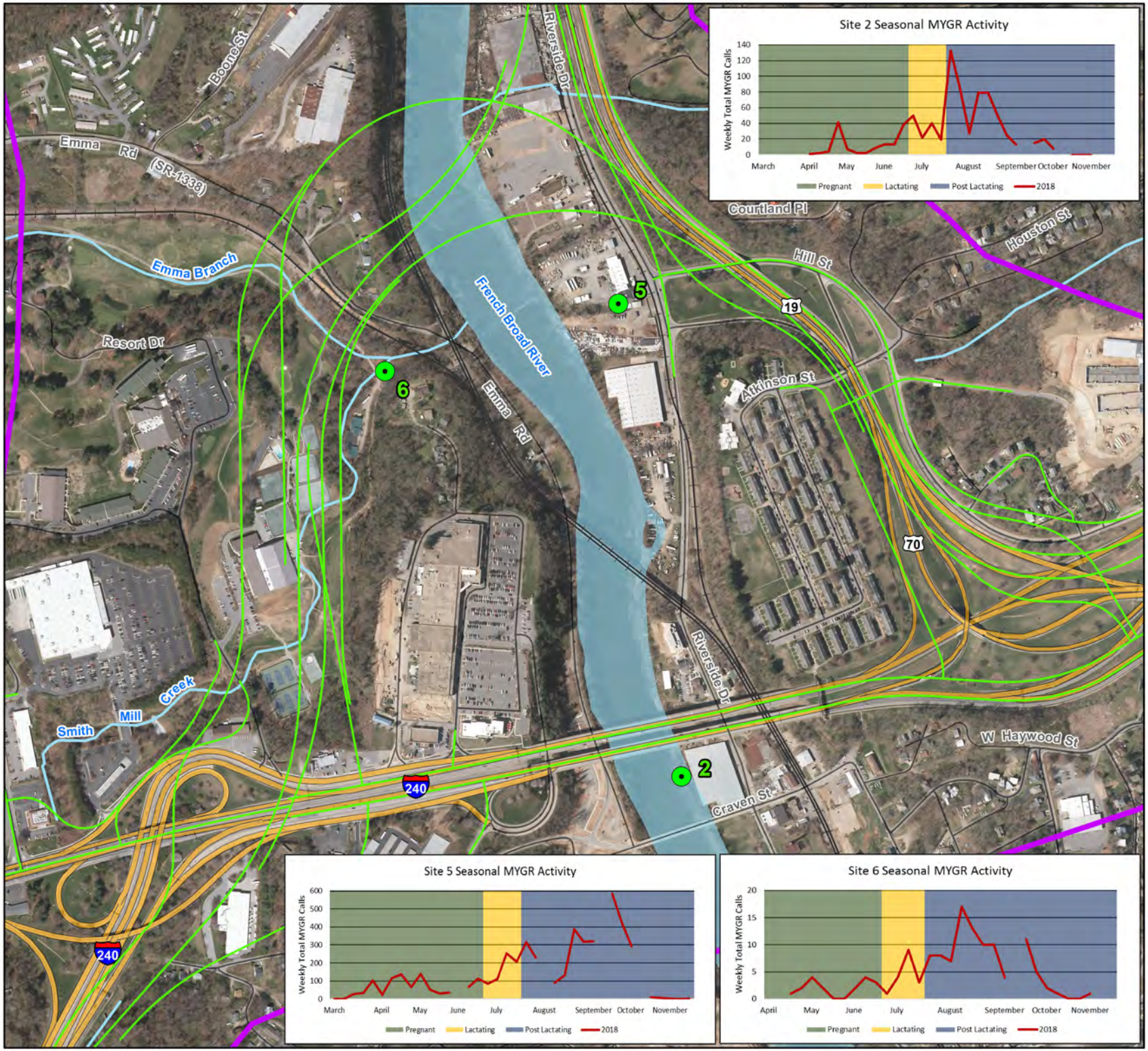
Sources: NCDEQ, NCDOT, Calyx Engineers and Consultants

Aerial Photography: NC OneMap



Legend

- Study Area
- Detector Locations
- Detailed Study Alternative
- NCDEQ 24K Stream
- NCDEQ 24K Waterbody

Figure 3D

Acoustic Detector Locations

I-26 Asheville Connector

TIP Project I-2513

Buncombe County, NC

Map Date: 2/26/2019

N

0 300 600

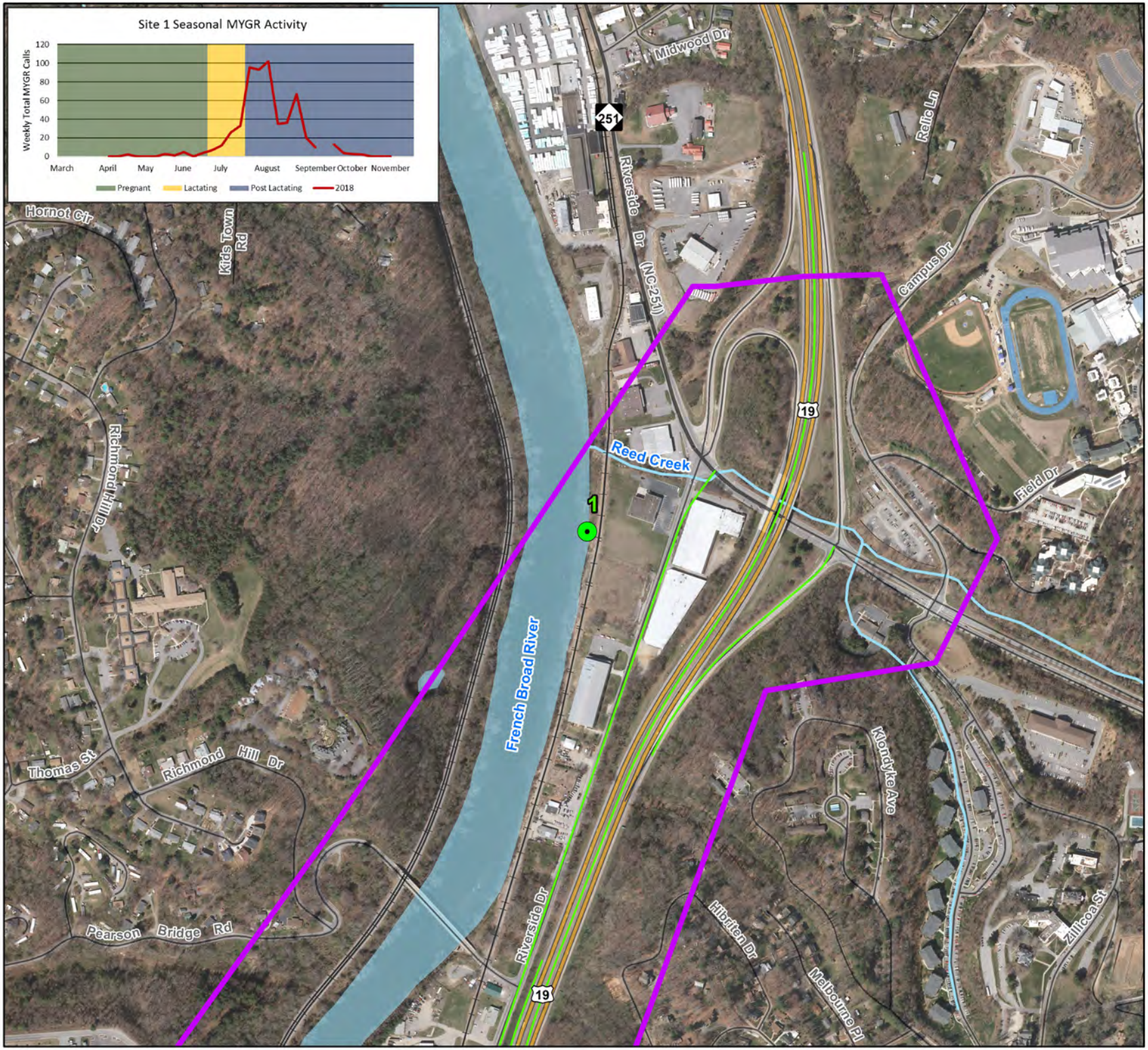
Feet

1 inch = 600 feet

This Exhibit is for planning purposes only and information shown hereon does not meet The Standards of Practice for Land Surveying in North Carolina (21 NCAC 56.1600). The Exhibit was compiled from available information obtained from the sources listed below. Streams and Wetlands: All features located in the field were recorded using a mapping grade Trimble GeoXT

Sources: NCDEQ, NCDOT, Calyx Engineers and Consultants

Aerial Photography: NC OneMap



Legend

- Study Area
- Detector Locations
- Detailed Study Alternative
- NCDEQ 24K Stream
- NCDEQ 24K Waterbody

Figure 3E

Acoustic Detector Locations

I-26 Asheville Connector

TIP Project I-2513

Buncombe County, NC

Map Date: 2/26/2019

N

0 300 600

Feet

1 inch = 600 feet

This Exhibit is for planning purposes only and information shown hereon does not meet The Standards of Practice for Land Surveying in North Carolina (21 NCAC 56.1600). The Exhibit was compiled from available information obtained from the sources listed below. Streams and Wetlands: All features located in the field were recorded using a mapping grade Trimble GeoXT

Sources: NCDEQ, NCDOT, Calyx Engineers and Consultants

Aerial Photography: NC OneMap

Appendix B

Tables

Table 2: 2017 & 2018 Deployment Schedule & Results

Detector Site #	Site Name	Associated Waterbody	2017				2018			
			Date Deployed	Approx. # Weeks Deployed*	Total # Bat Calls*	Total # MYGR Calls*	Date Deployed	Approx. # Weeks Deployed*	Total # Bat Calls*	Total # MYGR Calls*
1	Grainger	French Broad River	20170727	7 Weeks	5,734	273	20180405	30 Weeks	20,020	573
2	Smoky Park Bridge	French Broad River	20170727	7 Weeks	8,001	545	20180405	29 Weeks	18,134	799
3	Carrier Park	French Broad River	20170727	4 Weeks	5,342	490	20180503	25 Weeks	8,194	58
4	I-40 and Greenway	French Broad River	20170727	7 Weeks	7,601	270	20180405	29 Weeks	3,877	146
5	Culvert	UT French Broad River	20171009	5 Weeks	1,082	117	20180301	34 Weeks	14,804	4,711
6	Smith Mill Creek	Smith Mill Creek	N/A - Sites not established until 2018				20180419	28 Weeks	13,835	132
7	Hominy Creek and I-240	Hominy Creek					20180405	30 Weeks	8,574	15
8	Oakview Road	Hominy Creek					20180405	26 Weeks	3,925	26
9	Pond Road	Hominy Creek					20180405	28 Weeks	6,519	206
10	Outdoor Center	French Broad River					20180405	30 Weeks	19,952	704
11	I-26 Bridge	French Broad River	20170518	22 Weeks	59,121	17,767	20180301	32 Weeks	51,497	26,009

*Excluding weeks with less than 6 full nights of data (due to detector malfunctions and/or severe flooding)

Appendix C

Qualifications of Key Personnel

QUALIFICATIONS OF KEY PERSONNEL

Investigator:	Heather Wallace
Education:	B.S. Ecology, 1997
Experience:	Environmental Group Manager, CALYX, Inc., 2018-Present Environmental Project Manager, CALYX, Inc., 2015-2018 Environmental Program Consultant, NCDOT, 2013-2015 Environmental Senior Specialist, NCDOT, 2007-2013 Environmental Scientist, H.W. Lochner, 2003-2007 Biologist, Earth Tech, 2000-2003
Responsibilities:	Field investigation, detector deployment, data management, document preparation,
Other:	USFWS Endangered & Threatened Sp. Recovery Permit Number TE81430B-0 (northern long-eared bat, gray bat, Indiana bat, Virginia big-eared bat)

Investigator:	Dominique DiLandro
Education:	B.S., Fisheries, Wildlife, and Conservation Biology, 2017
Experience:	Jr. Environmental Scientist, CALYX, Inc., 2018-Present Environmental Technician, CALYX, Inc., 2017-2018
Responsibilities:	Field investigation, detector deployment, data management, document preparation

Investigator:	Kathryn Cunningham
Education:	B.S., Fisheries and Wildlife, concentration in Wildlife, 2006
Experience:	Senior Biologist, CALYX, Inc., 2017-Present Wildlife Biologist, Jackson Group, 2013-2017 Research Assistant, West Virginia University, 2008-2009
Responsibilities:	Field investigation, detector deployment
Other:	USFWS Endangered & Threatened Sp. Recovery Permit Number TE48049B-1 (northern long-eared bat, Indiana bat)

Investigator:	Mack Des Champs
Education:	B.S., Zoology, 2015
Experience:	Jr. Environmental Scientist, CALYX, Inc., 2017-Present Environmental Technician, CALYX, Inc., 2017-2017
Responsibilities:	Detector deployment, data management

Investigator:	Blake Ellett
Education:	M.N.R. (Masters of Natural Resources), 2016 B.S., Natural Resource and Environmental Management, 2012
Experience:	Environmental Scientist, CALYX, Inc., 2012-Present
Responsibilities:	Detector deployment, data management

Appendix D

Acoustic Survey Data Forms

Acoustic Survey Data Form

Project Name:	I-2513 Asheville Connector	**Site Number:**	1
Project #:	2015066.15	**Site Name:**	Grainger
State:	North Carolina	**Latitude:**	35.614356
County:	Buncombe	**Longitude:**	-82.576342
Nearest town:	Woodfin	**Elevation (m):**	596.494

Map:

Biologist selecting site: Heather Wallace

Habitat/Site description:

Detector located between RR tracks and river. Quiet, low human activity. Mature riparian vegetation nearby.

Acoustic Survey Data Form

Detector Make/Model/Serial:	Anabat Express
Firmware:	V5506L
FS or ZC:	Zero cross
Mic type:	omnidirectional
Weatherproofing	none
Horizontal Orientation:	300 degrees
Vertical Orientation:	0 degrees
Test Func Method:	rub fingers
Mic height (m):	3.658
Mic distance from vegetation (m):	4.5
Clutter:	low
Traffic noise:	low

Site Photo:

Detector settings:

night mode; data div = 16 ; sensitivity = 115.

Results: Site 1

Week		No. of Nights	Detector Serial #	Biologist Deployed	Time		Total # of Bat Calls	# of MYGR Calls
Start Date	End Date				Start Time	End Time		
Week 1 (April)		7	593	HW	19:30	7:35	502	0
20180405	20180411							
Week 2 (April)		7	593	HW	19:30	7:35	4048	0
20180412	20180418							
Week 3 (April)		7	593	HW	19:30	7:35	1355	2
20180419	20180425							
Week 4 (April)		7	593	HW	19:30	7:35	1457	0
20180426	20180502							
Week 1 (May)		7	593	HW	19:50	7:00	3046	0
20180503	20180509							
Week 2 (May)		7	593	HW	19:50	7:00	1052	0
20180510	20180516							
Week 3 (May)		7	593	HW	19:50	7:00	463	3
20180517	20180523							
Week 4 (May)*		6	593	HW	19:50	7:00	601	1
20180524	20180530							
Week 5 (May)*		6	593	HW	19:50	7:00	398	5
20180531	20180606							
Week 1 (June)**		7	593	HW	20:10	6:45	530	0
20180607	20180613							
Week 2 (June)		7	593	HW	20:10	6:45	875	4
20180614	20180620							
Week 3 (June)		7	593	HW	20:10	6:45	730	7
20180621	20180627							

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Acoustic Survey Data Form

Week		No. of Nights	Detector Serial #	Biologist Deployed	Time		Total # of Bat Calls	# of MYGR Calls
Start Date	End Date				Start Time	End Time		
Week 4 (June)		7	593	HW	20:10	6:45	260	12
20180628	20180704							
Week 1 (July)		7	593	HW	20:20	6:50	473	26
20180705	20180711							
Week 2 (July)		7	593	HW	20:20	6:50	238	33
20180712	20180718							
Week 3 (July)		7	593	HW	20:20	6:50	499	95
20180719	20180725							
Week 4 (July)		7	593	HW	20:20	6:50	630	93
20180726	20180801							
Week 1 (August)		7	593	HW	20:05	7:10	564	102
20180802	20180808							
Week 2 (August)		7	593	HW	20:05	7:10	414	35
20180809	20180815							
Week 3 (August)		7	593	HW	20:05	7:10	274	36
20180816	20180822							
Week 4 (August)		7	593	HW	20:05	7:10	468	67
20180823	20180829							
Week 5 (August)		7	593	HW	20:05	7:10	160	20
20180830	20180905							
Week 1 (September)*		6	593	HW	19:20	7:35	109	10
20180906	20180912							
Week 2 (September)*		N/A	593	HW	19:20	7:35	N/A	N/A
20180913	20180919							
Week 3 (September)		7	593	HW	19:20	7:35	466	13
20180920	20180926							
Week 4 (September)		7	593	HW	19:20	7:35	133	4
20180927	20181003							
Week 1 (October)		7	593	HW	18:40	8:00	153	3
20181004	20181010							
Week 2 (October)		7	593	HW	18:40	8:00	46	2
20181011	20181017							
Week 3 (October)		7	593	HW	18:40	8:00	12	0
20181018	20181024							
Week 4 (October)		7	593	HW	18:40	8:00	37	0
20181025	20181031							
Week 1 (November)		7	593	HW	18:40	8:00	27	0
20181101	20181107							
TOTALS		207	---	---	---	---	20020	573

Comments:
*Indicates missing data due to flooding/hurricane
**Indicates data was rearranged due to flooding
(Data was not used if there was less than 6 full nights of data)

Acoustic Survey Data Form

Project Name:	I-2513 Asheville Connector	**Site Number:**	2
Project #:	2015066.15	**Site Name:**	Smoky Park Bridge
State:	North Carolina	**Latitude:**	35.590214
County:	Buncombe	**Longitude:**	-82.571736
Nearest town:	Asheville	**Elevation (m):**	606.552

Map:

Biologist selecting site: Heather Wallace

Habitat/Site description:

Slightly narrower opening in vegetation than is optimal. Good riffle downstream.

Acoustic Survey Data Form

Detector Make/Model/Serial:	Anabat Express
Firmware:	V5506L
FS or ZC:	Zero cross
Mic type:	omnidirectional
Weatherproofing	none
Horizontal Orientation:	245 degrees
Vertical Orientation:	0 degrees
Test Func Method:	rub fingers
Mic height (m):	3.658
Mic distance from vegetation (m):	2.5
Clutter:	low
Traffic noise:	moderate

Site Photo:

Detector settings:

night mode; data div = 16; sensitivity = 115.

Results: Site 2

Week		No. of Nights	Detector Serial #	Biologist Deployed	Time		Total # of Bat Calls	# of MYGR Calls
Start Date	End Date				Start Time	End Time		
Week 1 (April)		7	869	HW	19:30	7:35	186	1
20180405	20180411							
Week 2 (April)		7	869	HW	19:30	7:35	641	2
20180412	20180418							
Week 3 (April)		7	869	HW	19:30	7:35	623	4
20180419	20180425							
Week 4 (April)		7	869	HW	19:30	7:35	717	41
20180426	20180502							
Week 1 (May)		7	869	HW	19:50	7:00	900	7
20180503	20180509							
Week 2 (May)		7	869	HW	19:50	7:00	669	2
20180510	20180516							
Week 3 (May)		7	869	HW	19:50	7:00	128	2
20180517	20180523							
Week 4 (May)		7	869	HW	19:50	7:00	206	9
20180524	20180530							
Week 5 (May)**		7	869	HW	19:50	7:00	203	13
20180531	20180606							
Week 1 (June)**		7	869	HW	20:10	6:45	252	13
20180607	20180613							
Week 2 (June)		7	869	HW	20:10	6:45	1716	38
20180614	20180620							
Week 3 (June)		7	869	HW	20:10	6:45	1590	50
20180621	20180627							

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Acoustic Survey Data Form

Week		No. of Nights	Detector Serial #	Biologist Deployed	Time		Total # of Bat Calls	# of MYGR Calls
Start Date	End Date				Start Time	End Time		
Week 4 (June)		7	869	HW	20:10	6:45	996	22
20180628	20180704							
Week 1 (July)		7	869	HW	20:20	6:50	1101	40
20180705	20180711							
Week 2 (July)		7	869	HW	20:20	6:50	375	19
20180712	20180718							
Week 3 (July)		7	869	HW	20:20	6:50	1134	133
20180719	20180725							
Week 4 (July)		7	869	HW	20:20	6:50	1010	86
20180726	20180801							
Week 1 (August)		7	869	HW	20:05	7:10	557	27
20180802	20180808							
Week 2 (August)		7	869	HW	20:05	7:10	883	79
20180809	20180815							
Week 3 (August)		7	869	HW	20:05	7:10	799	79
20180816	20180822							
Week 4 (August)		7	869	HW	20:05	7:10	796	51
20180823	20180829							
Week 5 (August)		7	869	HW	20:05	7:10	799	25
20180830	20180905							
Week 1 (September)*		6	869	HW	19:20	7:35	429	13
20180906	20180912							
Week 2 (September)*		N/A	869	HW	19:20	7:35	N/A	N/A
20180913	20180919							
Week 3 (September)		7	869	HW	19:20	7:35	520	15
20180920	20180926							
Week 4 (September)		7	869	HW	19:20	7:35	589	20
20180927	20181003							
Week 1 (October)		7	869	HW	18:40	8:00	270	8
20181004	20181010							
Week 2 (October)*		N/A	869	HW	18:40	8:00	N/A	N/A
20181011	20181017							
Week 3 (October)		7	869	HW	18:40	8:00	6	0
20181018	20181024							
Week 4 (October)		7	869	HW	18:40	8:00	26	0
20181025	20181031							
Week 1 (November)		7	869	HW	18:40	8:00	13	0
20181101	20181107							
TOTALS		**202**	---	---	---	---	**18134**	**799**

Comments:
*Indicates missing data due to flooding/hurricane
**Indicates data was rearranged due to flooding
(Data was not used if there was less than 6 full nights of data)

Acoustic Survey Data Form

Project Name:	I-2513 Asheville Connector	**Site Number:**	3
Project #:	2015066.15	**Site Name:**	Carrier Park
State:	North Carolina	**Latitude:**	35.565097
County:	Buncombe	**Longitude:**	-82.577786
Nearest town:	Asheville	**Elevation (m):**	603.809

Map:

Biologist selecting site: Heather Wallace

Habitat/Site description:

Quiet location with low human activity. Flatwater nearby.

Acoustic Survey Data Form

Detector Make/Model/Serial:	Anabat Swift/Express
Firmware:	V5506L (Express)
FS or ZC:	Zero cross
Mic type:	omnidirectional
Weatherproofing	none
Horizontal Orientation:	220 degrees
Vertical Orientation:	0 degrees
Test Func Method:	rub fingers
Mic height (m):	2.743
Mic distance from vegetation (m):	2.0
Clutter:	low
Traffic noise:	low

Site Photo:

Detector settings:

night mode; data div = 16; sensitivity = 115.

Results: Site 3

Week		No. of Nights	Detector Serial #	Biologist Deployed	Time		Total # of Bat Calls	# of MYGR Calls
Start Date	End Date				Start Time	End Time		
Week 1 (April)***		N/A	960	HW	19:30	7:35	N/A	N/A
20180405	20180411							
Week 2 (April)***		N/A	960	HW	19:30	7:35	N/A	N/A
20180412	20180418							
Week 3 (April)***		N/A	905	HW	19:30	7:35	N/A	N/A
20180419	20180425							
Week 4 (April)***		N/A	905	HW	19:30	7:35	N/A	N/A
20180426	20180502							
Week 1 (May)		7	352	HW	19:50	7:00	246	1
20180503	20180509							
Week 2 (May)		7	352	HW	19:50	7:00	181	0
20180510	20180516							
Week 3 (May)		7	352	HW	19:50	7:00	107	0
20180517	20180523							
Week 4 (May)		7	352	HW	19:50	7:00	59	0
20180524	20180530							
Week 5 (May)**		7	352	HW	19:50	7:00	179	0
20180531	20180606							
Week 1 (June)**		7	352	HW	20:10	6:45	208	0
20180607	20180613							
Week 2 (June)		7	905	HW	20:10	6:45	335	1
20180614	20180620							
Week 3 (June)		7	905	HW	20:10	6:45	183	1
20180621	20180627							

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Acoustic Survey Data Form

Week		No. of Nights	Detector Serial #	Biologist Deployed	Time		Total # of Bat Calls	# of MYGR Calls
Start Date	End Date				Start Time	End Time		
Week 4 (June)		7	905	HW	20:10	6:45	304	3
20180628	20180704							
Week 1 (July)		7	905	HW	20:20	6:50	277	1
20180705	20180711							
Week 2 (July)		7	905	HW	20:20	6:50	264	0
20180712	20180718							
Week 3 (July)		7	905	HW	20:20	6:50	119	1
20180719	20180725							
Week 4 (July)		7	905	HW	20:20	6:50	199	0
20180726	20180801							
Week 1 (August)		7	905	HW	20:05	7:10	196	0
20180802	20180808							
Week 2 (August)		7	905	HW	20:05	7:10	320	0
20180809	20180815							
Week 3 (August)		7	905	HW	20:05	7:10	599	0
20180816	20180822							
Week 4 (August)		7	905	HW	20:05	7:10	612	0
20180823	20180829							
Week 5 (August)		7	905	HW	20:05	7:10	1236	5
20180830	20180905							
Week 1 (September)*		6	905	HW	19:20	7:35	989	4
20180906	20180912							
Week 2 (September)*		N/A	905	HW	19:20	7:35	N/A	N/A
20180913	20180919							
Week 3 (September)		7	905	HW	19:20	7:35	764	18
20180920	20180926							
Week 4 (September)		7	905	HW	19:20	7:35	546	17
20180927	20181003							
Week 1 (October)		7	905	HW	18:40	8:00	161	6
20181004	20181010							
Week 2 (October)*		N/A	905	HW	18:40	8:00	N/A	N/A
20181011	20181017							
Week 3 (October)		7	905	HW	18:40	8:00	32	0
20181018	20181024							
Week 4 (October)		7	905	HW	18:40	8:00	71	0
20181025	20181031							
Week 1 (November)		7	905	HW	18:40	8:00	7	0
20181101	20181107							
TOTALS		**174**	**---**	**---**	**---**	**---**	**8194**	**58**

Comments:
*Indicates missing data due to flooding/hurricane
**Indicates data was rearranged due to flooding
***Indicates missing data due to detector malfunction.
(Data was not used if there was less than 6 full nights of data)

Acoustic Survey Data Form

Project Name:	I-2513 Asheville Connector	**Site Number:**	4
Project #:	2015066.15	**Site Name:**	I-40 and Greenway
State:	North Carolina	**Latitude:**	35.558631
County:	Buncombe	**Longitude:**	-82.593067
Nearest town:	Asheville	**Elevation (m):**	603.504

Map:

Biologist selecting site: Heather Wallace

Habitat/Site description:

Very open location along river. Adjacent to greenway.

Acoustic Survey Data Form

Detector Make/Model/Serial:	Anabat Express
Firmware:	V5506L
FS or ZC:	Zero cross
Mic type:	omnidirectional
Weatherproofing	none
Horizontal Orientation:	70 degrees
Vertical Orientation:	0 degrees
Test Func Method:	rub fingers
Mic height (m):	3.658
Mic distance from vegetation (m):	4.5
Clutter:	low
Traffic noise:	low

Site Photo:

Detector settings:

night mode; data div = 16; sensitivity = 115.

Results: Site 4

Week		No. of Nights	Detector Serial #	Biologist Deployed	Time		Total # of Bat Calls	# of MYGR Calls
Start Date	End Date				Start Time	End Time		
Week 1 (April)		7	622	HW	19:30	7:35	285	5
20180405	20180411							
Week 2 (April)		7	622	HW	19:30	7:35	1385	46
20180412	20180418							
Week 3 (April)		7	622	HW	19:30	7:35	423	0
20180419	20180425							
Week 4 (April)		7	622	HW	19:30	7:35	222	0
20180426	20180502							
Week 1 (May)		7	622	HW	19:50	7:00	65	0
20180503	20180509							
Week 2 (May)		7	622	HW	19:50	7:00	39	0
20180510	20180516							
Week 3 (May)		7	622	HW	19:50	7:00	22	0
20180517	20180523							
Week 4 (May)		7	622	HW	19:50	7:00	28	0
20180524	20180530							
Week 5 (May)**		7	622	HW	19:50	7:00	20	0
20180531	20180606							
Week 1 (June)**		7	622	HW	20:10	6:45	96	0
20180607	20180613							
Week 2 (June)		7	622	HW	20:10	6:45	498	0
20180614	20180620							
Week 3 (June)		7	622	HW	20:10	6:45	151	1
20180621	20180627							

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Acoustic Survey Data Form

Week		No. of Nights	Detector Serial #	Biologist Deployed	Time		Total # of Bat Calls	# of MYGR Calls
Start Date	End Date				Start Time	End Time		
Week 4 (June)		7	622	HW	20:10	6:45	75	3
20180628	20180704							
Week 1 (July)		7	622	HW	20:20	6:50	95	0
20180705	20180711							
Week 2 (July)		7	622	HW	20:20	6:50	63	2
20180712	20180718							
Week 3 (July)		7	622	HW	20:20	6:50	53	3
20180719	20180725							
Week 4 (July)		7	622	HW	20:20	6:50	93	9
20180726	20180801							
Week 1 (August)		7	622	HW	20:05	7:10	78	13
20180802	20180808							
Week 2 (August)		7	622	HW	20:05	7:10	34	3
20180809	20180815							
Week 3 (August)		7	622	HW	20:05	7:10	26	4
20180816	20180822							
Week 4 (August)		7	622	HW	20:05	7:10	40	13
20180823	20180829							
Week 5 (August)		7	622	HW	20:05	7:10	40	23
20180830	20180905							
Week 1 (September)*		6	622	HW	19:20	7:35	15	6
20180906	20180912							
Week 2 (September)*		N/A	622	HW	19:20	7:35	N/A	N/A
20180913	20180919							
Week 3 (September)		7	622	HW	19:20	7:35	8	3
20180920	20180926							
Week 4 (September)		7	622	HW	19:20	7:35	12	7
20180927	20181003							
Week 1 (October)		7	622	HW	18:40	8:00	9	5
20181004	20181010							
Week 2 (October)*		N/A	622	HW	18:40	8:00	N/A	N/A
20181011	20181017							
Week 3 (October)		7	622	HW	18:40	8:00	1	0
20181018	20181024							
Week 4 (October)		7	622	HW	18:40	8:00	1	0
20181025	20181031							
Week 1 (November)		7	622	HW	18:40	8:00	0	0
20181101	20181107							
TOTALS		**202**	---	---	---	---	**3877**	**146**

Comments:
*Indicates missing data due to flooding/hurricane
**Indicates data was rearranged due to flooding
(Data was not used if there was less than 6 full nights of data)

Acoustic Survey Data Form

Project Name:	I-2513 Asheville Connector	**Site Number:**	5
Project #:	2015066.15	**Site Name:**	Culvert
State:	North Carolina	**Latitude:**	35.596128
County:	Buncombe	**Longitude:**	-82.573072
Nearest town:	Asheville	**Elevation (m):**	599.237

Map:

Biologist selecting site: Heather Wallace

Habitat/Site description:

Not ideal location for acoustic recording due to heavy clutter and proximity to roost.

Acoustic Survey Data Form

Detector	
Make/Model/Serial:	Anabat Express
Firmware:	V5506L
FS or ZC:	Zero cross
Mic type:	omnidirectional
Weatherproofing	none
Horizontal Orientation:	71 degrees
Vertical Orientation:	0 degrees
Test Func Method:	rub fingers
Mic height (m):	3.658
Mic distance from vegetation (m):	2.0
Clutter:	moderate
Traffic noise:	moderate

Site Photo:

Detector settings:

night mode; data div = 16; sensitivity = 115.

Results: Site 5

Week		No. of Nights	Detector Serial #	Biologist Deployed	Time		Total # of Bat Calls	# of MYGR Calls
Start Date	End Date				Start Time	End Time		
Week 1 (March)		7	887	HW	19:30	7:35	3	0
20180301	20180307							
Week 2 (March)		7	887	HW	19:30	7:35	7	0
20180308	20180314							
Week 3 (March)		7	887	HW	19:30	7:35	162	29
20180315	20180321							
Week 4 (March)		7	887	HW	19:30	7:35	149	33
20180322	20180328							
Week 5 (March)		7	887	HW	19:30	7:35	482	103
20180329	20180404							
Week 1 (April)		7	887	HW	19:30	7:35	237	22
20180405	20180411							
Week 2 (April)		7	887	HW	19:30	7:35	590	117
20180412	20180418							
Week 3 (April)		7	887	HW	19:30	7:35	376	137
20180419	20180425							
Week 4 (April)		7	887	HW	19:30	7:35	166	66
20180426	20180502							
Week 1 (May)		7	887	HW	19:50	7:00	295	139
20180503	20180509							
Week 2 (May)		7	887	HW	19:50	7:00	122	52
20180510	20180516							
Week 3 (May)		7	887	HW	19:50	7:00	76	31
20180517	20180523							

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Acoustic Survey Data Form

Week		No. of Nights	Detector Serial #	Biologist Deployed	Time		Total # of Bat Calls	# of MYGR Calls
Start Date	End Date				Start Time	End Time		
Week 4 (May)*		6	887	HW	19:50	7:00	103	35
20180524	20180530							
Week 5 (May)*		N/A	887	HW	19:50	7:00	N/A	N/A
20180531	20180606							
Week 1 (June)**		7	887	HW	20:10	6:45	232	66
20180607	20180613							
Week 2 (June)		7	887	HW	20:10	6:45	253	114
20180614	20180620							
Week 3 (June)		7	887	HW	20:10	6:45	189	84
20180621	20180627							
Week 4 (June)		7	887	HW	20:10	6:45	297	111
20180628	20180704							
Week 1 (July)		7	887	HW	20:20	6:50	646	254
20180705	20180711							
Week 2 (July)		7	887	HW	20:20	6:50	539	207
20180712	20180718							
Week 3 (July)		7	887	HW	20:20	6:50	811	316
20180719	20180725							
Week 4 (July)		7	887	HW	20:20	6:50	810	231
20180726	20180801							
Week 1 (August)***		N/A	887	HW	20:05	7:10	N/A	N/A
20180802	20180808							
Week 2 (August)		7	887	HW	20:05	7:10	340	90
20180809	20180815							
Week 3 (August)		7	887	HW	20:05	7:10	429	132
20180816	20180822							
Week 4 (August)		7	887	HW	20:05	7:10	1177	388
20180823	20180829							
Week 5 (August)		7	887	HW	20:05	7:10	1307	318
20180830	20180905							
Week 1 (September)*		6	887	HW	19:20	7:35	1765	322
20180906	20180912							
Week 2 (September)*		N/A	887	HW	19:20	7:35	N/A	N/A
20180913	20180919							
Week 3 (September)		7	887	HW	19:20	7:35	1316	584
20180920	20180926							
Week 4 (September)		7	887	HW	19:20	7:35	1177	421
20180927	20181003							
Week 1 (October)		7	887	HW	18:40	8:00	677	291
20181004	20181010							
Week 2 (October)*		N/A	887	HW	18:40	8:00	N/A	N/A
20181011	20181017							
Week 3 (October)		7	887	HW	18:40	8:00	23	9
20181018	20181024							
Week 4 (October)		7	887	HW	18:40	8:00	16	6
20181025	20181031							
Week 1 (November)		7	887	HW	18:40	8:00	5	2
20181101	20181107							

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Acoustic Survey Data Form

Week 2 (November)		7	887	HW	18:40	8:00	22	0
20181108	20181114							
Week 3 (November)		7	887	HW	18:40	8:00	5	1
20181115	20181121							
TOTALS		236	---	---	---	---	14804	4711

Comments:
*Indicates missing data due to flooding/hurricane
**Indicates data was rearranged due to flooding
***Indicates missing data due to detector malfunction.
(Data was not used if there was less than 6 full nights of data)

Acoustic Survey Data Form

Project Name:	I-2513 Asheville Connector	**Site Number:**	6
Project #:	2015066.15	**Site Name:**	Smith Mill Creek
State:	North Carolina	**Latitude:**	35.595192
County:	Buncombe	**Longitude:**	-82.576586
Nearest town:	Asheville	**Elevation (m):**	613.258

Map:

Biologist selecting site: Heather Wallace

Habitat/Site description:

Hardwood forest adjacent to heavily incised stream. Riparian veg mainly Japanese knotweed.

Acoustic Survey Data Form

Detector Make/Model/Serial:	Anabat Express
Firmware:	V5506L
FS or ZC:	Zero cross
Mic type:	omnidirectional
Weatherproofing	none
Horizontal Orientation:	320 degrees
Vertical Orientation:	0 degrees
Test Func Method:	rub fingers
Mic height (m):	3.658
Mic distance from vegetation (m):	6
Clutter:	low
Traffic noise:	low

Site Photo:

Detector settings:

night mode; data div = 16; sensitivity = 115.

Results: Site 6

Week		No. of Nights	Detector Serial #	Biologist Deployed	Time		Total # of Bat Calls	# of MYGR Calls
Start Date	End Date				Start Time	End Time		
Week 3 (April)		7	903	HW	19:30	7:35	72	1
20180419	20180425							
Week 4 (April)		7	903	HW	19:30	7:35	109	2
20180426	20180502							
Week 1 (May)		7	903	HW	19:50	7:00	169	4
20180503	20180509							
Week 2 (May)		7	903	HW	19:50	7:00	164	2
20180510	20180516							
Week 3 (May)		7	903	HW	19:50	7:00	145	0
20180517	20180523							
Week 4 (May)		7	903	HW	19:50	7:00	385	0
20180524	20180530							
Week 5 (May)**		7	903	HW	19:50	7:00	649	2
20180531	20180606							
Week 1 (June)**		7	903	HW	20:10	6:45	836	4
20180607	20180613							
Week 2 (June)		7	903	HW	20:10	6:45	693	3
20180614	20180620							
Week 3 (June)		7	903	HW	20:10	6:45	453	1
20180621	20180627							
Week 4 (June)		7	903	HW	20:10	6:45	498	4
20180628	20180704							
Week 1 (July)		7	903	HW	20:20	6:50	825	9
20180705	20180711							

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Acoustic Survey Data Form

Week		No. of Nights	Detector Serial #	Biologist Deployed	Time		Total # of Bat Calls	# of MYGR Calls
Start Date	End Date				Start Time	End Time		
Week 2 (July)		7	903	HW	20:20	6:50	1034	3
20180712	20180718							
Week 3 (July)		7	903	HW	20:20	6:50	854	8
20180719	20180725							
Week 4 (July)		7	903	HW	20:20	6:50	756	8
20180726	20180801							
Week 1 (August)		7	903	HW	20:05	7:10	818	7
20180802	20180808							
Week 2 (August)		7	903	HW	20:05	7:10	552	17
20180809	20180815							
Week 3 (August)		7	903	HW	20:05	7:10	602	13
20180816	20180822							
Week 4 (August)		7	903	HW	20:05	7:10	417	10
20180823	20180829							
Week 5 (August)		7	903	HW	20:05	7:10	950	10
20180830	20180905							
Week 1 (September)*		6	903	HW	19:20	7:35	586	4
20180906	20180912							
Week 2 (September)*		N/A	903	HW	19:20	7:35	N/A	N/A
20180913	20180919							
Week 3 (September)		7	903	HW	19:20	7:35	761	11
20180920	20180926							
Week 4 (September)		7	903	HW	19:20	7:35	649	5
20180927	20181003							
Week 1 (October)		7	903	HW	18:40	8:00	666	2
20181004	20181010							
Week 2 (October)		7	903	HW	18:40	8:00	136	1
20181011	20181017							
Week 3 (October)		7	903	HW	18:40	8:00	6	0
20181018	20181024							
Week 4 (October)		7	903	HW	18:40	8:00	38	0
20181025	20181031							
Week 1 (November)		7	903	HW	18:40	8:00	12	1
20181101	20181107							
TOTALS		195	---	---	---	---	13835	132

Comments:
*Indicates missing data due to flooding/hurricane
**Indicates data was rearranged due to flooding
(Data was not used if there was less than 6 full nights of data)

Acoustic Survey Data Form

Project Name:	I-2513 Asheville Connector	**Site Number:**	7
Project #:	2015066.15	**Site Name:**	Hominy Creek and I-240
State:	North Carolina	**Latitude:**	35.563131
County:	Buncombe	**Longitude:**	-82.597792
Nearest town:	Asheville	**Elevation (m):**	609.905

Map:

Biologist selecting site: Heather Wallace

Habitat/Site description:

mature hardwoods along creek with lots of Japanese knotweed along bank. Nice riffle, rock outcrop near detector.

Acoustic Survey Data Form

Detector Make/Model/Serial:	Anabat Express
Firmware:	V5506L
FS or ZC:	Zero cross
Mic type:	omnidirectional
Weatherproofing	none
Horizontal Orientation:	30 degrees
Vertical Orientation:	0 degrees
Test Func Method:	rub fingers
Mic height (m):	3.658
Mic distance from vegetation (m):	4
Clutter:	low
Traffic noise:	low

Site Photo:

Detector settings:

night mode; data div = 16; sensitivity = 115.

Results: Site 7

Week		No. of Nights	Detector Serial #	Biologist Deployed	Time		Total # of Bat Calls	# of MYGR Calls
Start Date	End Date				Start Time	End Time		
Week 1 (April)		7	616	HW	19:30	7:35	26	0
20180405	20180411							
Week 2 (April)		7	616	HW	19:30	7:35	667	2
20180412	20180418							
Week 3 (April)		7	616	HW	19:30	7:35	122	1
20180419	20180425							
Week 4 (April)		7	616	HW	19:30	7:35	111	0
20180426	20180502							
Week 1 (May)		7	616	HW	19:50	7:00	97	0
20180503	20180509							
Week 2 (May)		7	616	HW	19:50	7:00	54	0
20180510	20180516							
Week 3 (May)		7	616	HW	19:50	7:00	55	0
20180517	20180523							
Week 4 (May)		7	616	HW	19:50	7:00	45	0
20180524	20180530							
Week 5 (May)**		7	616	HW	19:50	7:00	51	0
20180531	20180606							
Week 1 (June)**		7	616	HW	20:10	6:45	132	0
20180607	20180613							
Week 2 (June)		7	616	HW	20:10	6:45	160	0
20180614	20180620							
Week 3 (June)		7	616	HW	20:10	6:45	142	1
20180621	20180627							

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Acoustic Survey Data Form

Week		No. of Nights	Detector Serial #	Biologist Deployed	Time		Total # of Bat Calls	# of MYGR Calls
Start Date	End Date				Start Time	End Time		
Week 4 (June)		7	616	HW	20:10	6:45	223	0
20180628	20180704							
Week 1 (July)		7	616	HW	20:20	6:50	308	0
20180705	20180711							
Week 2 (July)		7	616	HW	20:20	6:50	120	0
20180712	20180718							
Week 3 (July)		7	616	HW	20:20	6:50	262	0
20180719	20180725							
Week 4 (July)		7	616	HW	20:20	6:50	778	0
20180726	20180801							
Week 1 (August)		7	616	HW	20:05	7:10	468	2
20180802	20180808							
Week 2 (August)		7	616	HW	20:05	7:10	437	0
20180809	20180815							
Week 3 (August)		7	616	HW	20:05	7:10	452	0
20180816	20180822							
Week 4 (August)		7	616	HW	20:05	7:10	537	3
20180823	20180829							
Week 5 (August)		7	616	HW	20:05	7:10	1626	1
20180830	20180905							
Week 1 (September)*		6	616	HW	19:20	7:35	1111	1
20180906	20180912							
Week 2 (September)*		N/A	616	HW	19:20	7:35	N/A	N/A
20180913	20180919							
Week 3 (September)		7	616	HW	19:20	7:35	225	1
20180920	20180926							
Week 4 (September)		7	616	HW	19:20	7:35	200	1
20180927	20181003							
Week 1 (October)		7	616	HW	18:40	8:00	117	2
20181004	20181010							
Week 2 (October)		7	616	HW	18:40	8:00	13	0
20181011	20181017							
Week 3 (October)		7	616	HW	18:40	8:00	8	0
20181018	20181024							
Week 4 (October)		7	616	HW	18:40	8:00	23	0
20181025	20181031							
Week 1 (November)		7	616	HW	18:40	8:00	4	0
20181101	20181107							
TOTALS		**209**	---	---	---	---	**8574**	**15**

Comments:
*Indicates missing data due to flooding/hurricane
**Indicates data was rearranged due to flooding
(Data was not used if there was less than 6 full nights of data)

Acoustic Survey Data Form

Project Name:	I-2513 Asheville Connector	**Site Number:**	8
Project #:	2015066.15	**Site Name:**	Oakview Road
State:	North Carolina	**Latitude:**	35.553911
County:	Buncombe	**Longitude:**	-82.603992
Nearest town:	Asheville	**Elevation (m):**	616.610

Map:

Biologist selecting site: Heather Wallace

Habitat/Site description:

nice open area along creek. Good riffle habitat nearby.

Acoustic Survey Data Form

Detector Make/Model/Serial:	Anabat Express
Firmware:	V5506L
FS or ZC:	Zero cross
Mic type:	omnidirectional
Weatherproofing	none
Horizontal Orientation:	160 degreees
Vertical Orientation:	0 degrees
Test Func Method:	rub fingers
Mic height (m):	3.658
Mic distance from vegetation (m):	>5
Clutter:	low
Traffic noise:	low

Site Photo:

Detector settings:

night mode; data div = 16; sensitivity = 115.

Results: Site 8

Week		No. of Nights	Detector Serial #	Biologist Deployed	Time		Total # of Bat Calls	# of MYGR Calls
Start Date	End Date				Start Time	End Time		
Week 1 (April)		7	888	HW	19:30	7:35	6	1
20180405	20180411							
Week 2 (April)		7	888	HW	19:30	7:35	318	2
20180412	20180418							
Week 3 (April)		7	888	HW	19:30	7:35	87	1
20180419	20180425							
Week 4 (April)		7	888	HW	19:30	7:35	106	0
20180426	20180502							
Week 1 (May)		7	888	HW	19:50	7:00	313	1
20180503	20180509							
Week 2 (May)		7	888	HW	19:50	7:00	70	0
20180510	20180516							
Week 3 (May)***		N/A	888	HW	19:50	7:00	N/A	N/A
20180517	20180523							
Week 4 (May)***		N/A	888	HW	19:50	7:00	N/A	N/A
20180524	20180530							
Week 5 (May)***		N/A	888	HW	19:50	7:00	N/A	N/A
20180531	20180606							
Week 1 (June)***		N/A	888	HW	20:10	6:45	N/A	N/A
20180607	20180613							
Week 2 (June)		7	356	HW	20:10	6:45	268	30
20180614	20180620							
Week 3 (June)		7	356	HW	20:10	6:45	267	11
20180621	20180627							

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Acoustic Survey Data Form

Week		No. of Nights	Detector Serial #	Biologist Deployed	Time		Total # of Bat Calls	# of MYGR Calls
Start Date	End Date				Start Time	End Time		
Week 4 (June)		7	356	HW	20:10	6:45	248	9
20180628	20180704							
Week 1 (July)		7	888	HW	20:20	6:50	77	3
20180705	20180711							
Week 2 (July)		7	888	HW	20:20	6:50	359	18
20180712	20180718							
Week 3 (July)		7	888	HW	20:20	6:50	156	4
20180719	20180725							
Week 4 (July)		7	888	HW	20:20	6:50	322	6
20180726	20180801							
Week 1 (August)		7	888	HW	20:05	7:10	645	10
20180802	20180808							
Week 2 (August)		7	888	HW	20:05	7:10	256	36
20180809	20180815							
Week 3 (August)		7	888	HW	20:05	7:10	203	17
20180816	20180822							
Week 4 (August)		7	888	HW	20:05	7:10	77	11
20180823	20180829							
Week 5 (August)		7	888	HW	20:05	7:10	20	3
20180830	20180905							
Week 1 (September)*		6	888	HW	19:20	7:35	46	1
20180906	20180912							
Week 2 (September)*		N/A	888	HW	19:20	7:35	N/A	N/A
20180913	20180919							
Week 3 (September)		7	888	HW	19:20	7:35	29	1
20180920	20180926							
Week 4 (September)		7	888	HW	19:20	7:35	13	1
20180927	20181003							
Week 1 (October)		7	888	HW	18:40	8:00	10	3
20181004	20181010							
Week 2 (October)		7	888	HW	18:40	8:00	5	0
20181011	20181017							
Week 3 (October)		7	888	HW	18:40	8:00	8	1
20181018	20181024							
Week 4 (October)		7	888	HW	18:40	8:00	10	0
20181025	20181031							
Week 1 (November)		7	888	HW	18:40	8:00	6	0
20181101	20181107							
TOTALS		**181**	---	---	---	---	**3925**	**170**

Comments:
*Indicates missing data due to flooding/hurricane
***Indicates missing data due to detector malfunction.
(Data was not used if there was less than 6 full nights of data)

Acoustic Survey Data Form

Project Name:	I-2513 Asheville Connector	**Site Number:**	9
Project #:	2015066.15	**Site Name:**	Pond Road
State:	North Carolina	**Latitude:**	35.546828
County:	Buncombe	**Longitude:**	-82.602439
Nearest town:	Asheville	**Elevation (m):**	613.562

Map:

Biologist selecting site: Heather Wallace

Habitat/Site description:

great riffle habitat and rocky ledges nearby. Also good pools just up and downstream. Mature hardwoods nearby.

Acoustic Survey Data Form

Detector	
Make/Model/Serial:	Anabat Express
Firmware:	V5506L
FS or ZC:	Zero cross
Mic type:	omnidirectional
Weatherproofing	none
Horizontal Orientation:	50 degrees
Vertical Orientation:	0 degrees
Test Func Method:	rub fingers
Mic height (m):	3.658
Mic distance from vegetation (m):	>5
Clutter:	low
Traffic noise:	low

Site Photo:

Detector settings:

night mode; data div = 16; sensitivity = 115.

Results: Site 9

Week		No. of Nights	Detector Serial #	Biologist Deployed	Time		Total # of Bat Calls	# of MYGR Calls
Start Date	End Date				Start Time	End Time		
Week 1 (April)		7	881	HW	19:30	7:35	4	0
20180405	20180411							
Week 2 (April)		7	881	HW	19:30	7:35	141	14
20180412	20180418							
Week 3 (April)		7	881	HW	19:30	7:35	47	3
20180419	20180425							
Week 4 (April)		7	881	HW	19:30	7:35	78	6
20180426	20180502							
Week 1 (May)		7	881	HW	19:50	7:00	152	4
20180503	20180509							
Week 2 (May)		7	881	HW	19:50	7:00	120	3
20180510	20180516							
Week 3 (May)		7	881	HW	19:50	7:00	67	5
20180517	20180523							
Week 4 (May)		7	881	HW	19:50	7:00	13	1
20180524	20180530							
Week 5 (May)***		N/A	881	HW	19:50	7:00	N/A	N/A
20180531	20180606							
Week 1 (June)**		7	881	HW	20:10	6:45	115	5
20180607	20180613							
Week 2 (June)***		N/A	881	HW	20:10	6:45	N/A	N/A
20180614	20180620							
Week 3 (June)		7	881	HW	20:10	6:45	32	2
20180621	20180627							

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Acoustic Survey Data Form

Week		No. of Nights	Detector Serial #	Biologist Deployed	Time		Total # of Bat Calls	# of MYGR Calls
Start Date	End Date				Start Time	End Time		
Week 4 (June)		7	881	HW	20:10	6:45	157	7
20180628	20180704							
Week 1 (July)		7	960	HW	20:20	6:50	187	10
20180705	20180711							
Week 2 (July)		7	960	HW	20:20	6:50	114	4
20180712	20180718							
Week 3 (July)		7	960	HW	20:20	6:50	427	19
20180719	20180725							
Week 4 (July)		7	960	HW	20:20	6:50	836	16
20180726	20180801							
Week 1 (August)		7	960	HW	20:05	7:10	1369	17
20180802	20180808							
Week 2 (August)		7	960	HW	20:05	7:10	1008	14
20180809	20180815							
Week 3 (August)		7	960	HW	20:05	7:10	618	22
20180816	20180822							
Week 4 (August)		7	960	HW	20:05	7:10	464	19
20180823	20180829							
Week 5 (August)		7	960	HW	20:05	7:10	293	13
20180830	20180905							
Week 1 (September)*		6	960	HW	19:20	7:35	87	5
20180906	20180912							
Week 2 (September)*		N/A	N/A	HW	19:20	7:35	N/A	N/A
20180913	20180919							
Week 3 (September)		7	960	HW	19:20	7:35	81	13
20180920	20180926							
Week 4 (September)		7	960	HW	19:20	7:35	27	1
20180927	20181003							
Week 1 (October)		7	960	HW	18:40	8:00	22	0
20181004	20181010							
Week 2 (October)		7	960	HW	18:40	8:00	26	3
20181011	20181017							
Week 3 (October)		7	960	HW	18:40	8:00	7	0
20181018	20181024							
Week 4 (October)		7	960	HW	18:40	8:00	22	0
20181025	20181031							
Week 1 (November)		7	960	HW	18:40	8:00	5	0
20181101	20181107							
TOTALS		195	---	---	---	---	6519	206

Comments:
*Indicates missing data due to flooding/hurricane
**Indicates data was rearranged due to flooding
***Indicates missing data due to detector malfunction.
(Data was not used if there was less than 6 full nights of data)

Acoustic Survey Data Form

Project Name:	I-2513 Asheville Connector	**Site Number:**	10
Project #:	2015066.15	**Site Name:**	Outdoor Center
State:	North Carolina	**Latitude:**	35.566053
County:	Buncombe	**Longitude:**	-82.585486
Nearest town:	Asheville	**Elevation (m):**	618.744

Map:

Biologist selecting site: Heather Wallace

Habitat/Site description:

thin strip of riparian vegetation along both banks at this location. Not much riffle habitat nearby.

Acoustic Survey Data Form

Detector Make/Model/Serial:	Anabat Express
Firmware:	V5506L
FS or ZC:	Zero cross
Mic type:	omnidirectional
Weatherproofing	none
Horizontal Orientation:	198 degrees
Vertical Orientation:	0 degrees
Test Func Method:	rub fingers
Mic height (m):	2.743
Mic distance from vegetation (m):	3
Clutter:	low
Traffic noise:	low

Site Photo:

Detector settings:

night mode; data div = 16; sensitivity = 115.

Results: Site 10

Week		No. of Nights	Detector Serial #	Biologist Deployed	Time		Total # of Bat Calls	# of MYGR Calls
Start Date	End Date				Start Time	End Time		
Week 1 (April)		7	948	HW	19:30	7:35	84	0
20180405	20180411							
Week 2 (April)		7	948	HW	19:30	7:35	255	7
20180412	20180418							
Week 3 (April)		7	948	HW	19:30	7:35	258	6
20180419	20180425							
Week 4 (April)		7	948	HW	19:30	7:35	228	3
20180426	20180502							
Week 1 (May)		7	948	HW	19:50	7:00	258	6
20180503	20180509							
Week 2 (May)		7	948	HW	19:50	7:00	244	7
20180510	20180516							
Week 3 (May)		7	948	HW	19:50	7:00	160	1
20180517	20180523							
Week 4 (May)		7	948	HW	19:50	7:00	123	1
20180524	20180530							
Week 5 (May)**		7	948	HW	19:50	7:00	325	9
20180531	20180606							
Week 1 (June)**		7	948	HW	20:10	6:45	570	2
20180607	20180613							
Week 2 (June)		7	948	HW	20:10	6:45	839	5
20180614	20180620							
Week 3 (June)		7	948	HW	20:10	6:45	764	9
20180621	20180627							

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Acoustic Survey Data Form

Week		No. of Nights	Detector Serial #	Biologist Deployed	Time		Total # of Bat Calls	# of MYGR Calls
Start Date	End Date				Start Time	End Time		
Week 4 (June)		7	948	HW	20:10	6:45	1214	19
20180628	20180704							
Week 1 (July)		7	948	HW	20:20	6:50	718	36
20180705	20180711							
Week 2 (July)		7	948	HW	20:20	6:50	899	37
20180712	20180718							
Week 3 (July)		7	948	HW	20:20	6:50	1135	43
20180719	20180725							
Week 4 (July)		7	948	HW	20:20	6:50	1764	93
20180726	20180801							
Week 1 (August)		7	948	HW	20:05	7:10	904	31
20180802	20180808							
Week 2 (August)		7	948	HW	20:05	7:10	1236	65
20180809	20180815							
Week 3 (August)		7	948	HW	20:05	7:10	1714	57
20180816	20180822							
Week 4 (August)		7	948	HW	20:05	7:10	1118	82
20180823	20180829							
Week 5 (August)		7	948	HW	20:05	7:10	2346	73
20180830	20180905							
Week 1 (September)*		6	948	HW	19:20	7:35	1201	43
20180906	20180912							
Week 2 (September)*		N/A	N/A	HW	19:20	7:35	N/A	N/A
20180913	20180919							
Week 3 (September)		7	948	HW	19:20	7:35	547	24
20180920	20180926							
Week 4 (September)		7	948	HW	19:20	7:35	431	24
20180927	20181003							
Week 1 (October)		7	948	HW	18:40	8:00	307	17
20181004	20181010							
Week 2 (October)		7	948	HW	18:40	8:00	146	4
20181011	20181017							
Week 3 (October)		7	948	HW	18:40	8:00	41	0
20181018	20181024							
Week 4 (October)		7	948	HW	18:40	8:00	101	0
20181025	20181031							
Week 1 (November)		7	948	HW	18:40	8:00	22	0
20181101	20181107							
TOTALS		**209**	---	---	---	---	**19952**	**704**

Comments:
*Indicates missing data due to flooding/hurricane
**Indicates data was rearranged due to flooding
(Data was not used if there was less than 6 full nights of data)

Acoustic Survey Data Form

Project Name:	I-26 Widening (STIP I-4400/I-4700)	**Site Number:**	11
Project #:	2015066.14	**Site Name:**	I-26 Bridge
State:	North Carolina	**Latitude:**	35.512805
County:	Buncombe	**Longitude:**	-82.583988
Nearest town:	Bent Creek	**Elevation (m):**	609.295

Map:

Biologist selecting site: Heather Wallace

Habitat/Site description:

Permanent detector location at I-26 bridge over French Broad River.

Acoustic Survey Data Form

Detector Make/Model/Serial:	Anabat Express
Firmware:	V5506L
FS or ZC:	Zero cross
Mic type:	omnidirectional
Weatherproofing	none
Horizontal Orientation:	315
Vertical Orientation:	0 degrees
Test Func Method:	rub fingers
Mic height (m):	3.65
Mic distance from vegetation (m):	4
Clutter:	low
Traffic noise:	high

Site Photo:

Detector settings:

night mode; data div = 16; sensitivity = 115.

Results: Site 11

Week		No. of Nights	Detector Serial #	Biologist Deployed	Time		Total # of Bat Calls	# of MYGR Calls
Start Date	End Date				Start Time	End Time		
Week 1 (March)		7	578	HW	19:30	7:35	0	0
20180301	20180307							
Week 2 (March)		7	578	HW	19:30	7:35	0	0
20180308	20180314							
Week 3 (March)		7	578	HW	19:30	7:35	1743	100
20180315	20180321							
Week 4 (March)		7	578	HW	19:30	7:35	229	67
20180322	20180328							
Week 5 (March)		7	578	HW	19:30	7:35	863	390
20180329	20180404							
Week 1 (April)		7	578	HW	19:30	7:35	176	64
20180405	20180411							
Week 2 (April)		7	578	HW	19:30	7:35	3467	1038
20180412	20180418							
Week 3 (April)		7	578	HW	19:30	7:35	643	325
20180419	20180425							
Week 4 (April)		7	578	HW	19:30	7:35	1163	633
20180426	20180502							
Week 1 (May)		7	578	HW	19:50	7:00	3010	1568
20180503	20180509							
Week 2 (May)		7	578	HW	19:50	7:00	1459	661
20180510	20180516							
Week 3 (May)*		N/A	578	HW	19:50	7:00	N/A	N/A
20180517	20180523							

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Acoustic Survey Data Form

Week		No. of Nights	Detector Serial #	Biologist Deployed	Time		Total # of Bat Calls	# of MYGR Calls
Start Date	End Date				Start Time	End Time		
Week 4 (May)*		6	578	HW	19:50	7:00	1212	670
20180524	20180530							
Week 5 (May)*		N/A	578	HW	19:50	7:00	N/A	N/A
20180531	20180606							
Week 1 (June)		7	578	HW	20:10	6:45	1406	613
20180607	20180613							
Week 2 (June)		7	578	HW	20:10	6:45	2625	1318
20180614	20180620							
Week 3 (June)		7	578	HW	20:10	6:45	1501	484
20180621	20180627							
Week 4 (June)		7	578	HW	20:10	6:45	1657	555
20180628	20180704							
Week 1 (July)		7	578	HW	20:20	6:50	1646	758
20180705	20180711							
Week 2 (July)		7	578	HW	20:20	6:50	1021	460
20180712	20180718							
Week 3 (July)		7	578	HW	20:20	6:50	892	451
20180719	20180725							
Week 4 (July)		7	578	HW	20:20	6:50	1107	579
20180726	20180801							
Week 1 (August)		7	578	HW	20:05	7:10	1331	744
20180802	20180808							
Week 2 (August)		7	578	HW	20:05	7:10	3017	1485
20180809	20180815							
Week 3 (August)		7	578	HW	20:05	7:10	4875	2882
20180816	20180822							
Week 4 (August)		7	578	HW	20:05	7:10	4791	2894
20180823	20180829							
Week 5 (August)		7	578	HW	20:05	7:10	4907	3083
20180830	20180905							
Week 1 (September)*		6	578	HW	19:20	7:35	3729	2188
20180906	20180912							
Week 2 (September)*		N/A	578	HW	19:20	7:35	N/A	N/A
20180913	20180919							
Week 3 (September)		7	578	HW	19:20	7:35	1986	1329
20180920	20180926							
Week 4 (September)		7	578	HW	19:20	7:35	628	456
20180927	20181003							
Week 1 (October)		7	578	HW	18:40	8:00	346	191
20181004	20181010							
Week 2 (October)		7	578	HW	18:40	8:00	37	17
20181011	20181017							
Week 3 (October)		7	578	HW	18:40	8:00	12	2
20181018	20181024							
Week 4 (October)		7	578	HW	18:40	8:00	18	4
20181025	20181031							
TOTALS		**222**	---	---	---	---	**51497**	**26009**

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Acoustic Survey Data Form

Comments:
*Indicates missing data due to flooding/hurricane
(Data was not used if there was less than 6 full nights of data)

Appendix D : Indiana State University 2018 Activity Report

Activity Report 18 November 2018

Distribution, Roosting & Foraging Ecology, & Migration Pathways for Gray Bats in Western NC

Prepared by Joey Weber, Joy O'Keefe, and Brianne Walters

Center for Bat Research, Outreach, and Conservation

Indiana State University, Terre Haute, IN

Introduction

Until recently, gray bats (*Myotis grisescens*), a federally endangered species, were thought to be uncommon in western North Carolina (WNC). However, 2016–2017 survey work by the NC Wildlife Resources Commission (NCWRC) and others has shown that large gray bat colonies are using manmade structures in the French Broad River (FBR) basin in Buncombe and Madison counties, NC, including bridges and a culvert. The presence of gray bats in structures constructed and maintained by the North Carolina Department of Transportation (NCDOT) and the foraging and roosting habits of the bat has the potential to affect multiple large scale projects and a range of smaller projects and maintenance activities in NCDOT Divisions 13 and 14.

To address NCDOT research needs, we are conducting a 3-year (2018–2020) study with 5 major objectives. The first field season (March to November 2018) involved intensive field work by a crew of personnel dedicated to this project and partners from NCDOT, UNC-Asheville, NCWRC, NPS, USFWS, and other agencies. Herein we report data from this first field season; note that these data are preliminary and that some results and conclusions may change with additional analyses.

Objectives

1) Literature Review and Data Synthesis Review existing literature on gray bat distribution, roosting and foraging habitat requirements, migration patterns, and use of anthropogenic structures. Synthesize all previously-collected data from the FBR basin, including data collected via NCDOT and NCWRC.

2) Distribution Use bridge checks, acoustic monitoring, and winter surveys across 2 years to describe the distribution of the gray bat in WNC. Conduct micro- and macrohabitat assessments at used and unused bridges, including collecting detailed temperature and humidity measurements where bats are/are not roosting. We will merge bridge assessment data with existing data that NCDOT has collected at more than 600 bridges from 1996–2017. For 2 full calendar years, we will collect acoustic data at regular monitoring stations across the FBR basin to identify high, low, and no activity sites for gray bats. We will also aid in winter surveys in suspected gray bat hibernacula in WNC and will communicate with biologists in other states to attempt to recover information on bands placed on bats in WNC.

3) Roost Sites We will track 90 bats per year (45 with beeper tags and 45 with coded tags) for 2 years to locate additional daytime roosts. Because of the long distance capabilities of gray bats, we suspect we may only locate about half of the bats carrying beeper tags and fewer carrying coded tags. We will conduct exit counts at all known roosts to describe the relative importance of each roost found.

4) Foraging Areas We will use a combination of ground-based telemetry and datalogging towers to identify foraging areas and ranges of radio-tagged gray bats during 3 periods per year for 2 years. With ground-based telemetry, we will attempt to track up to 45 bats with beeper tags each year. With datalogging towers, we will record the nightly locations and movements (between towers) of 45 bats with coded tags each year. Data from aerial telemetry searches during autumn will also yield data on gray bat foraging areas.

5) Migration Pathway We will use a combination of telemetry (ground and aerial), datalogging towers, and acoustic surveys to describe the migration pathways of gray bats in autumn. With telemetry, we will focus on bats carrying beeper tags (15 each autumn), while datalogging towers will be re-positioned along suspected pathways to track the movements of bats carrying coded tags (15 each autumn).

Methods

1) Literature Review and Data Synthesis We reviewed 14 published papers on gray bats, summarizing the salient parts of each article. We will continue to add to this review during the 2018–2019 winter/spring.

2) Distribution

We conducted structure checks at 100(+) bridges in the FBR basin (Figure 1). We randomly selected 100 bridges from bridges located within 400 m of major streams in the FBR Basin. At each bridge we performed a thorough survey for bats and evidence of use by bats, then recorded descriptive information mostly based on NCDOT's standard operating procedures (SOP) for bat habitat assessments (see Appendix A for our datasheet). We also opportunistically surveyed 6 bridges for bats, but did not record descriptive information.

We deployed bat detectors at 12 stations throughout the FBR basin (Figure 2). We selected major streams in the FBR basin from a major hydrography layer available at nconemap.org. For each stream, we selected a site 0.1–6.6 km from the midpoint. We divided the FBR into 3 sections (North, Middle, South) and created a station near the midpoints of those sections. Each station had two Anabat SD1s or SD2s (Titley Scientific, Inc., USA), with directional hi-type, weatherproofed microphones (housed inside a 31.75 mm PVC tube with a 40° axis angle) on 10-m cables, powered by a combination of 12V batteries and a solar panel. The mics were elevated 1.5–2.5 meters above ground level and set so one recorded upstream and the other downstream.

We downloaded calls from compact flash cards and organized data by site, mic direction, and night. We used automated identification software, Bat Call Identification (BCID; v2.7c; Bat Call Identification 2016), to identify bat echolocation calls to species from a list of 13 species that occur in western North Carolina (*Tadarida brasiliensis* is not an option).By default, BCID discards files that have noise or no bat pulses, where a pulse is defined as an individual sound wave that is a part of the larger bat echolocation call sequence; files that pass the filter are identifiable sequences of search phase calls. For species identification, we required call sequences with a 5-pulse minimum within 15 s, a 70% species confidence level (at least 4 pulses identified as 1 species), and minimum discriminant probability of 0.35. If the minimum discriminant probability was not met, BCID marked the file as unknown.

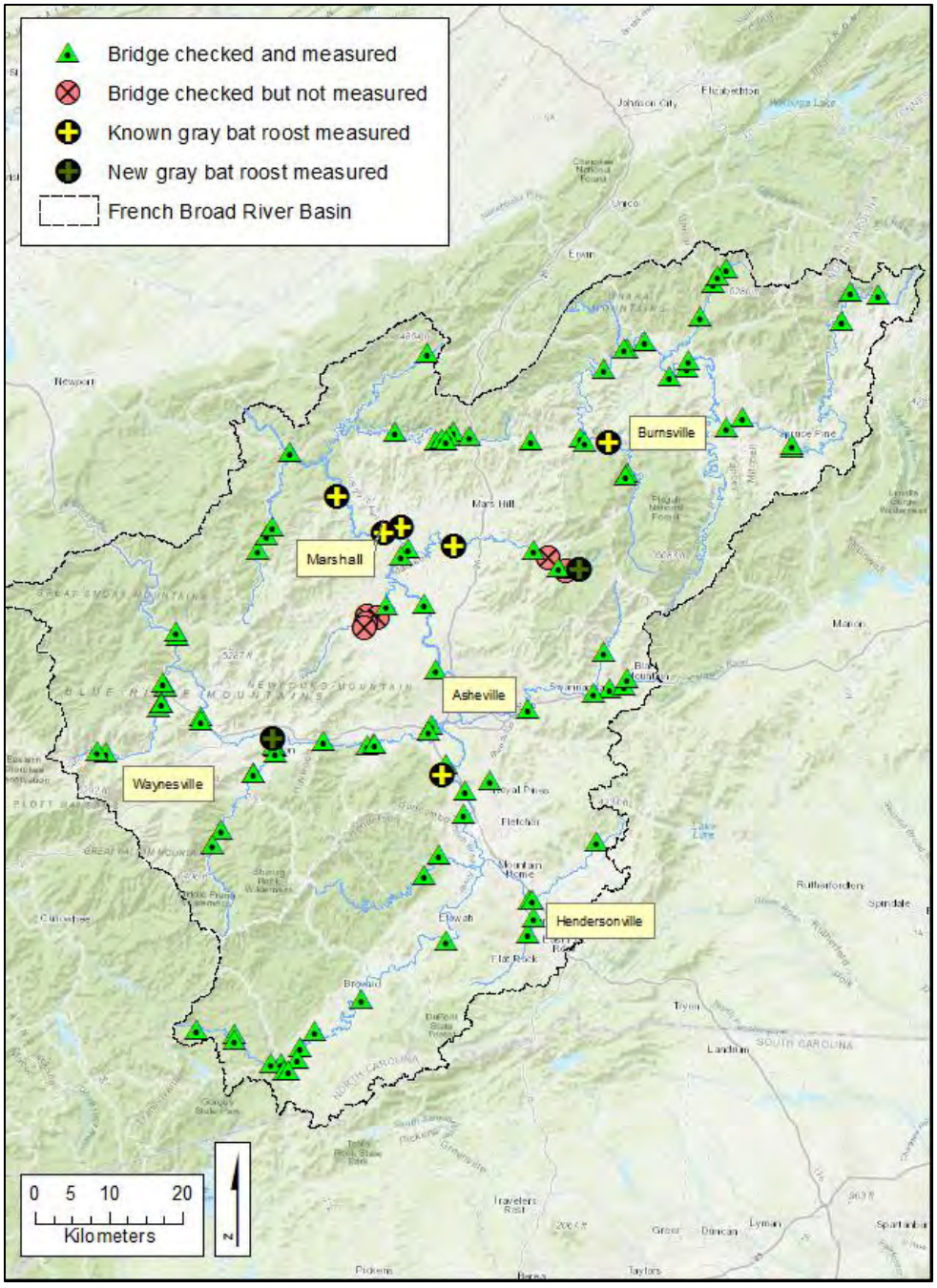

Figure 1. Bridges surveyed for gray bats in the French Broad River Basin (Avery, Buncombe, Haywood, Henderson, Madison, Mitchell, Transylvania, and Yancey counties) between 29 May–14 July 2018. Note: This map does not show all known gray bat roosts; rather, it shows those we measured.

For this report, we present the number of files identified as gray bats according to the BCID criteria above. We also present the calls per detector night, where a detector night is one detector active for one entire night (dusk to dawn).

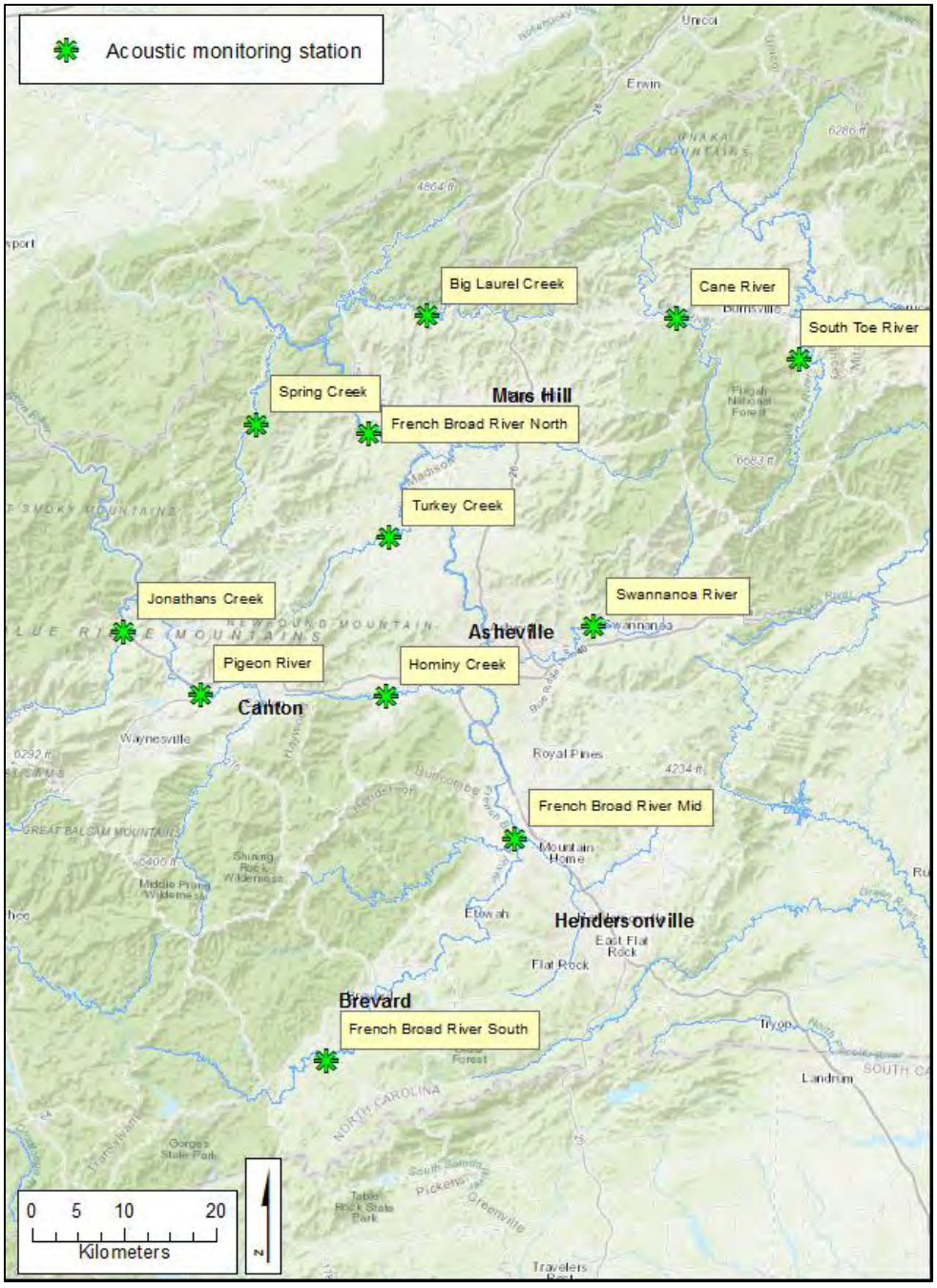

Figure 2. Acoustic monitoring station locations in the French Broad River Basin in Buncombe, Haywood, Henderson, Madison, Transylvania, and Yancey counties. We do not present data for the South Toe River station, which came online in late October.

We have not yet completed any winter surveys, but have engaged in discussions with NCWRC and Tennessee Wildlife Resources Agency (TWRA) about checking their winter hibernacula for banded gray bats.

3) Roost Sites

We used mistnets and a harp trap to capture bats at known roosts and additional net sites. We banded >97% of gray bats we handled and usually did not band other species. We attached radio tags to 91 bats (45 coded tags and 46 beeper tags) between 15 April and 25 October 2018. By tracking bats during the day, we mainly confirmed their use of structures already known to us when the project began. However, we also discovered some new roosts via radio telemetry and opportunistic searches.

We checked known roosts as often as possible to assess the presence of gray bats and population sizes. We conducted simultaneous, coordinated exit counts on known roosts on 3 occasions. We also conducted additional exit counts on a few primary roosts or suspected roosts. For example, we returned to 3 potential roosts to do exit counts after structure checks indicated bats were present.

4) Foraging Areas

To identify foraging areas, we followed 2–3 bats per night, as feasible. From immediately after emergence time (around 20:00 EDT) until as late as 02:06, we recorded a series of simultaneous multi-azimuth (2–5) triangulations/biangulations at 5–6 minute intervals to obtain location estimates for foraging bats. We stationed personnel at various points on the landscape around a focal bat's foraging area, with each person recording an azimuth or bearing for the focal bat at set time intervals. Azimuths were recorded on a 5-minute cycle when a single bat was being tracked or a 3-minute cycle when multiple bats were being tracked; thus, when tracking two bats, personnel recorded azimuths for each bat every six minutes. We converted foraging telemetry triangulations/biangulations to point location estimates using the program Locate III, Version 3.34 (Nams 2006). When estimating point locations, we excluded biangulations that were < 15 degrees different, and triangulations or biangulations with lines that did not cross. Also, we recorded areas where we tracked foraging bats but did not obtain triangulations/biangulations. Copperhead Consulting also provided some foraging locations, which we present without correction/modification in Appendix C.

We positioned 16 fixed telemetry towers 5–10 km apart from each other and centered in Asheville on the midpoint between the confluences of Hominy Creek and Swannanoa Rivers with the FBR (Figure 3). Tower sites were along the FBR, Hominy Creek, Swannanoa River, and at Lake Julian. Each fixed telemetry tower consisted of a SRX-DL1 or SRX800-D datalogging telemetry receiver (Lotek Wireless, Inc., Newmarket, Ontario) powered by a 12V battery, two 9-element Yagi antennae, and one antenna mast (approximately 5–6 m elevation for antennae). One antenna pointed upstream and the other downstream. We checked or changed batteries regularly, but at times the towers were not operational because the battery died.

The dataloggers allowed for simultaneous monitoring of 15 coded tags with the same frequency but digitally-encoded unique IDs that could be separated by the datalogging telemetry receivers. Coded tags transmitted a signal every 5 seconds. When analyzing data from the datalogging receivers, we considered signals to be detections if they were at 5-second intervals and there were ≥ 3 detections within one minute of each other; thus, if there were two signals at a 5-second interval within one minute of each other but no other signals within a minute's time, we did not consider this a detection.

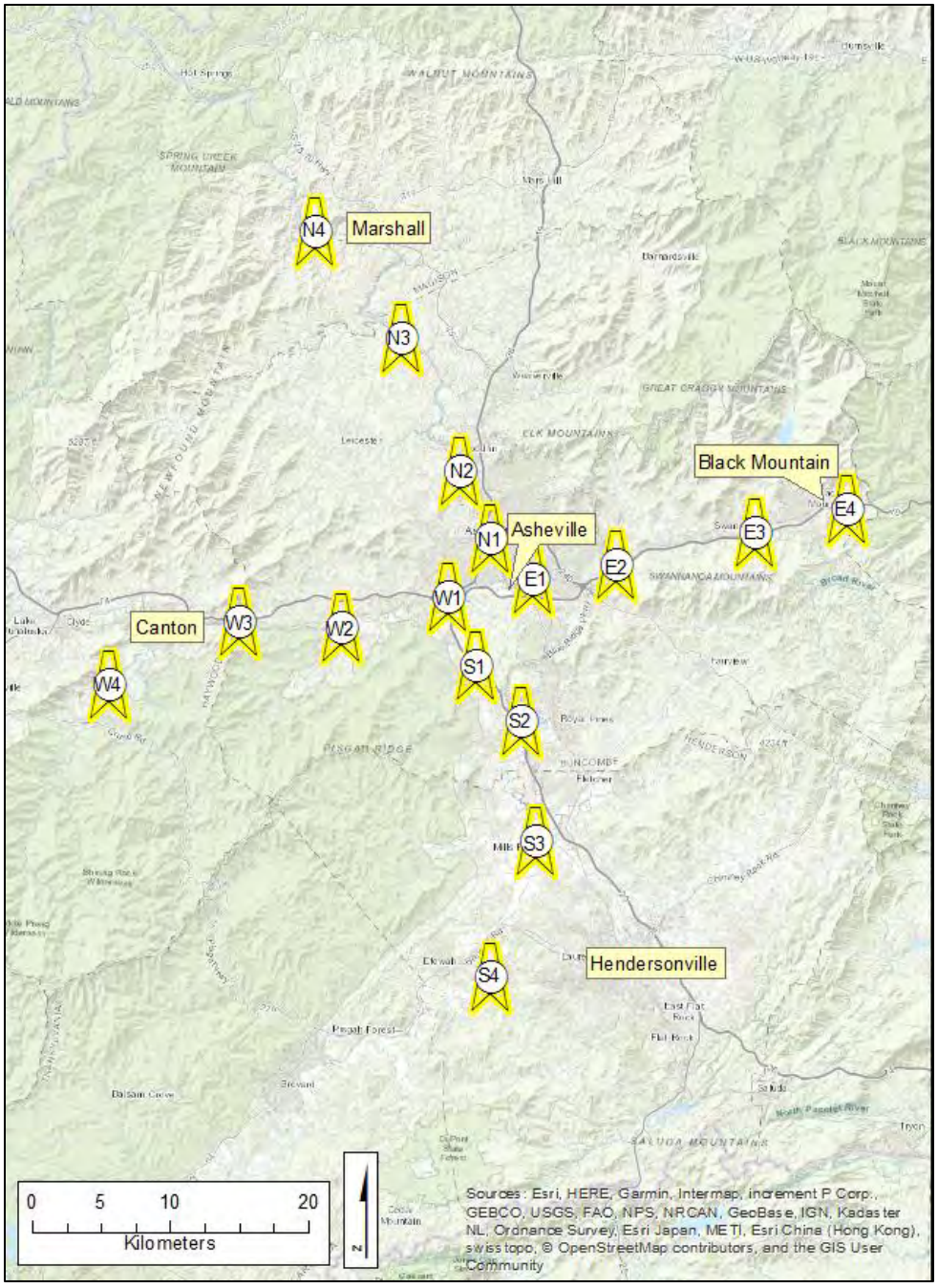

Figure 3. Telemetry tower locations along the French Broad River, Hominy Creek, Swannanoa River, and Lake Julian. Gray bats were radio-tagged at roost sites in Asheville, Canton, and Marshall; towers recorded their movements between 18 April and early-November.

5) Migration Pathway

We maintained all telemetry towers through Nov 6 and kept the 4 towers north of Asheville (along the FBR) active through 15 November. We will use tower data to assess migration movements of bats radio tagged in September and October 2018.

In addition to the 16 fixed telemetry towers centered on Asheville, we deployed 1 additional datalogger at the N4 tower to record beeper transmitters on 31 October and 4 dataloggers (3 beeper and 1 coded) at the entrance to Rattling Cave (a known gray bat hibernaculum) near Newport, TN between 3 October–mid November. Rattling Cave is ~0.4 km from the Pigeon River and < 3 km from the FBR. Beeper tags transmitted a signal approximately every 2 seconds. When analyzing data from the datalogging receivers for beeper transmitters, we considered signals to be detections if they were at 2-second intervals and there were 4 consecutive detections within 8 seconds; if there were ≤ 3 consecutive signals at a 2-second interval, we did not consider this a detection. We also did not consider it a detection if the beeps per minute of the signals varied by more than 1 beep per minute. Note: we positioned dataloggers at Pearson Cave (about 3 hrs north of Asheville) and at the confluence of the FBR and the Pigeon River in TN from early to late October, but did not have any detections.

We contracted Copperhead Consulting to conduct aerial searches for bats beginning in early October. Their start date was delayed due to Hurricane Michael, which passed through the Southeast 8–11 October. Copperhead flew the nights of 12, 13, 15, 17, 18, and 19 October; we asked them to discontinue flights after it became apparent that we were not picking up on migration flights for females. Copperhead collected foraging data for several bats, mostly males, captured at Blue Ridge Parkway Bridge, Southern States Culvert, and Blackwell Canton Bridge (see Foraging Areas, above, and Appendix C).

Results and Discussion

1) Literature Review and Data Synthesis

The summary of available literature is provided as Appendix B.

2) Distribution

Of the 113 bridges we surveyed, 99 were bridges that we randomly selected for recording descriptive information (Figure 1). Of those 99 bridges, we documented gray bat usage at 2 bridges, at the Blackwell Canton Bridge on the Pigeon River (NCDOT #430445) and at the Dillingham Bridge on Dillingham Creek (NCDOT #100148). Not including those 2 bridges or previously-known gray bat bridges, we recorded evidence of use (guano or bats), but did not confirm the bat species at 23 bridges.

We recorded gray bats at each of the 11 acoustic stations deployed in late summer through fall (Table 1, see also Figure 2). Considering calls/detector night, activity was greatest at the Pigeon River (22.2 calls/detector night), followed by Swannanoa River and Hominy Creek (> 7 calls/detector night). The lowest activity levels were at French Broad Middle and French Broad South. We recorded < 1 gray bat call/detector night at each of these stations. Given their proximity to known gray bat roosts, we suspect the low activity rates may reflect the greater distance from the mics to the center of the river relative to other acoustic stations. It is noteworthy that activity is high along the Swannanoa River by Warren Wilson College (second highest activity rate), as we have not located any roosts due east of Asheville and also have not tracked bats in this direction. Summing data across all acoustic stations, it appears there was a substantial drop off in activity in mid-October (data not shown). However, during this time we also removed half of the detectors to reduce the risk of inundation with floodwaters and thus missed the opportunity to adequately capture the decline in acoustic activity as bats moved to wintering site(s).

Table 1. Summary of acoustic data recorded at 11 Anabat stations deployed throughout the French Broad River basin (see Figure 2 map). Each station had 2 Anabat detectors, with microphones pointing upstream and downstream. A detector night is 1 detector operational for a night (dusk to dawn). Typically a station would yield 2 detector nights for each calendar night.

Site	Sum of MYGR calls	Detector Nights	Calls/detector night
Big Laurel	110	32	3.4
Cane River	70	41	1.7
FB Middle	65	80	0.8
FB North	322	92	3.5
FB South	33	168	0.2
Hominy Creek	1027	143	7.2
Jonathans Creek	564	111	5.1
Pigeon River	2642	119	22.2
Spring Creek	605	181	3.3
Turkey Creek	439	123	3.6
Swannanoa River	1009	128	7.9

3) Roost Sites

We captured bats at 3 roost sites along the FBR (BR Parkway Bridge, Marshall Bridge, and Southern States Culvert; Table 2). We also surveyed Sandy Bottoms, a net site near the FBR. In October 2018, we netted a newly discovered roost in Canton (Blackwell Canton Bridge N) and then a nearby bridge (not known to be a roost; Blackwell Canton Bridge S). We captured 488 gray bats, 41 big brown bats (EPFU, all at BR Parkway Bridge), 3 eastern red bats (LABO), 1 tri-colored bat (PESU), and 316 Mexican free-tailed bats (TABR, at BR Parkway and Marshall bridges). Approximately 82% of the gray bat captures were adult males, 12% were adult females, and 4% were juveniles. These calculations are for first time captures only. We recaptured 1 adult female at the BR Parkway Bridge, 26 adult males, and 1 male of unknown age (bat got out of hand). We caught our last female gray bat on 13 October, even though we netted and caught male gray bats on 4 later nights (14–25 October).

Table 2. Captures for 2018 season by site (roost or net) and date. Gray bat (MYGR) captures divided by age and sex. Recaptures are indicated after a plus (+). We also present data for big brown bats (EPFU), red bats (LABO), tri-colored bats (PESU), and Mexican free-tailed bats (TABR), which were not banded in 2018.

		Species (ages and sexes encountered indicated below species code)									
		MYGR						EPFU	LABO	PESU	TABR
Site Name	Date	AF	AM	JF	JM	UF	UM	AF, AM, J	F + M	AF	AF, AM, J
Blackwell Canton Bridge N	Oct 4	4	29								
Blackwell Canton Bridge S	Oct 13	1	20								
BR Parkway Bridge	Apr 18		5					1	2		
	Apr 25		1					2 + 1			
	Jul 21	3	17		1			12	1		7
	Jul 22	4	9		3			7			40
	Aug 3							1 + 1			35
	Aug 9	1	4 + 1		1	1					24
	Sept 25	2 + 1	7					5 + 1			107
	Sept 26	3	16					5			14
	Oct 3	1	19								29
	Oct 14		25 + 5				1				53
Marshall Bridge	Apr 20	5	14								
	Apr 21	5	19 + 1								2
	Apr 28	4	7							1	
	Apr 29	2	3								1
	Apr 30	2									
	Jul 15	1	5 + 1								
	Aug 14	2	6								2
	Sept 28	2	25 + 1								2
	Oct 18		1 + 1								
Sandy Bottom Net Site	Jul 18		1								
Southern States Culvert	Apr 19		6								
	Apr 27		10 + 1								
	Jul 26	5	27 + 1	4	3						
	Aug 6	2	17 + 2	2	6						
	Aug 15	8	40		2						
	Oct 1	4	33 + 5				0 + 1				
	Oct 8		12 + 3								
	Oct 10	1	20 + 1								
	Oct 19		4 + 2								
	Oct 25		0 + 1								

We surveyed 4 primary roost sites; 3 were known before the study began and Blackwell Canton North was discovered during a structure survey. Via radio telemetry and opportunistic searches (some prior to 2018), we and others discovered 11 secondary roost sites for gray bats (Figure 4).

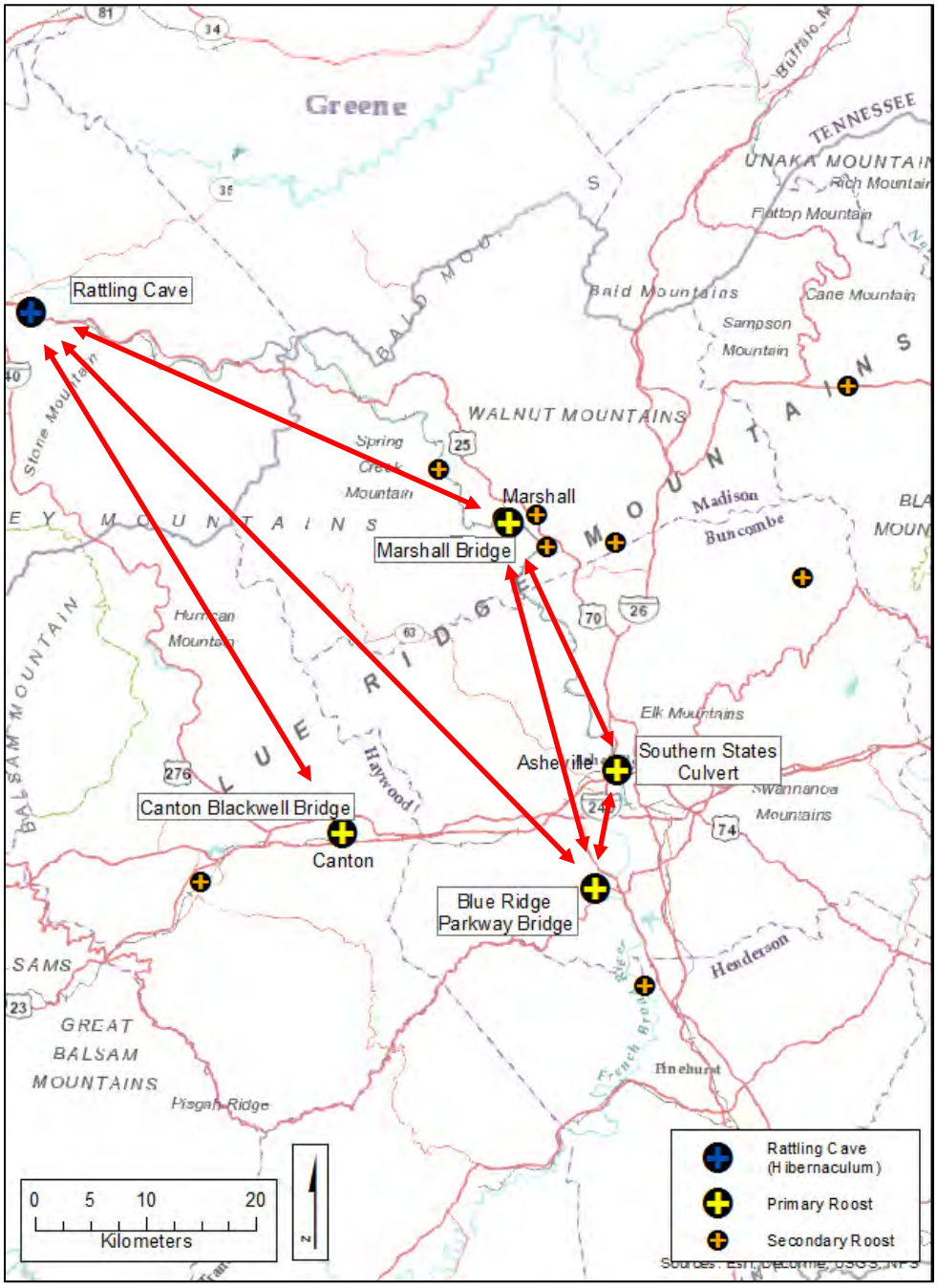

Figure 4. Gray bat roosts in the French Broad River Basin in North Carolina as of November 2018. Primary roosts were used by >100 gray bats and secondary roosts were used by <100 gray bats. Three secondary roosts are hidden under points of primary roosts (Marshall Bridge and Southern States Culvert). Arrows depict movements (but not necessarily actual routes taken) between primary roosts by individual bats, as recorded by radio-telemetry and capture data. Rattling Cave (a known hibernaculum) is located in Tennessee.

Table 3. Counts of bats observed via exit counts (bold numbers) and spotlight checks at known primary (significant) roosts for the gray bat population in the French Broad River Basin, NC, 2018.

		French Broad River						Pigeon River	
		Blue Ridge Parkway Bridge		Marshall Bridge		Southern States Culvert		Blackwell Canton (NCDOT# 430445)	
Months	Date (2018)	MYGR	UNKWN	MYGR	UNKWN	MYGR	UNKWN	MYGR	UNKWN
Apr	21-Apr	0	0						
	22-Apr	0	0						
	23-Apr	8	0						
	25-Apr								
May	2-May	12	0						
	4-May		1						
	7-May			83	0				
	16-May								
	24-May								
	26-May								
Jun	4-Jun		**373**		**2**	**0**	**0**		
	16-Jun			160	0				
	23-Jun			250	0				
Jul	3-Jul		**731**	**240**	0	0	0		
	8-Jul		11						
	12-Jul			130	0				
	14-Jul			150	0				
	15-Jul			0	0				
Aug	9-Aug		2						
	13-Aug			275	0				
Sep	10-Sep			1005	0				
	13-Sep		**703**	**498**	0	**35**	0		
	14-Sep							**361**	0
	24-Sep			489	0				
Oct	12-Oct		**382**	**8**	0			**61**	**0**
	13-Oct		**546**						
	14-Oct		**687**						
	15-Oct		**623**						
	19-Oct		**322**						
	20-Oct		**235**						
	28-Oct			4	0				

From simultaneous exit counts at known primary roosts, which occurred on 4 June, 3 July, and 13 September, we can assess the size of the gray bat population in the Asheville area. One primary roost was not detected until mid September, so it was not included in earlier counts. Combining data for 13–14 September, there were approximately 1600 bats in the four known primary roosts. Capture data indicates that the BR Parkway holds gray bats and Mexican free-tailed bats in similar numbers (see Table 2; note we do not band TABR so we do not account for recaptures in these data) and fewer big brown bats. We occasionally capture another species at the Marshall Bridge, but these bats are likely just flying through the area. We are confident the numbers in Table 3 represent mainly gray bats. At Southern States Culvert and Blackwell Canton Bridge, our observations during capture surveys suggest the population is entirely gray bats. Further, we are likely undercounting the bats at the Culvert, which has many entrances and is difficult to count.

Counts at secondary roosts were typically made by spotlight checks (Table 4). The 25/70 Bridge and Lower Gabriel's Bridge offer good views of gray bats at roost. We are confident in gray bats use of a hole in the outside of the Marshall Community Center, as we have tracked multiple bats to this building.

Table 4. Counts of bats observed via exit counts (bold numbers) and spotlight checks at known secondary (alternate) roosts for the gray bat population in the French Broad River Basin, NC, 2018.

		Hwy 280 Bridge		25/70 Bridge		Barnard Bridge		Lower Gabriel's Creek Bridge		Clyde McIntosh Bridge		Dillingham Bridge		Marshall Community Center		Al's Used Cars Building		Marshall Sycamore Tree	
	Date (2018)	MYGR	UNKWN	MYGR	UNKWN	MYGR	UNKWN	MYGR	UNKWN	MYGR	UNKWN	MYGR	UNKWN	MYGR	UNKWN	MYGR	UNKWN	MYGR	UNKWN
Apr	22-Apr			0	51		20	7	0										
	23-Apr							7	2										
	24-Apr							5	2										
	27-Apr							17	1										
May	1-May							0	0							**1**	0		
	2-May							2	0										
	4-May													**3**	0				
	5-May							1	0										
	12-May													**0**	0				
	15-May			15															
	22-May			0	25			0	0										
	30-May							0	0										
Jun	4-Jun													**0**	0	**0**	**0**		
	18-Jun																		
	23-Jun			0	50														
Jul	3-Jul			0	15									**0**	0				
	5-Jul									1	0								
	12-Jul							0	0										
Aug	1-Aug											1	0						
	19-Aug									1	0								
	20-Aug	1	0																
	24-Aug								1										
Sep	7-Sep									3	0								
	12-Sep			0				21	10										
	13-Sep													**0**	0				
	19-Sep									1	0								
	24-Sep							0	0										
	30-Sep																	**1**	**0**
Oct	2-Oct													**44**	0				
	12-Oct													**0**	0				

4) Foraging Areas

We conducted ground-based foraging telemetry in 3 areas. Near the Blue Ridge Parkway Bridge we tracked 3 gray bats while they foraged on 4 nights in July, August, and October (Figure 5a). These bats foraged south of the Blue Ridge Parkway Bridge mostly along the FBR, but also in the Sandy Bottom area across Hwy 191. In Asheville we tracked 3 bats while they foraged in and near the I-2513 Project Study Area (Figure 5b and Figure 6). For one of these bats, NCWRC A3740, we were able to obtain a relatively complete foraging range, except for when we lost her on the Biltmore Estate and Biltmore Farms properties. On 1 night in May we tracked a male bat north of Asheville (~10 km) near Hwy 251 along the FBR (Figure 7a). In May we also tracked a female bat ~0.9 km northwest of the Marshall Bridge while she foraged along the FBR (Figure 7b).

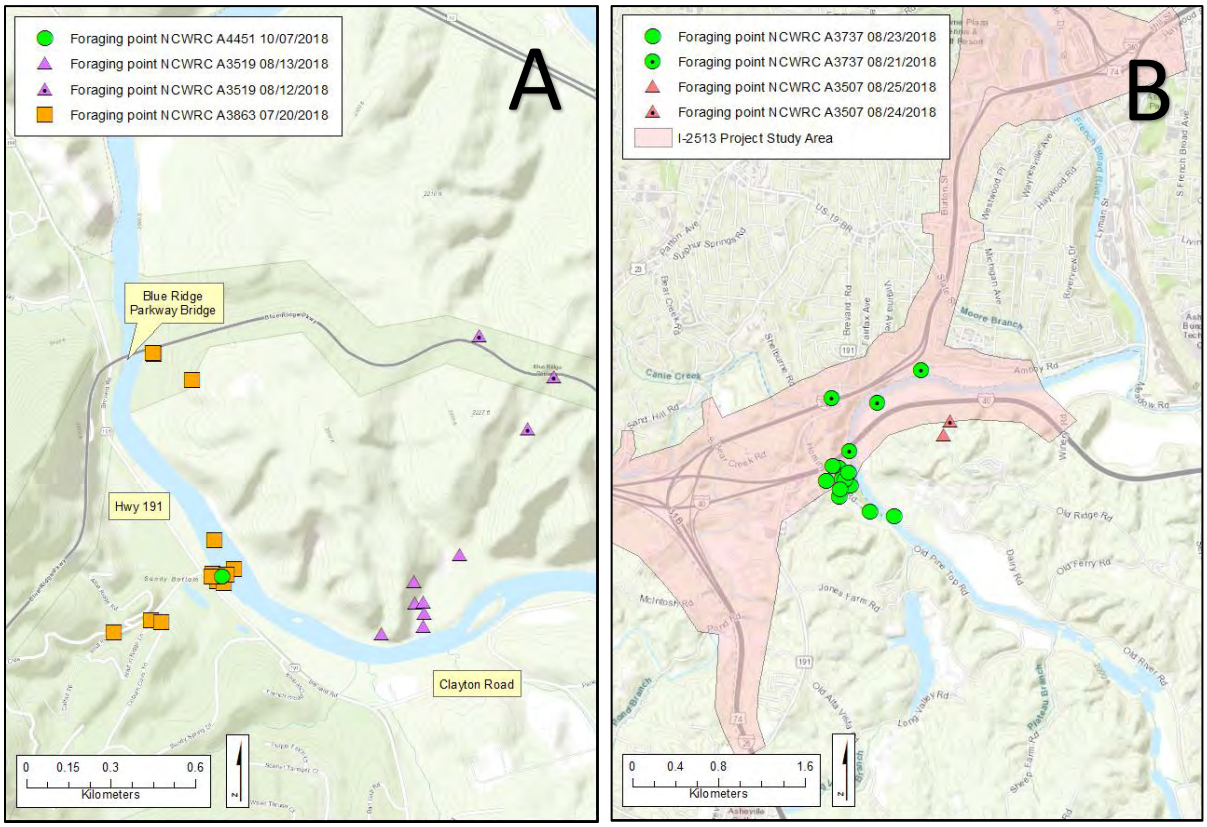

Figure 5. Foraging areas near the Blue Ridge Parkway Bridge and Asheville for 5 gray bats tracked on 8 nights in June, July, August, and October 2018.

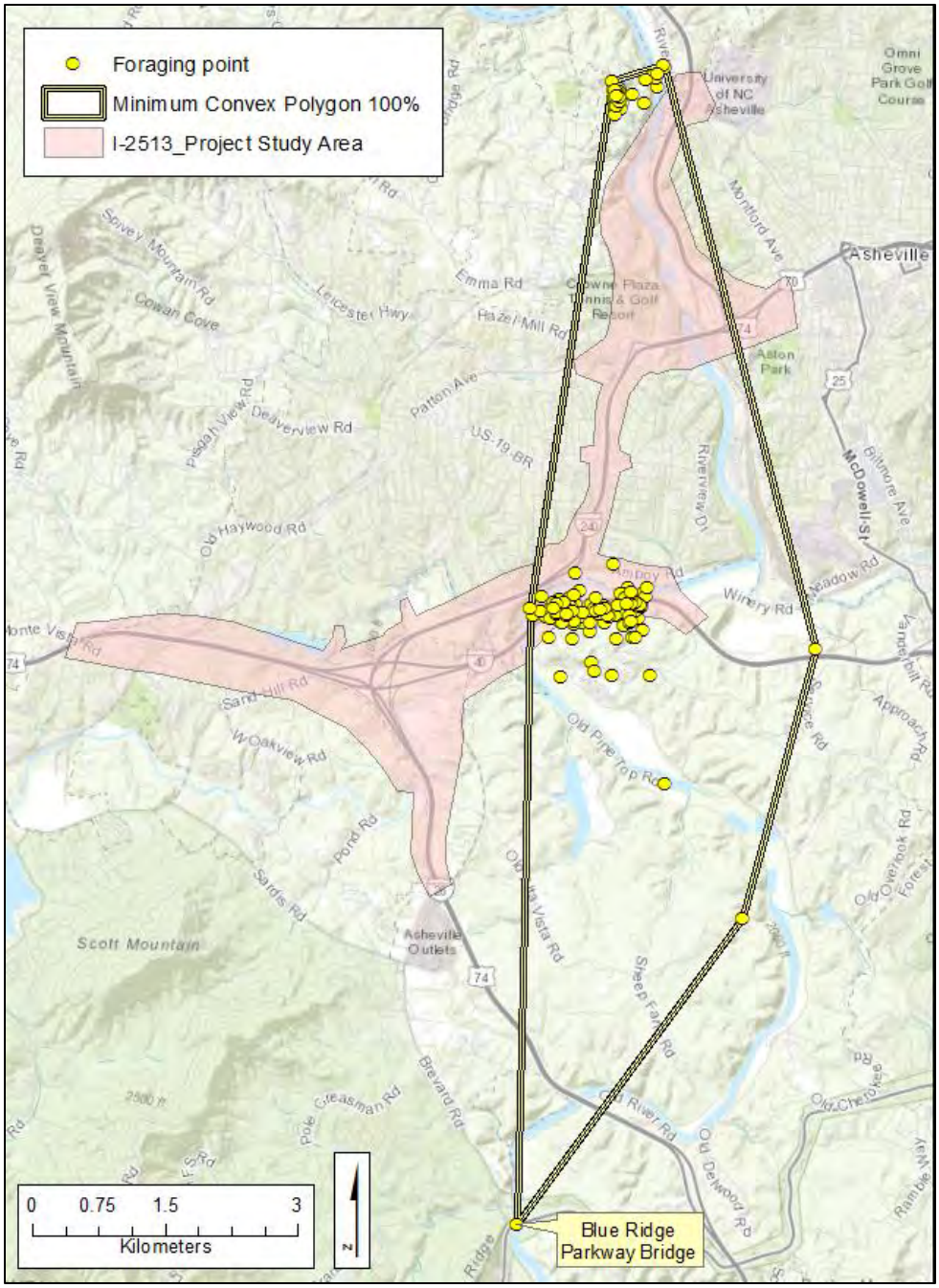

Figure 6. Foraging range of bat NCWRC A3740 in and around Asheville for the dates of 22–30 August 2018. There were 165 foraging points gathered for this bat.

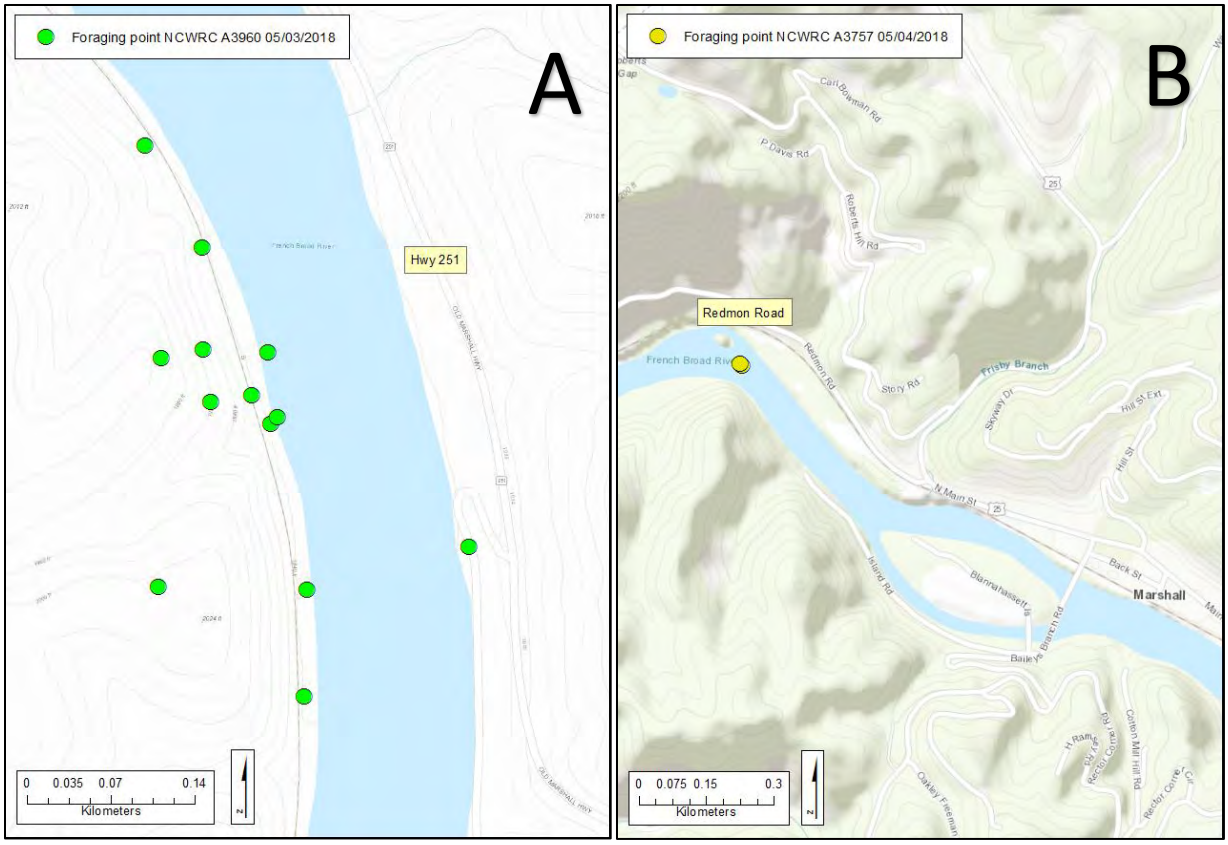

Figure 7. Foraging areas north of Asheville and Marshall for 2 gray bats tracked on 2 nights in May 2018.

We also followed other bats while they foraged by tracking them from a vehicle (but without attempting triangulation, as bats were moving too quickly). We recorded bats foraging along the FBR as far north as Ledges Whitewater River Park (~21.5 km north of the Blue Ridge Parkway Bridge). We tracked foraging bats near the Southern States Culvert, north of the Southern States Culvert behind the Mattress Mart on Riverside Drive and as far north as Ledges Whitewater River Park, west and north of Carrier Park, along the FBR east of the state farmer's market, and at locations between the state farmer's market and south of the Blue Ridge Parkway, including west of Hwy 191. We have tracked radio-tagged gray bats at night everywhere that the connector project I-2513 comes near the FBR. We have followed other foraging bats in Madison County, NC.

We have detected bats on 9 of 16 telemetry towers, mostly along the axis of the FBR north and south of Asheville, but also west along Hominy Creek (Table 5, Figure 3). Activity as measured by the number of tagged bats detected, is highest at N4 (north of Marshall), N1 (within Connector project boundaries), and N2 (Riverside Dr. near water treatment plant) (Table 2). On a few occasions, bats traveled from tower S1 or S2 to N4 in one evening.

Table 5. Number of radio-tagged gray bats detected by each telemetry tower (see Figure 3 for tower locations) from April–November 2018.

Tower	Number of Bats Detected
N1	22
N2	17
N3	14
N4	23
S1	16
S2	6
S3	4
S4	0
W1	6
W2	2
W3	0
W4	0
E1	0
E2	0
E3	0
E4	0

5) Migration Pathway

We did not detect any bats along the east axis of towers, nor on West 3–4. However, we did not deploy coded tags at the Blackwell Canton Bridge until mid-October, so we may have missed the opportunity to detect bats from this bridge on towers W1–W4. Most activity was along the north-south axis of the FBR throughout the three tracking periods and these data strongly suggest the north portion of the FBR is a migration corridor. We will analyze the data for individual bats to look for patterns in movements in fall.

Tracking beeper bats on the ground and via air was difficult due to weather. We did not detect bats migrating away from the Asheville area via active radio telemetry. However, we did detect 5 bats at Rattling Cave in Newport, TN (Table 6). Bat 151.513 (BRR A5589) was the only female we detected there; she was radio tagged on 13 October at Blackwell Canton Bridge. This bat foraged around the paper mill along the Pigeon River on the night of 15 October, but disappeared around 23:15 (see Appendix C). The next night, 16 October, we heard her foraging in the same spot, but she disappeared again at 19:50. The plane was grounded that night due to storms. Based on the detection at Rattling Cave the morning of 17 October, we suggest 151.513 traveled to the cave in one night (16–17 October).

Table 6. Bats detected via datalogging receivers positioned at the entrance to Rattling Cave in Newport, TN.

Band #	Radio	Date	Start time
BRR A5589	151.513	10/17/2018	4:47:10
NCWRC A4406	151.148	10/22/2018	22:55:58
BRR A5579	151.239	10/28/2018	23:48:50
NCWRC A4403	151.350	10/31/2018	23:06:50
NCWRC A4451	151.389	11/6/2018	6:16:35
NCWRC A4451	151.389	11/6/2018	6:19:55

Bat 151.148 (NCWRC A4406) was radio tagged at the Southern States Culvert on 10 October. He roosted in the BR Parkway Bridge 16–17 October. He was detected at Rattling Cave on 22 October.

Bat 151.239 (BRR A5579) was radio tagged at the Marshall Bridge on 18 October and detected foraging around the bridge that night (see Appendix C). He roosted in the Marshall Bridge again on 20 October and again 27–28 October. Based on the detection at Rattling Cave the night of 28 October at 23:48, we suggest 151.239 traveled to the cave, 47 km north, in a few hours on one night (28 October).

Bat 151.350 (NCWRC A4403) was radio tagged at Southern States Culvert on 19 October. Shortly after being tagged, he moved to the BR Parkway Bridge (see Appendix C). He roosted in the BR Parkway Bridge until 30 October. He was detected at Rattling Cave on the evening of 31 October.

Bat 151.389 (NCWRC A4451) was radio tagged at BR Parkway Bridge on 3 October. He roosted in the BR Parkway Bridge off and on throughout October and up until 5 November. He was detected at Rattling Cave on the morning of 6 November. Based on the detection at Rattling Cave the morning of 6 November, we suggest 151.389 traveled to the cave, 73 km north, in one night (5–6 November).

It seems likely that more of the Asheville area gray bats are in Rattling Cave, which will be surveyed by TWRA this winter.

Preliminary Conclusions

Acoustic surveys, and to a lesser extent structure checks, indicate that gray bats are relatively widespread in the FBR basin in western North Carolina. We feel that we have not fully captured their distribution with this first year of survey work and, thus, will aim to expand our coverage within the basin via structure checks and acoustic surveys.

This population of gray bats appears to use primarily manmade structures (bridges, culverts, and buildings). However, because we often lost radio-tagged bats, we believe there are additional roosts in the FBR basin that are still to be found. In 2019, we plan to use Copperhead Consulting for aerial surveys during parts of the summer in order to find some of those unknown roosts. Primary bridge roosts were mainly concrete bridges over relatively large bodies of water. The bats roosted in large expansion joints, which were sometimes covered in metal (BR Parkway and Canton bridges). Secondary roosts tended to be in bridges, but were also in buildings near primary roosts. Two secondary roosts were over small streams.

This gray bat population forages mainly over water, usually the FBR and associated tributaries. The bats appear to be comfortable foraging in the urban areas of Asheville (see Figure 6, for example), but also use less developed lands like the Biltmore Estate and Farms and the FBR near Marshall, NC.

While we did not successfully track bats as they migrated, the relatively quick movements between known roosts and Rattling Cave indicates that bats can travel fairly quickly. Based on what is known of the gray bat's biology (see Appendix B), we suspect these bats traveled mainly via the major river corridors (French Broad and Pigeon Rivers). We will deploy Copperhead Consulting earlier in the fall of 2019 in hopes of capturing the flights of females as they move to hibernacula.

APPENDIX E. MUSSEL SURVEY REPORT

Freshwater Mussel Surveys:

I-26 Connector Final Report

TIP No. R-2513

WBS 34165.1.2

Buncombe County, North Carolina

Creeper in situ French Broad River Site 171005.2ted

Prepared For:

NC Department of Transportation
Raleigh, North Carolina

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January 3, 2018

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Table of Contents

Appendix A Figures:

1.0 INTRODUC TION

The North Carolina Department of Transportation (NCDOT) proposes an I-26 connector (TIP No. R-2513) in Buncombe County, North Carolina (Figure 1). The project will cross streams in the French Broad River Basin. The Federally Endangered Appalachian Elktoe (*Alasmidonta raveneliana*) is listed by the U.S. Fish and Wildlife Service (USFWS) for Buncombe and Henderson Counties and is currently known to occur in portions of the French Broad River Basin in Henderson County. The Federally Endangered Tan Riffleshell (*Epioblasma florentina walkeri*) is listed by the USFWS for Buncombe County as "Historic and Obscure" based on museum shell records from the early 20th century collected from the Asheville area, however, the species has not been collected since. Additionally, The NC Scientific Council of Mollusks 2010 reevaluation of the listing status of NC mollusks recommended the species status be changed from Endangered to Extirpated, a recommendation which was accepted in February 2011. As such, the project will have "No Effect" on the Tan Riffleshell.

According to the NC Natural Heritage Program database (NCNHP 2017), two element occurrence (EO) for Appalachian Elktoe are located near the Project Study Area (Figure 2). The most downstream EO (EO ID: 21150) is a historic record located in the French Broad River at the study area. This occurrence includes part of the Swannanoa River, is about 5.3 RM in length, and captures the original description of the species collected in the early 19th century. Continuing upstream, there is a current EO in the Mills River (EO ID: 7990) approximately 2.8 RM in length. It is approximately 18.9 RM upstream of the I-40 crossing of the French Broad River in the study area, was first observed in July 2003 and last observed in October 2014.

As part of the federal permitting process that requires an evaluation of potential project-related impacts to federally protected species, Three Oaks Engineering (Three Oaks) was contracted by NCDOT to conduct surveys targeting Appalachian Elktoe.

2.0 WATE RS IMP ACTED

The project is located in the Upper French Broad River subbasin (HUC# 06010105).

2.1 303(d) Classification

French Broad River is listed on the NCDWR 2014 303(d) list of impaired streams for fecal coliform approximately 9.1 RM upstream of the study area (Figure 3). Additionally, the French Broad River is also listed for Benthos (fair) greater than 10 RM downstream of the study area.

2.2 NDPES dischargers

There are multiple minor permitted NPDES dischargers in the French Broad survey area. Two major permitted dischargers in the immediate vicinity of the study area are the Asheville Steam Electric Power Plant (NC 0000396) and the French Broad River WRF (NC0024911) (Figure 3).

3.0 TARGET FEDERALLY PROTECTED SPECIES DESCRIPTIONS

3.1 Appalachian Elktoe (Alasmidonta raveneliana)

3.1.1 Characteristics

Isaac Lea (1834) described Appalachian Elktoe from the French Broad River system in North Carolina. Its shell is thin, but not fragile, oblong and somewhat kidney-shaped, with a sharply rounded anterior margin and a broadly rounded posterior margin. Parmelee and Bogan (1998) site a maximum length of 3.1 inches (80 mm). However, recently observed individuals from the Little River (French Broad River Basin) in Transylvannia County and West Fork Pigeon River (French Broad River Basin) in Haywood County measured in excess of 3.9 inches (100 mm) in length (USFWS 2009). The periostracum (outer shell) of the adult Appalachian Elktoe varies in color from dark brown to yellowish-brown. Rays may be prominent in some individuals, usually on the posterior slope, and nearly obscure in other specimens. The nacre (inside shell surface) is a shiny bluish white, changing to salmon color in the beak cavity portion of the shell. A detailed description of the shell characteristics is contained in Clarke (1981). Ortmann (1921) provides descriptions of the soft anatomy.

The reproductive cycle of Appalachian Elktoe is similar to that of other native freshwater mussels. Males release sperm into the water column, and the sperm are then taken in by the female through their siphons during feeding and respiration. The females retain the fertilized eggs in their gills until the larvae (glochidia) fully develop. The mussel glochidia are released into the water, and within a few days they must attach to the appropriate species of fish, which they parasitize for a short time while they develop into juvenile mussels. They then detach from their fish host and sink to the stream bottom where they continue to develop, provided they land in a suitable substrate with the correct water conditions (USFWS 2002).

Many mussel species have specific fish hosts that must be present to complete their life cycle. Based upon laboratory infestation experiments (Watters 1994), Banded Sculpin (*Cottus carolinae*) was identified as a potential fish host for Appalachian Elktoe; however, the ranges of these two species rarely overlap. Keller documented transformation of Appalachian Elktoe glochidia on Mottled Sculpin (*Cottus bairdi*) in 1999 (USFWS 2002), and ongoing research at Tennessee Technical University (TTU) identified 10 fish species with encysted Appalachian Elktoe glochidia from the Little Tennessee River in North Carolina (Jim Layzer and Kendall Mole, TTU personal communication; Table 1).

Table 1. Fish species collected from the Little Tennessee River (NC) that contained encysted *Alasmidonta raveneliana* glochidia.

Common Name	Scientific Name
Banded Darter	*Etheostoma zonale*
Wounded Darter	*Etheostoma vulneratum*
Greenfin Darter	*Etheostoma chlorobranchium*
Tangerine Darter	*Percina aurantiaca*
Mottled Sculpin	*Cottus bairdi*
Black Redhorse	*Moxostoma duquesnei*
River Redhorse	*Moxostoma carinatum*
Sicklefin Redhorse	*Moxostoma sp.*
Northern Hog Sucker	*Hypentelium nigricans*
Warpaint Shiner	*Luxilus coccogenis*

Additionally, nine of the species shown in Table 2 were shown to successfully transform Appalachian Elktoe glochidia in laboratory induced infestations (Jim Layzer and Kendall Mole, TTU, personal communication). Based on over two years of ongoing monitoring of Appalachian Elktoe population in the Little Tennessee River by the NC Wildlife Resource Commission (NCWRC), it is apparent that Appalachian Elktoe is a bradytictic (long-term) breeder, with the females retaining glochidia in their gills from late August to mid-June (USFWS 2009). Glochidia are released in mid-June attaching to either the gills or fins of a suitable fish host species, and encysting within 2-36 hours. Transformation time (time until encystment) for Appalachian Elktoe occurs within 18-22 days at a mean temperature of 18° C (Jim Layzer, TTU, personal communication). Encystment time for freshwater mussels is reduced at higher temperatures (Zale and Neves 1982). McMahon and Bogan (2001) and Pennak (1989) should be consulted for a general overview of freshwater mussel reproductive biology.

Table 2. Fish species collected from the Tuckasegee River (NC) on April 21, 2004, and used for laboratory induced infestations.

Common Name	Scientific Name	Number
Gilt Darter	*Percina evides*	6
Banded Darter	*Etheostoma zonale*	8
Wounded Darter *	*Etheostoma vulneratum*	17
Greenfin Darter *	*Etheostoma chlorobranchium*	32
Greenside Darter *	*Etheostoma blennioides*	3
Olive Darter	*Percina squamata*	1
Mottled Sculpin *	*Cottus bairdi*	19
Rock Bass	*Ambloplites rupestris*	1
River Chub *	*Nocomis micropogon*	20
Northern Hogsucker *	*Hypentelium nigricans*	3
Central Stoneroller *	*Campostoma anomalum*	6
Longnose Dace *	*Rhinichthys cataractae*	9
Rosyside Dace *	*Clinostomus funduloides*	1
Mirror Shiner	*Notropis spectrunculus*	3

Common Name	Scientific Name	Number
Tennessee Shiner	*Notropis leuciodus*	2
Total	**15**	**131**

* Species that successfully transformed *Alasmidonta raveneliana* glochidia.

3.1.2 Distribution and Habitat Requirements

Appalachian Elktoe is known only from the mountain streams of western North Carolina and eastern Tennessee. Historically, the species has also been recorded from Tulula Creek (Tennessee River drainage), the main stem of the French Broad River, and the Swannanoa River (French Broad River system) (Clarke 1981), but it was reported to have been eliminated from these streams (USFWS 1994; USFWS 1996). Currently, it is known to occur in low numbers in a reach of the mainstem French Broad River in Transylvania County (see discussion below). It is unclear whether this represents a re-colonization, or an erroneous conclusion of extirpation. There is also a historical record of Appalachian Elktoe from the North Fork Holston River in Tennessee (S.S. Haldeman collection); however, this record is believed to represent a mislabeled locality (Gordon 1991). If the historical record for the species in the North Fork Holston River was a valid record, the species has apparently been eliminated from this river as well.

Although the complete historic range of Appalachian Elktoe is unknown, available information suggests that the species once lived in the majority of the rivers and larger creeks of the upper Tennessee River system in North Carolina, with the possible exception of the Hiwassee and Watauga River systems (the species has not been recorded from either of these river systems). At the time of listing, two known populations of the Appalachian Elktoe existed, the Nolichucky River including its tributaries, the Cane River and the North Toe River, and the Little Tennessee River and its tributaries. The record in the Cane River was represented by one specimen found just above the confluence with the North Toe River (USFWS 1996). Since listing, the Appalachian Elktoe has been found in additional areas. These occurrences include extensions of the known ranges in the Nolichucky River (North Toe River, South Toe River and Cane River) and Little Tennessee River (Tuckasegee River and Cheoah River) as well as a rediscovery in the French Broad River Basin (Pigeon River, Little River, Mills River and main stem French Broad River). Many of these newly discovered populations are relatively small in size and range.

Of the known surviving Appalachian Elktoe populations, two – the Nolichucky River system population and the Tuckasegee River population – currently appear to meet the definition of a viable population given in the Recovery Plan (though the number of individuals needed to comprise a viable population is presently unknown and is one of the tasks identified in the Recovery Plan to be completed).

The other populations of Appalachian Elktoe currently appear to be comprised of scattered individuals restricted to very short stream reaches and their viability is questionable (USFWS 2009). The Cheoah River, Pigeon River, Little River, Mills River and French Broad River populations are restricted to scattered areas of suitable habitat in stream reaches of approximately 5.8 km (3.60 RM), 22.6 km (14.04 RM), 17.8 km (11.1 RM), 3.2 km (2.0 RM), and 28 km (17.4 RM), respectively, making them vulnerable to extirpation from a single catastrophic event such as a major chemical spill (USFWS 2009).

3.1.3 Threats to Species

The decline of Appalachian Elktoe throughout its historic range has been attributed to a variety of factors, including sedimentation, point and non-point source pollution, and habitat modification (impoundments, channelization etc.).

The low numbers of individuals and the restricted range of most of the surviving populations make them extremely vulnerable to extirpation from a single catastrophic event or activity. Catastrophic events may consist of natural events such as flooding or drought, as well as human influenced events such as toxic spills associated with highways or railroads.

Siltation resulting from improper erosion control of various types of land usage, including agricultural, forestry, and development, has been recognized as a major contributing factor to degradation of mussel populations (USFWS 1996). Siltation has been documented to be extremely detrimental to mussel populations by degrading substrate and water quality, increasing potential exposure to other pollutants, and direct smothering of mussels (Ellis 1936, Marking and Bills 1979). Sediment accumulations of less than 1 inch have been shown to cause high mortality in most mussel species (Ellis 1936). In Massachusetts, a bridge construction project decimated a population of the endangered Dwarf Wedgemussel (*Alasmidonta heterodon*) because of accelerated sedimentation and erosion (Smith 1981). The abrasive action of sediment on mussel shells has been shown to cause erosion of the outer shell, which allows acids to reach and corrode underlying layers (Harman 1974).

The impact of impoundments on freshwater mussels has been well-documented (USFWS 1992, Neves 1993). Construction of dams transforms lotic habitats into lentic habitats, which results in changes with aquatic community composition. These changes associated with inundation adversely affect both adult and juvenile mussels as well as fish community structure, which could eliminate possible fish hosts for glochidia (Fuller 1974). In addition, the construction of dams often results in fragmentation of mussel populations by effectively blocking upstream expansion and recruitment of mussel and fish species. Along with modification of habitat, dams can indirectly impact freshwater mussel species by posing as a barrier to fish migration. The construction of the Petitcodiac River Causeway in Canada in 1968, resulted in the extirpation of the Dwarf Wedgemussel because the causeway restricted the migration of the diadromous Inner Bay of Fundy stock of Atlantic salmon (*Salmo salar*), which served as the fish host for the Dwarf Wedgemussel in this region (Locke et al. 2003).

Sewage treatment effluent has been documented to significantly affect the diversity and abundance of mussel fauna (Goudreau et al. 1988). Goudreau et al. (1988) found that recovery of mussel populations might not occur for up to 2 mi (3.2 km) below points of chlorinated sewage effluent. Most of the water bodies where Appalachian Elktoe still exist have relatively few point source discharges within the watershed and are rated as having ‘good’ to ‘excellent’ water quality (NCDWQ 2012, USFWS 1996).

The introduction of exotic species such as the Asian Clam (*Corbicula fluminea*) and Zebra Mussel (*Dreissena polymorpha*) has also been shown to pose significant threats to native freshwater mussels. The Asian clam is now established in most of the major river systems in the

United States (Fuller and Powell 1973). Concern has been raised over competitive interactions for space, food, and oxygen between this species and native mussels, possibly at the juvenile stages (Neves and Widlak 1987; Alderman 1997). When Appalachian Elktoe was listed, it was speculated that due to its restricted distribution, it "may not be able to withstand vigorous competition" (USFWS 1996).

The Zebra Mussel, native to the Black, Caspian and Aral Seas, is an exotic freshwater mussel that was introduced into the Great Lakes in the 1980s. Since its introduction, this species has rapidly expanded its range into the surrounding river basins, including those of the South Atlantic slope (O'Neill and MacNeill 1991). This species competes for food resources and space with native mussels and is expected to contribute to the extinction of at least 20 freshwater mussel species if it becomes established throughout most of the eastern United States (USFWS 1996). The Zebra Mussel is not currently known from any river supporting Appalachian Elktoe populations.

Another exotic species that has the potential to adversely impact aquatic species, including Appalachian Elktoe, is Japanese Knotweed (*Fallopia japonica*). The plant is considered to be an invasive species that can reproduce from its seed or from its long, stout rhizomes. It can tolerate a variety of conditions such as full shade, high temperatures, high salinity, and drought. It can be spread by wind, water, and soil movement to an area where it quickly forms dense thickets that excludes native vegetation and greatly alters the natural ecosystem. This species has become established in riparian habitats throughout western North Carolina. The species has a very shallow root system; because of this shallow root system and its preclusion of other vegetation, areas where this species has been established may be susceptible to erosion during flood events.

3.2 Tan Riffleshell (Epioblasma florentina walkeri)

3.2.1 Characteristics

Two subspecies of *Epioblasma florentina* are currently recognized based on differences in shell morphology; the Tan Riffleshell (*Epioblasma florentina walkeri*), described by Wilson and H. W. Clark (1914) from the East Fork of the Stones River, Rutherford County, Tennessee and the Yellow Blossom (*E. florentina florentina)* described from the Tennessee River in Florence, Alabama by Issac Lea (1857). These two purported subspecies represent two extremes of a cline, with the Yellow Blossom being the "big river form" and the Tan Riffleshell the "headwater form". The Yellow Blossom form occurring in big rivers is presumed extinct and the Tan Riffleshell form occurring in head water streams is very restricted. In 1976, the US Fish and Wildlife Service (USFWS) listed the Yellow Blossom (*E. florentina*) as endangered. While Turgeon et al. (1988, 1998) did not recognize the separate subspecies, the USFWS listed the Tan Riffleshell as a subspecies and endangered in 1977.

The Tan Riffleshell is a relatively small mussel, seldom exceeding 60 mm in length. Its periostracum is a dull brownish green or yellowish green in color with numerous faint green rays evenly distributed over the entire valve surface; the nacre is a bluish white. Its shell outline is irregularly elliptical or obovate with inequilateral valves, subinflated, and rather solid. Both valves contain two small triangular pseudocardinal teeth. Lateral teeth are double in the left

valve, single or sometimes double in the right; they are short and curved. Anterior muscle scars are well impressed, while posterior muscle scars are shallow; the pallial line is distinct only anteriorly.

The Tan Riffleshell shows sexual dimorphism in many features. Males have a slightly protruding posterior end while females have a pronounced posterior marsupial swelling defined by anterior and posterior sulchi and are often serrated along the ventral margin. The posterior ridge of the male shell appears faintly doubled, ending in a slight biangulation posteriorly while it is scarcely visible in females. In male shells the umbo is quite full and elevated and located slightly anterior of middle while in female you find it in the anterior third of the shell. Additionally, the posterior end of female shell is especially thin and iridescent.

Like many other freshwater mussels, life history information is limited for this species. It is assumed that their reproductive cycle is like that of other native freshwater mussels (See Section *3.1.1*). They then detach from their fish host and sink to the stream bottom where they continue to develop, provided they land in a suitable substrate with the correct water conditions (USFWS 2002). Rogers et al. (2001), working with the Indian Creek population in southwest Virginia, reported collecting gravid females of the Tan Riffleshell from February through August with glochidia being released principally in May and June. A fecundity estimate of almost 20,000 glochidia from one female was made. Maximum age of individuals from this population was estimated at 11 years based on shell thin sections (Rogers et al. 2001).

Laboratory tests of the Tan Riffleshell glochidia resulted in identification of five species of fish as suitable hosts (Table 3) (Watson and Neves 1996; Rogers et al. 2001). Of the 16 species tested, it was the benthic, riffle dwelling species that were successful fish hosts (Rogers et al. 2001).

Table 3. Laboratory identified fish hosts for Tan Riffleshell

Common Name	Scientific Name
Banded Sculpin	*Cottus bairdi*
Mottled Sculpin	*Cottus carolinae*
Greenside Darter	*Etheostoma blennioides*
Fantail Darter	*Etheostoma flabellare*
Redline Darter	*Etheostoma ruflineatum*

3.2.2 Distribution and Habitat Requirements

Historically the Tan Riffleshell was wide spread in the headwaters of the Tennessee and Cumberland River drainages. Recent populations of the Tan Riffleshell have been reported from the Duck River (Tennessee), Hiwassee River (Tennessee), Middle Fork Holston River (Virginia), Clinch River (Virginia), Indian Creek (Virginia), and the Big South Fork Cumberland River (Tennessee) (Parmalee and Hughes 1994; Rogers et al. 2001; Jones et al. 2004; Jones et al. 2006). The Tan Riffleshell is known in North Carolina from two museum lots from the French Broad River, Asheville, Buncombe County [identifications by D. H. Stansbery and confirmed by J. W. Jones].

Extant populations of the Tan Riffleshell in the Clinch (Virginia) and Hiwassee (Tennessee) River drainages are found in less than three feet of flowing water in a substrate of coarse sand, gravel, and some silt (Parmalee and Hughes 1994).

3.2.3 Threats to Species

Threats to the Tan Riffleshell are similar to those described for the Appalachian Elktoe and have contributed to the decline of this species throughout its range. All the remaining Tan Riffleshell populations are generally small in numbers and restricted to short reaches of isolated streams. The low numbers of individuals and the restricted range of most of the surviving populations make them extremely vulnerable to extirpation from a single catastrophic event.

4.0 MUSSEL SURVEY EFFORTS

Surveys were led by Three Oaks Engineering with the personnel listed on the following dates (Table 4):

Table 4. Survey Dates and Personnel

Date	Surveyors
6-12-17	Tom Dickinson (TD, Permit 17-ES00343), Jonathan Hartsell (JH)
8-25-17	Tim Savidge (TS, Permit 17-ES0034), John Fridell (JF), Mary Frazer (MF), Luke Etchinson (NCWRC, LE), Morgan Harris (NCWRC, MH)
10-5-17	TD, Lizzy Stokes-Cawley (LSC), Chris Sheats (CS)
10-6-17	TS, Evan Morgan (EM), Nathan Howell (NH), LE, MH

4.1 Survey Methodology

Mussel surveys were conducted at ten distinct sites: eight sites in the French Broad River and two sites in Hominy Creek (Figure 4). The reach length and methodologies were determined individually for each site in the field based on habitat and survey conditions and survey crew size. Areas of appropriate habitat were searched, concentrating on the stable habitats preferred by the target species. The survey team spread out into survey lanes. Visual surveys were conducted using either mask/snorkel, SCUBA, glass bottom view buckets (bathyscopes), or a combination of the above depending upon survey conditions. Tactile methods were employed, particularly in streambanks under submerged rootmats. Further description of the methodologies used for each site are provided by site. All freshwater bivalves were recorded and returned to the substrate. Timed survey efforts provided Catch Per Unit Effort (CPUE) data for each species. Relative abundance for freshwater snails and freshwater clam species were estimated using the following criteria:

- (VA) Very abundant > 30 per square meter
- (A) Abundant 16-30 per square meter
- (C) Common 6-15 per square meter
- (U) Uncommon 3-5 per square meter
- (R) Rare 1-2 per square meter
- (P-) Ancillary adjective "Patchy" indicates an uneven distribution of the species within the sampled site.

5.0 MUSSEL SURVEY RESULTS

The following details survey results for the project by site.

5.1 Hominy Creek 170612.1 ted

This survey reach extends from Hominy Creek's confluence with the French Broad to the I-40 crossing. The creek was approximately 60 feet wide with banks 10 to 12 feet high that exhibited some erosion and undercutting. Habitat consisted of a shallow run with primarily fine unconsolidated shifting sand and silt substrates. A total of 1.6-person hours of survey time with bathyscopes was spent in the reach during which no mussels were located. The only mollusk species found was the Asian Clam, which was uncommon. A narrow buffer was present to surrounding urban land uses.

5.2 Hominy Creek 170612.2ted

This survey was conducted in the vicinity of the South Bear Creek Road crossing. The creek was approximately 50 feet wide with banks over 12 feet high that were stabilized with rock. Habitat consisted of a riffle, run, pool sequence. Unconsolidated sand and silt substrates were dominant, with areas of gravel, cobble, and boulder interspersed in the reach. A total of 1.33-person hours of survey time with bathyscopes was spent during which no mussels were located. The only mollusk species found was the Asian Clam, which was uncommon. A narrow to nonexistent buffer was present to surrounding residential land use.

5.3 French Broad River Site 170825.1tws

The survey reach occurs adjacent to Carrier Park. Surveys were completed by a five-person crew using mask/snorkel focusing mainly on areas considered to provide the best habitat attributes for the targeted species based on professional opinion. However, all in-stream habitat types (pool, riffle, slackwater, etc.) were surveyed to some degree. Each surveyor stayed in a loosely defined survey lane of variable width, but were basically segmented into left, middle, and right thirds of the river. Surveys proceeded in an upstream direction in a zigzag manner and generally followed the upstream transitions between microhabitats. The rate at which the surveyor moved through the lane was dependent on microhabitat conditions within the respective lanes to maximize coverage of the "best" habitats. For example, an area of solid bedrock, with no crevices, or a slackwater areas with large accumulations of silt, which are generally considered "poor" habitat for mussels were traversed more quickly than a bedrock area with crevices, or a cobble/gravel dominated area.

The river was approximately 170-210 feet wide in this location with relatively stable banks up to 16 feet high. Wooden steps and a gravel ramp used for hand launching small vessels (canoes, kayaks, inflatable rafts, etc.) occurred along the left descending bank near the upstream portion of the reach. Water depth ranged from six inches along the bank to four feet in the deepest pools; however, over 70% was between 1.5 and 2.5 feet. The weather was warm and mostly sunny, and the water was clear.

General habitat conditions consisted of a pool/riffle/run sequence with the pool occurring in the upper third of the reach. The substrate was well sorted and consisted of cobble, gravel, and sand with scattered bedrock and boulders. Large boulder accumulations within the general run habitat create pool/riffle/run sequences on a smaller scale. A slackwater area approximately 200 feet long by 20 feet wide occurs along the left descending bank in a back eddy just above the ramp and steps.

A total of 8.75 person hours of survey time were spent in the reach during which no mussels were located. The only mollusk species found were the Asian Clam (common), the Pointed Campeloma represented by shell evidence, and Sprite Elimia (patchy uncommon).

5.4 French Broad River Site 170825.2tws

The survey reach occurs adjacent to the French Broad River Park immediately below the Amboy Road crossing, which crosses the river at its confluence with the Swannanoa River. Surveys were completed by a five-person crew using mask/snorkel in a similar manner as site 170825.1tws. The river was approximately 220-235 feet wide in this location with banks up to eight feet high that have been stabilized with rip rap in some areas. Water depth ranged from six inches along the bank to three feet. The weather was warm and mostly sunny, and the water was slightly turbid.

General habitat conditions consisted of a relatively high gradient long riffle/run sequence. The substrate was well sorted and consisted of cobble, gravel, and sand with scattered bedrock and boulders. Large boulder accumulations within the general run habitat create pool/riffle/run sequences on a smaller scale.

A total of 3.33 person hours of survey time was spent in the reach during which no mussels were located. The only mollusk species found were the Asian Clam (abundant), and the Pointed Campeloma and Sprite Elimia (present and patchy common, respectively).

5.5 French Broad River Site 170825.3tws

The survey reach occurs above the Amboy Road crossing and the confluence with the Swannanoa River. Surveys were completed by a four-person crew using mask/snorkel in a similar manner as site 170825.1tws. The river was 250 feet wide in this location with relatively stable banks up to eight feet high. Water depth ranged from six inches along the bank to three feet. The weather was warm and mostly sunny and the water was slightly turbid.

General habitat conditions consisted of a pool/run sequence. The substrate was well sorted and consisted of cobble, gravel, and sand with scattered bedrock and boulder. Large boulder accumulations within the general run habitat created pool/riffle/run sequences on a smaller scale.

A total of 4.0 person hours of survey time was spent in the reach during which no mussels were located. The only mollusk species found were the Asian Clam (abundant) and the Sprite Elimia (patchy common).

5.6 French Broad River Site 171005.2ted

This survey reach was approximately 1,500 feet in length starting near the confluence of Hominy Creek and extending upstream near the Antler Hill Village area of Biltmore. Surveys were completed by a three-person crew using view bathyscopes and mask/snorkel.

The river was approximately 200 feet wide with variably stable to moderately eroded banks six to 10 feet high. Water depths searched ranged from one to three feet. The weather was warm and sunny, and the water was clear.

The survey reach occurred in a section of uniform run habitat with a consistent mix of sand, gravel, and cobble; little bedrock or boulder was present

A total of 4.5 person hours of survey time was spent in the reach. Two Creeper and one individual Eastern Elliptio comprised the mussel species observed (Table 5).

Table 5. CPUE for Freshwater Mussels at Site 171005.2ted

Scientific Name	Common Name	# live	Abundance/ CPUE
Freshwater Mussels			**CPUE**
Elliptio complanata	Eastern Elliptio	1	0.22/hr
Strophitus undulatus	Creeper	2	0.44/hr
Freshwater Snails and Clams			**Relative Abundance**
Corbicula fluminea	Asian Clam	~	C

5.7 French Broad River Site 171005.3ted

This approximately 600-foot reach was surveyed in the vicinity of the Pearson Bridge Road crossing. Surveys were completed by a three-person crew using bathyscopes.

The river was approximately 250 feet wide in this location with generally stable banks 10-15 feet high. The weather was warm and mostly sunny, and the water was clear.

The survey reach occurs within a higher gradient riffle/run section with a large amount of bedrock and boulder and interspersed patches of sand, gravel, and cobble. Riverweed (*Podostemum* sp.) covered all rocky substrates.

A total of 1.5 person hours of survey time was spent in the reach during which no mussels were located. The only mollusk species found were the Asian Clam (common) and the Sprite Elimia (patchy common).

5.8 French Broad River Site 171005.4ted

This approximately 800-foot reach was surveyed in the vicinity of the Salvage Station. Surveys were completed by a three-person crew using bathyscopes.

The river was approximately 280 feet wide in this location with stabilized banks 10-15 feet high. The weather was warm and sunny, and water was clear.

The reach occurs within a riffle/run section with sand, gravel, cobble, and bedrock substrate. Riverweed covered all rocky substrates.

A total of 1.7 person hours of survey time was spent in the reach during which no mussels were located. The only mollusk species found were the Asian Clam (common) and the Sprite Elimia (patchy common).

5.9 French Broad River Site 171006.1tws

The survey reach occurs in the French Broad River at Haywood Bridge Road. Surveys were completed by a five-person crew using mask/snorkel.

The river was approximately118-130 feet wide in this location and the banks approximately 11 feet high with some erosion and undercutting. Water depth ranged from six inches along the bank to four feet in the deepest pools; with the majority of the area between 1.5 and 2.5 feet deep. The weather was cool and mostly sunny and the water was clear.

The survey reach occurs within a riffle/run section below the bridge and a long pool above the bridge. The substrate consisted of bedrock and cobble and gravel and sand of varying depth over bedrock.

A total of 5.0 person hours of survey time was spent in the reach. The only mollusk species found were the Asian Clam (abundant), Sprite Elimia (patchy common), and Pointed Campeloma (present).

5.10 French Broad River Site 171006.2tws

The survey reach occurs in the French Broad River adjacent to Lyman Street at the Foundation. Surveys were completed by a five-person crew using mask/snorkel.

The river was approximately 125-140 feet wide in this location the banks approximately 11 feet high; manmade stabilization is present along the banks. Water depth ranged from six inches along the bank to five feet in the deepest pools; with the majority of the area between 1.5 and 2.5 feet. The weather was cool, mostly sunny, and the water was clear.

The survey reach occurs within a riffle, run, pool sequence. The substrate consisted of cobble and sand of varying depth over bedrock.

A total of 5.0 person hours of survey time was spent in the reach. The Eastern Elliptio was observed along with the Asian Clam and Sprite Elimia (Table 6).

Table 6. CPUE for Freshwater Mussels at Site 171006.2tws

Scientific Name	Common Name	# live	Abundance/ CPUE
Freshwater Mussels			**CPUE**
Elliptio complanata	Eastern Elliptio	1	0.2/hr
Freshwater Snails and Clams			**Relative Abundance**
Corbicula fluminea	Asian Clam	~	A
Elimia proxima	Sprite Elimia	~	P-C

6.0 DISCUSSION/CONCLUSIONS

The Appalachian Elktoe was not found at any sites within the subject study area, but recent survey data indicates Appalachian Elktoe are present in the mainstem French Broad upstream of surveyed sites, approximately 1.5 RM from the study area boundary. These upstream locations are a significant expansion (32 RM downstream) of the previously known extant range of this species in the river. Based on habitat conditions and the difficulty detecting species that are present in low numbers, it is possible that the Appalachian Elktoe occurs at other sites surveyed on the French Broad River, but was not detected. The Tan Riffleshell was not found during the surveys. Records of this species in this portion of the French Broad River Basin are historic.

Based on these survey results, impacts could occur in the project area. Biological conclusions on potential impacts from the project to these two species are provided below.

Biological Conclusion Appalachian Elktoe: Unresolved

Biological Conclusion Tan Riffleshell: No Effect

The USFWS is the regulating authority for Section 7 Biological Conclusions and as such, it is recommended that they be consulted regarding their concurrence with the finding of this document.

7.0 LITERATURE CITED

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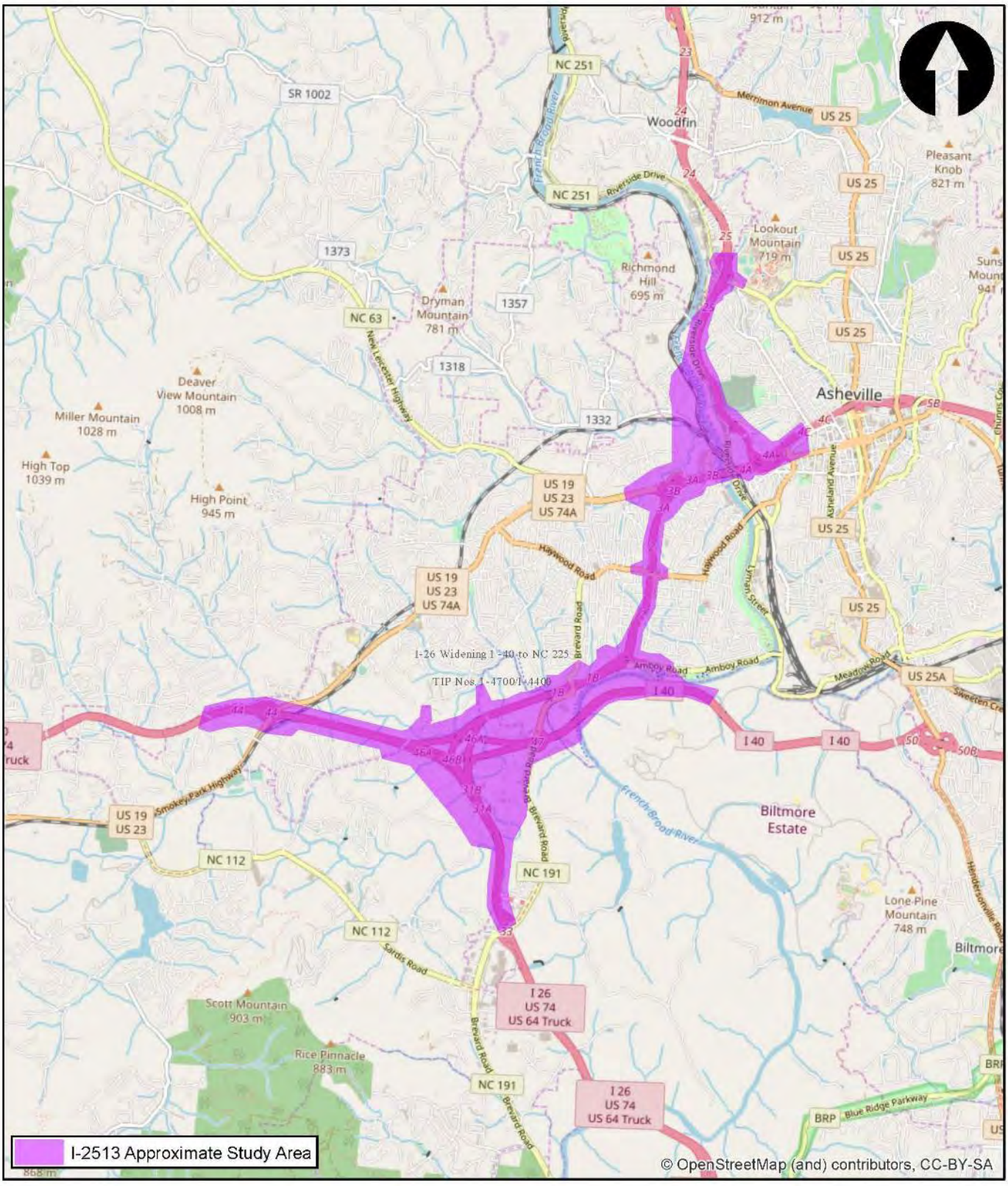
Appendix A: Figures



THREE OAKS ENGINEERING

Prepared For: STATE OF NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

Freshwater Mussel Surveys

I-26 Connector
(TIP No. I-2513)
Vicinity Map

Buncombe County, North Carolina

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Scale:	0 2,000 4,000 Feet
Job No.:	17-311
Drawn By:	KEMS
Checked By:	TED

Figure

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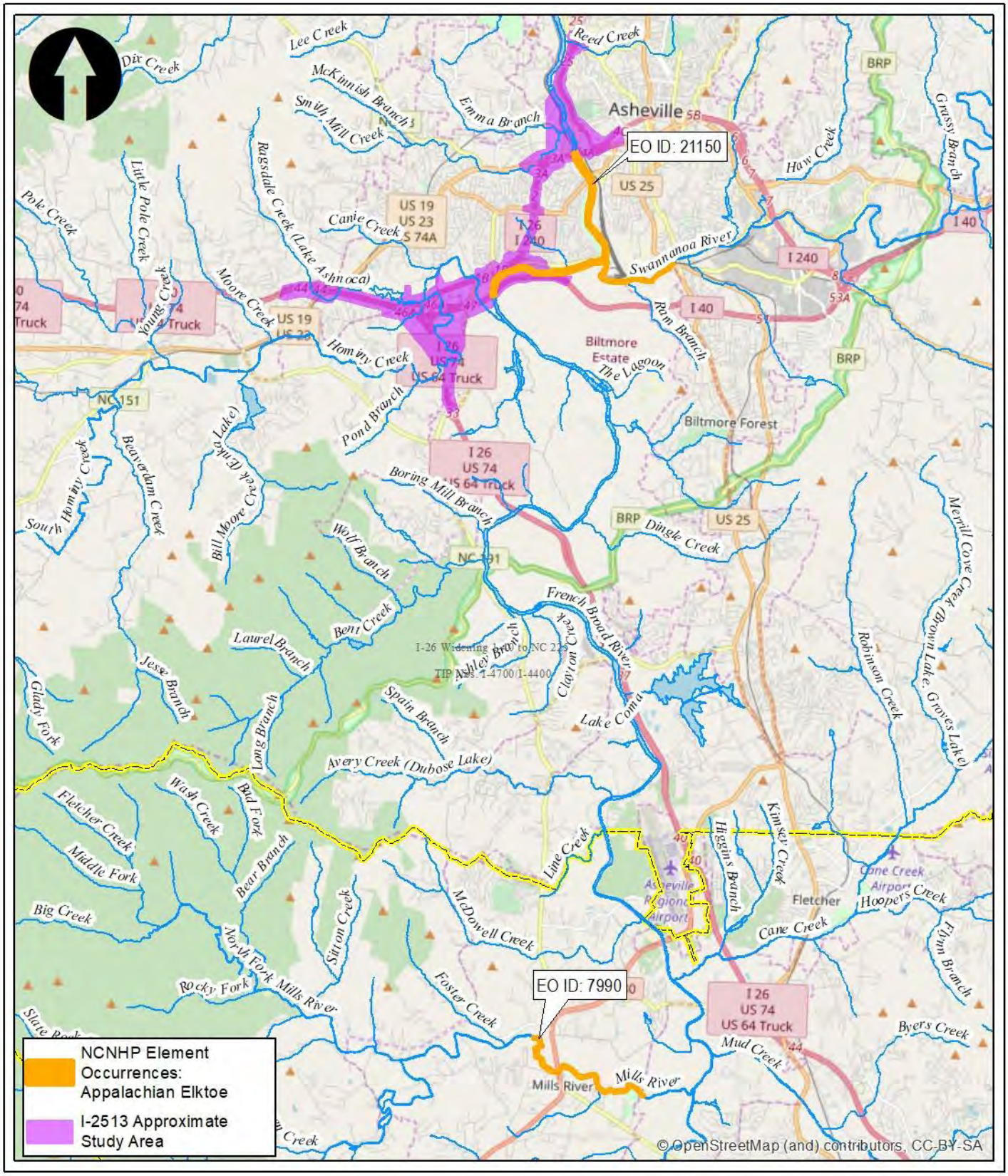

Prepared For:

Freshwater Mussel Surveys

I-26 Connector
(TIP No.I-2513)
NCNHP Element Occurrences:
Appalachian Elktoe

Buncombe County, North Carolina

Date:	November 2017
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Drawn By:	KEMS
Checked By:	TED

Figure

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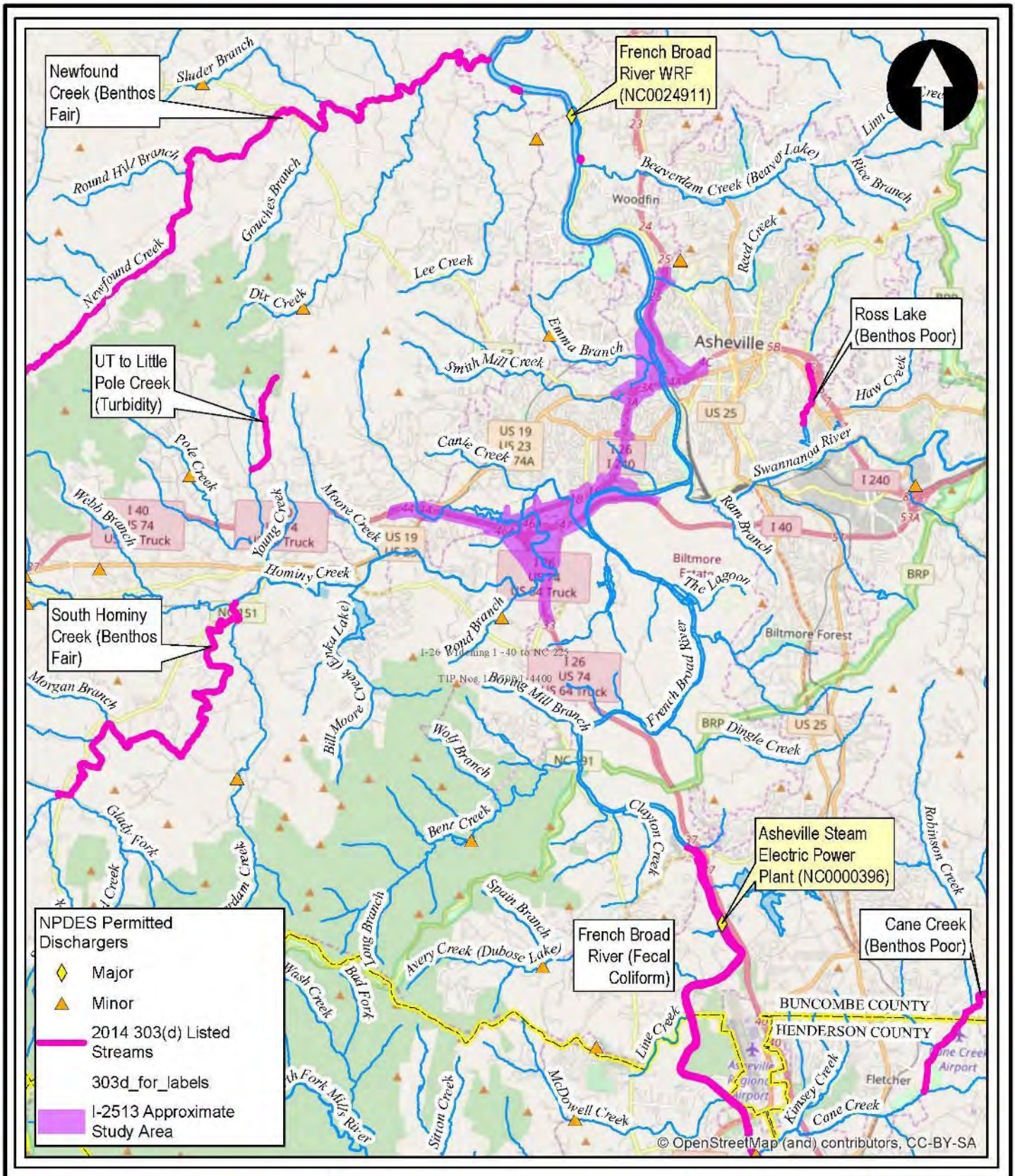

Prepared For:

Freshwater Mussel Surveys

I-26 Connector
(TIP No. I-2513)
NPDES Discharges &
303(d) Listed Streams

Buncombe County, North Carolina

Date:	November 2017
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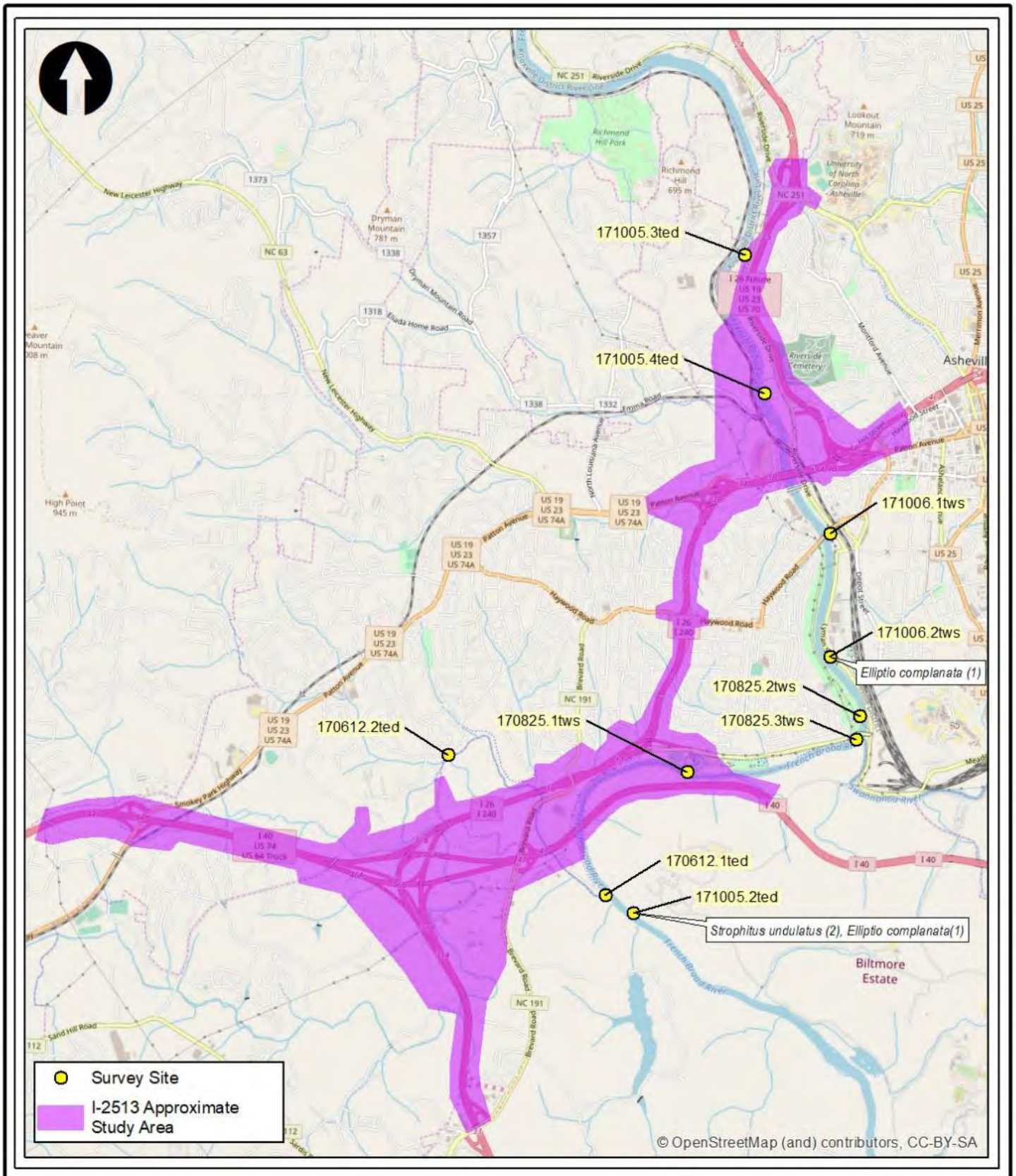
Job No.:	17-311
Drawn By:	KEMS
Checked By:	TED

Figure

3



Prepared For:

Freshwater Mussel Surveys

I-26 Connector
(TIP Nos. I-2513)
Survey Locations

Buncombe County, North Carolina

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Job No.:	17-311
Drawn By:	KEMS
Checked By:	TED

Figure

4

APPENDIX F. BRIDGE CONSTRUCTION DOCUMENT

I-26 CONNECTOR BRIDGE CONSTRUCTION AND DEMOLITION

I-26 Asheville Connector
Buncombe County, North Carolina

STIP I-2513

North Carolina Department of Transportation

October 2019

1 INTRODUCTION

As part of the North Carolina Department of Transportation's (NCDOT) State Transportation Improvement Program (STIP) Project No. I-2513, the roadways associated with I-40, I-240, and I-26 will be upgraded to accommodate additional traffic needs. The French Broad River, Hominy Creek, Emma Branch, and Smith Mill Creek are bridged by existing and proposed roadways and lie within an area occupied by two federally protected species: gray bat (*Myotis grisescens*) and Appalachian elktoe (*Alasmidonta raveneliana*). For the purposes of securing compliance with Section 7 of the Endangered Species Act and preparing a Biological Assessment (BA) for review by the US Fish and Wildlife Service (USFWS), the NCDOT evaluated the various constraints associated with construction of new bridges, the replacement of existing bridges, and the expansion of roadways and impervious surfaces within the I-2513 project. NCDOT has coordinated with the US Army Corps of Engineers (USACE), USFWS, the Federal Highway Administration (FHWA), NC Department of Water Resources (NCDWR), and the NC Wildlife Resources Commission (NCWRC) to gain input on the considerations and likely construction methods.

NCDOT has identified that the two existing bridges over the French Broad River carrying I-40 will likely be replaced, as will four bridges carrying I-40 and four bridges carrying I-240 over Hominy Creek. Twelve new bridges carrying I-240, I-240 ramps, and I-26 will be constructed on new location. (Note: these bridges may be identified separately however may be a part of a larger structure crossing multiple water bodies.) Preliminary designs were used to establish potential impacts in a "worst-case scenario" given the current designs at the time. This project has been identified to be let as a design-build project, and as such, the final designs may differ from those presented herein.

This document describes the likely structure type, possible construction and demolition staging, and the additional challenges associated with construction and demolition as currently known. All claims are based on the preliminary designs that were utilized during project development, although designs may change during the final design process.

A map key identifying the bridge crossing ID is included in the Appendix.

2 STRUCTURES

2.1 I-40 OVER THE FRENCH BROAD RIVER (FBR-1)

EXISTING

The existing two bridges carry I-40 utilizing eight spans. The bridges are approximately 575 feet long each and have a clear space between them of approximately 35 feet. Each structure has spread footings. The river is approximately 235 feet wide at this location. It is estimated that five bents are located in the waterway.

PROPOSED

The project is still in the preliminary design phase, therefore detailed bridge drawings are not currently available. The bridge pair is expected to be replaced in place by one bridge using three bents, each within the water. Property to the east is owned by the Biltmore Estate and is not available for use during construction. Each side of the river, beneath the bridge, has a greenway trail. Access to the site can be

made by moving goods within the right-of-way of the existing roadway. Property to the west includes a power line right-of-way that may be utilized also. Access will occur parallel to the existing roadway, within the right-of-way. Areas adjacent to the bridges will be cleared to the right-of-way limits; however this area would need to be cleared as part of typical construction process for this project.

For the purposes of establishing a "worst-case scenario" of impacts at this location, a 25x25-foot spread footing has been used for estimates because it covers more square footage of the river bottom. Using the basic estimate for a "worst case", spread footings may cover as much as 6,600 square feet in the river. Drilled shafts may also be used, but the construction method will ultimately be decided during final design. An uneven span arrangement will allow for avoidance of existing foundations, thereby limiting the river disturbance.

The current bridge foundations exist within the waterway of the French Broad River. During construction, the existing piers will be either removed or cut below water level. To accomplish this, causeways may need to be constructed that, for short durations, cover more than 50 percent of the river. It is estimated that causeways will be used to demolish the existing bridges and to build the new substructure, totaling up to 36,600 square feet coverage (temporary fill) of the riverbed. Further discussion of causeways can be found in section 3.1.

2.2 I-40 over Hominy Creek (HC-1, HC-2, HC-5, HC-6)

Existing

I-40 crosses Hominy Creek in two locations: over Upper Hominy Creek and over Lower Hominy Creek. The existing pair of bridges carrying I-40 eastbound and I-40 westbound over Lower Hominy Creek (HC-5) includes five spans each and are approximately 357 and 345 feet long, respectively. The existing bridges have two bents adjacent to the water's edge currently. The structures have spread footings and the creek is approximately 50 feet wide at this location. The I-40 bridges crossing Upper Hominy Creek are adjacent to the I-26/I-40 interchange. The pair have 3 spans each. The I-40 eastbound bridge (HC-1) is 180 feet long while the westbound bridge (HC-2) is approximately 170 feet long. They currently each have three bents each, none of which are in the water, and are expected to be replaced in kind. The creek is approximately 50 feet wide at this location also.

Proposed

The project is still in the preliminary design phase, so detailed bridge drawings are not currently available. The existing bridges carrying I-40 across Lower Hominy Creek (HC-5) will be replaced by a single bridge in the same location. It is estimated that the bridge will have a total of five spans and one to two bents will be located at the water's edge. Causeways for demolition are anticipated, covering 825 square feet of creek bed, but none are anticipated for construction. No more than 50 percent of the width of the river will be blocked by the causeways at any point during demolition or construction.

The I-40 ramp to NC 191 will be constructed on new location (HC-6). No bents are expected to be located in the water at this location; the bridge is expected to span the creek and no causeways will be needed.

Access to the site may be available via the existing right-of-way. Additional access may be necessary via Hominy Creek Road; however this serves as a main access for the Buncombe County Transfer Station and will likely require an agreement with the county so as not to block access. Parallel access roads may need to be constructed adjacent to the roadway on the west bank, however the area where they may be constructed will be cleared during construction.

The pair of Upper Hominy Creek bridges carrying I-40 eastbound (HC-1) and I-40 (HC-2) westbound east of the I-40/I-26/I-240 interchange are also called for replacement. No new bents are expected in the water. No causeways are anticipated for demolition or construction of these bridges. Access to the site is available via the NCDOT right-of-way on both sides of the creek, and phased construction is expected.

2.3 I-26 over Hominy Creek (HC-3, HC-4, HC-7)

Existing

I-26 crosses Upper Hominy Creek just west of Bear Creek Road (HC-3, HC-4), then it crosses Lower Hominy Creek near Brevard Road (HC-7). The existing pair of bridges over Upper Hominy Creek have 3 spans each. The bridge carrying the eastbound lanes is 170 feet long and the bridge carrying the westbound lanes is 200 feet long. The bridge pair over Lower Hominy Creek utilize 3 spans with continuous girders. They are 300 feet (eastbound) and 330 feet long (westbound). The creek is approximately 50 feet wide at both of these locations along Hominy Creek. The bridges spanning Lower Hominy Creek also span another, potentially historic, bridge. The historic bridge currently functions as a footbridge for greenway traffic and is closed to vehicles. This bridge has a single bent in the waterway of Hominy Creek and is in disrepair.

Proposed

The bridges over Upper Hominy Creek are expected to be replaced in kind, but widened to accommodate 3 lanes of traffic each. No bents are expected to be placed in the water at this location, and no causeways are anticipated for construction. The bents can currently be reached from land, so causeways needed during demolition would be minimal, if even needed at all. The bridges can be accessed via existing right-of-way in this vicinity.

The bridges over Lower Hominy Creek are expected to be replaced with a single bridge structure that spans the creek and the potentially historic bridge. However, this proposal may be altered by the design-build team. As it is shown in the preliminary plans, an uneven span arrangement would be necessary to avoid placing bents in the water and avoid hitting the lower bridge. It is anticipated that one bent could be expected in Lower Hominy Creek, with up to 3 additional bents located near the water. The bridge bents would be separated and offset such that they do not affect the historic bridge. A worst-case estimate assumes that all 4 bents may be placed in the water, with up to 3,125 square feet of spread footings located on the creek bed, depending on final bent design.

2.4 I-40/I-240 Smith Mill Creek and Emma Branch Bridges (SMC-1, SMC-2, SMC-3, SMC-4, SMC-5, SMC-6, SMC-7, SMC-8, SMC-9, EB-1, EB-2, EB-3, EB-4)

Existing

No bridges exist in the project construction area along Smith Mill Creek and Emma Branch. One existing culvert, carrying Resort Drive, will be removed as part of the project.

Proposed

Three bridges and associated ramps are proposed to cross the French Broad River north of existing I-26 (described below in Section 2.5). In addition to crossing the French Broad River, the proposed structure will cross Smith Mill Creek and Emma Branch at 13 locations. No bridge bents are expected to be constructed within the waterway of Smith Mill Creek or other waterways. No causeways are anticipated for the Smith Mill Creek and Emma Branch bridges.

Access to the bridge construction site will be obtained by purchasing right-of-way. Construction activities associated with the structures is expected to occur wholly within the right-of-way. SR 1338 (Emma Road) crosses the alignment and may be needed for construction traffic. Special considerations may need to be taken to accommodate residences along Emma Road. Additionally, the alignment crosses the Norfolk Southern rail corridor and coordination with the rail will be necessary.

2.5 I-26/I-240 Bridges over the French Broad River (FBR-2, FBR-3, FBR-4)

Existing

There are no existing bridges carrying vehicle traffic over the French Broad River downstream of the Captain Jeff Bowen Bridges within the project study area. The project includes new location bridges to carry I-26 and I-240 over the French Broad River. A railroad bridge crosses the French Broad River upstream of the proposed new bridge crossing.

Proposed

Three bridges are proposed to cross the French Broad River north of existing I-26. The Captain Jeff Bowen Bridges that carry existing I-26/I-240/Patton Avenue over the river are to remain in place. The three new bridges include one bridge for carrying I-26 (FBR-3), and two flyover bridges to carry I-240 eastbound (FBR-2) and westbound (FBR-4). The I-26 bridge is expected to be wide enough to carry five lanes of traffic in each direction, though only three through-lanes will be utilized. Additional space is necessary for shoulders and auxiliary lanes. Analyzing a “worst-case scenario”, the footing size estimates for these bridges in the French Broad River are 1,875 square feet (FBR-2), 9,375 square feet (FBR-3), and 1,875 square feet (FBR-4), for a total of 13,125 square feet. It is assumed that 100-foot maximum length curved steel spans will likely be used.

The two flyover bridges carrying I-240 eastbound and westbound are expected to have the same 100-foot curved steel girders. These two bridges will each be smaller than the I-26 bridge. They are expected to be approximately two lanes wide each.

These three bridges will require causeways during construction. Access to the crossing site is limited due to the railroad bridge to the west of the river. A temporary rail crossing may be required for

construction. Limited access may be available via Emma Road from the west, and by way of right-of-way from the south. “Top-down” construction will be considered as a viable construction method to reduce the access requirements needed, but the decision on the method used will be made during final design development. Construction activities originating from the east bank of the river will utilize acquired right-of-way for staging and construction. Construction time in the river shall be reduced as much as possible, and causeways will remain in place for as short of a period as practicable. No more than 50 percent of the river width shall be blocked by causeways at any one period. The river width at this location is approximately 350 feet.

Detailed construction methods and timelines/phasing will be developed during the final design process.

3 DEMOLITION AND CONSTRUCTION ACTIVITIES AND METHODS

At the time of this writing, Smith Mill Creek has been proposed to be included on the 2018 303(d) list for North Carolina. Design Standards for Sensitive Waters (DSSW) will be used within one mile of the French Broad River and Environmentally Sensitive Areas will apply within 50 feet of the river to mitigate the amount of sediment and erosion that enters the French Broad River Environmentally Sensitive Areas (ESAs) require a 50-foot buffer between construction and stream. USFWS and USACE will have the opportunity to review the design of the SEC measures prior to construction. The NCDOT Design-Build Team will provide USFWS with the sediment and erosion control plan and allow 15 days for review upon acknowledgement of receipt of notice. A revegetation and monitoring plan shall be developed for the bridge once the project is complete.

3.1 CAUSEWAYS

Due to the length of the bridges and the location of the existing and proposed interior bents, causeways will be required to provide construction access for some of the bridges. For the purposes of this report, causeway sizes are estimated based on the width of the bridge and the location of the bridge bents. The size, width, and length of the causeways will vary depending on the construction activities taking place. Causeways will be removed from the river when possible, and causeways will not block more than half of the river width unless agreed upon by USACE and USFWS.

Causeway sizes and locations will be determined during final design; however the table below summarizes the anticipated sizes of the causeways in the river needed to perform demolition and construction of the bridges.

TABLE 1. BRIDGE CONSTRUCTION CROSSINGS AND CAUSEWAY SIZE ESTIMATES

Crossing ID	Existing/ New Bridge	Road Carried	Waterbody	Causeway 1 Size[a]	Causeway 2 Size[a]	Causeway 3 Size[a]	Demolition Causeway Size[a]	Total Causeway Area (ft^2)
HC-1	Existing	I-40 EB	Hominy Creek	0	0	0	N/A	0
HC-2	Existing	I-40 WB	Hominy Creek	0	0	0	N/A	0
HC-3	Existing	I-26 NB/I-240NB	Hominy Creek	0	0	0	N/A	0
HC-4	Existing	I-26 SB/I-240 SB	Hominy Creek	0	0	0	N/A	0
HC-5	Existing	I-40	Hominy Creek	0	0	0	55X15	825
FBR-1	Existing	I-40	French Broad River	200X90	100X90	0	60X160	36,600
HC-6	New	I-40 RAMP TO 191	Hominy Creek	0	0	0	N/A	0
HC-7	Existing	I-26/I-240 NB AND SB	Hominy Creek	0	0	0	35X35	1,225
NONE	Existing	NC 191	Hominy Creek	0	0	0	N/A	0
SMC-1	New	RESORT DRIVE	Smith Mill Creek	0	0	0	N/A	0
SMC-2	New	I-240 RAMPS	Smith Mill Creek	0	0	0	N/A	0
SMC-3	New	I-26	Smith Mill Creek	0	0	0	N/A	0
SMC-4	New	I-240 RAMPS	Smith Mill Creek	0	0	0	N/A	0
SMC-5	New	I-26	Smith Mill Creek	0	0	0	N/A	0
SMC-6	New	I-240/I-26 RAMPS	Smith Mill Creek	0	0	0	N/A	0
SMC-7	New	I-240 RAMPS	Smith Mill Creek	0	0	0	N/A	0
SMC-8	New	I-240 RAMPS	Smith Mill Creek	0	0	0	N/A	0
SMC-9	New	I-240 RAMPS	Smith Mill Creek	0	0	0	N/A	0
EB-1	New	I-240 RAMPS	Emma Branch	0	0	0	N/A	0
EB-2	New	I-26	Emma Branch	0	0	0	N/A	0
EB-3	New	I-240/I-26 RAMPS	Emma Branch	0	0	0	N/A	0
EB-4	New	I-240 RAMPS	Emma Branch	0	0	0	N/A	0

FBR-2	New	I-240 EB	French Broad River	350X130	260X60	150X80	N/A	73,100
FBR-3	New	I-26 EB/WB	French Broad River	300X90	350X130	0	N/A	72,500
FBR-4	New	I-240 WB	French Broad River	100X80	490X90	0	N/A	52,100
							TOTAL	**236,350**

[a] Causeway size is an estimated length times width in feet based on the 2018 preliminary designs. Estimated sizing was determined per coordination with NCDOT Division 13 on 12/18/2018. . Estimated sizes are for the surface of each causeway, not the base on the riverbed. Actual sizes will be determined during final design.

Demolition of the existing bridges, including superstructure and interior bents, will occur in conjunction with the construction of the new bridges. The phases will be staggered to allow for traffic to be maintained during construction. Due to the design-build nature of this project, the selected contractor will be permitted to establish their preferred construction phasing plan once a design has been finalized. However, it is anticipated that for existing bridges, traffic will be rerouted to accommodate construction. For new bridges, construction will occur without the interference of roadway traffic. Some causeways may need to be extended to cover greater than 50% of the waterway to allow for demolition activities. The length of time these causeways are in place will be minimized as much as possible. Time estimates for this length of time will be available during final design. These additional restrictions will be coordinated with USACE and USFWS prior to permitting.

NCDOT has committed to performing a channel morphology study of the French Broad River to determine the preconstruction channel condition, as well as any effects of the causeways during and after construction.

3.2 Access Roads

Generally, construction locations will be reached using existing roadways where possible and temporary access roads may be constructed to physically restricted locations. Access roads will be constructed where no existing right-of-way is available for use. The construction of the flyover bridges over the French Broad River will likely require the use of access roads due to vertical height restrictions near the site, and the constricted access due to the railroad line on the west bank of the French Broad River. Additional bridge-specific access road considerations are discussed above.

3.3 Construction Lighting

As part of its evaluation, NCDOT also took into consideration the time of day when construction and demolition may take place. It was determined that some work would likely need to be completed at night. These activities may include setting girders, drilling shafts, concrete pours, deck concrete pours, beam setting, construction material(s) stockpiling, and traffic shifts. The amount and type of lighting for all activities will be minimized to the extent possible. All lights will be directed towards the work area and will not shine out over any waterways and no nighttime lighting directed away from the work area will be permitted within 50 ft. of the French Broad River, Hominy Creek, Emma Branch, or Smith Mill Creek between March 15 and November 15. Below is a list of some construction operations that may occur at night, as well as the likelihood and/or circumstances under which the operation may occur. Lighting considerations for each night operation are also included.

- Causeway construction – Will occur – Access road and causeway construction and removal may take place at night throughout the life of the project. This will allow the contractor to utilize the lower traffic volume to access the site. Installing the access roads and causeways at night allows longer-term operations to be constructed during daylight hours. Due to the easier site access the contractor may be able to construct the access roads and causeways more quickly.

    - Lighting for this operation will likely consist of one to two light plants that will be used to directly light up the construction area. Care will be taken to not shine light directly out into the river or into the adjacent forest.
- Drilled shafts – Possible – This is dependent upon construction schedule, contract, and availability of the concrete plant.
    - Lighting for this operation will be at water level. Lights on the drill rig will be used, and one light plant may be used if needed. Only the active work area (where the hole is currently being drilled) will be lit. No lights will be shining down from the bridge deck during this operation.
- Concrete pours during hot weather – Will occur – Night pours of concrete are required during hot weather to achieve the proper cure. These pours may include elements such as bent caps, end bents, and barrier rail wall.
    - The use of lights for this operation will be minimal, because these will be small-area and short-duration (six hours or less) pours. Lights will generally be set up on the causeway, shining upward at the bridge member being poured. Small lights, such as headlamps, will be used on the structure. There will be pump truck and concrete trucks with headlights either on the bridge deck or on the causeway.
- Deck concrete pours from May to November (summer) – Will occur – Deck concrete pours are generally larger, more complex, and more time consuming than other types of concrete pours.
    - Of all potential night time operations, this will be the operation with the most lighting. The majority of lighting will be at bridge deck level, with lights shining toward the bridge rather than down toward the river. Any lighting that shines down toward the river or adjacent woods will be indirect and minimal.
    - Headlights on concrete delivery trucks will also be used.
- Beam setting – Will occur – Setting beams at night is required due to the volume of daytime traffic and the need to maintain traffic.
    - Cranes sitting on either of the causeways or on the new or existing bridges will be used to set the beams for the new bridges. There will be a light plant on the structure where the truck with the beams is parked, either on the new or existing structure. These lights will be shining toward the truck. There will also be lights shinning toward each structure where the beam ends sit.
    - It is difficult to determine if the lights will be placed on the causeway shining up toward the structure, or on the bridge deck shining down. This decision will need to be made on site at the time of the activity.
- Traffic shifts – Will occur – Traffic shifts will be necessary to construct the new bridges on existing location. These shifts will occur at night and be of short duration, and will likely require minimal lighting on the bridge. All other activities with traffic shifts will occur beyond the end bents of the bridge and will not be part of the work on the bridge or in the area of the river.

There are other operations that may occur at night; however, this would be evaluated after phasing and final design. The previously listed operations are not operations that occur on a regular schedule.

3.4 Demolition of Existing Structures

During demolition, removal of the bents will be accomplished by tipping them over and removing the entire bent, or by cutting the bent off at stream bed elevation or, if the bent is on land, one foot below ground elevation. Because the base of the remaining bent in the stream is at stream elevation, no material will be put back over the remaining bent. The method of removal will be dependent on the foundation conditions present at the site. No loose portion of the existing bents can remain in the streambed.

Causeways have been identified as the most likely mechanism to be used during bridge demolition and construction. Work bridges are not anticipated to be used. Demolition and construction are expected to take place from temporary causeways placed in waterways where needed, not covering more than 50 percent of the waterway width. Channel restrictions greater than 50 percent may be necessary for short durations, and these additional restrictions will be coordinated with USACE and USFWS prior to permitting. See Table 1 for estimates of the causeway sizes needed for demolition.

Removal of the existing bridges shall be performed in a manner that prevents debris from falling into the water. The Contractor shall remove the bridges and submit plans for demolition in accordance with Article 402-2 of the Standard Specifications. However, if bridge material inadvertently ends up in the river, it will be removed.

USFWS will review the demolition plans, from an environmental permitting perspective prior to the finalization of the plans. USFWS will also be notified prior to the start of bridge demolition, so they may have a representative on-site during that stage of the project.

3.5 Bridge Summary

The total area anticipated to be covered by causeways in all Waters of the US for new bridge construction and bridge replacements is 236,350 square feet, of which 234,300 square feet will be in the French Broad River. The total area to be covered by bridge footings is 22,850 square feet. The footing totals for the French Broad River are 19,725 square feet.

3.6 Other Considerations

Additional measures to protect the French Broad River, Smith Mill Creek, Hominy Creek, and Emma Branch during construction will be taken and are summarized in the Avoidance and Minimization Measures.

4 Hydraulics

A review of flood map data of the study area and bridge vicinities indicates that there are several residential and commercial structures that are currently located in the 100-year floodplain. During the construction of the proposed bridges, should causeways be used, they will create a temporary constriction in the flow of the river that will cause the upstream water surface elevation (WSE) to rise. The extent of the rise will be determined once the causeway phasing and bridge construction phasing is determined during final design. Should the final design minimize the number of bridge bents located in

the waterways, the potential for debris to become lodged and the potential for a WSE rise as a result is lessened. Dangers to river users will also be lessened. Strides shall be made to minimize the number of bents in the river and streams.

4.1 Analysis

Hydraulic analysis of the French Broad River will be performed in conjunction with final design. Impacts will be modeled using the US Army Corps of Engineers (USACE) Hydrologic Engineering Center's River Analysis System (HEC-RAS). Per the USACE website, HEC-RAS "allows the user to perform one-dimensional steady flow, one-dimensional steady flow, and one- and two-dimensional unsteady flow calculations, sediment transport/mobile bed calculations, and water temperature/water quality modeling." For this project, HEC-RAS models are under development to guide final design. The proposed designs and construction phasing will be input into the models and storm return periods will be run that will represent conditions during flood events along the French Broad River. The approximate cross sections of the model are shown in Appendix A. Using the Flood Risk Information System (FRIS) database provided by the North Carolina Emergency Management (NCEM) and the Flood Inundation Mapping Alert Network (FIMAN) data, impacts to properties can be estimated, if present.

The HEC-RAS model is scheduled to be competed in spring/summer 2019.

4.2 Stormwater and Erosion Control

Access roads, if needed, will use Design Standards for Sensitive Waters (DSSW) to mitigate the amount of sediment and erosion control material that enters the French Broad River, Smith Mill Creek, or Hominy Creek. The NCDOT Design-Build Team will provide USFWS with the sediment and erosion control plan and allow 15 days for review upon acknowledgement of receipt of notice. Roadway and bridge construction will be in accordance with appropriate permitting and stormwater plans.

Sediment and Erosion control plans are required to be in place prior to any ground disturbance. When needed, combinations of erosion control measures will be used to ensure protective measures are being implemented.

NCDOT is working with the USGS to install/monitor gages along the French Broad River to collect continuous streamflow, precipitation, and water-quality (temperature, conductance, and turbidity) data. The baseline information can be used to compare to water quality in the river during construction.

4.3 Deck Drainage

NCDOT makes every attempt to eliminate direct deck drainage into water bodies whenever federally protected aquatic species or sensitive habitats are present. It is anticipated that direct drainage into the French Broad River can be avoided by conveying runoff via the deck over water. Overland discharge via deck drains will provide treatment through vegetative conveyance or other stormwater BMPs.

5 AVOIDANCE AND MINIMIZATION

The avoidance and minimization measures are summarized below.

Project Design Modification for Avoidance and Minimization

- Eliminated approximately 20,000 ft. of collector-distributer roads and added retaining walls added in Section C, along I-40. This resulted in reduction of impacts to Ragsdale Creek and avoidance of impacts to Upper Hominy Creek.
- Reduced overall permanent impacts to streams by 724 linear ft.
- Reduced overall impacts to wetlands by 0.63 ac.

Measures to Avoid/Minimize Effects to Gray Bat during Culvert Roost Construction

Timing of Construction

- The RCBC portion of the culvert system, as well as the dual CMAP at the culvert outlet will remain in place. Work on this portion of the culvert system will not occur until bat activity ceases for the season (and bats are presumably no longer using the culvert for roosting). This time frame is approximately between November 15 and March 15. NCDOT will monitor the culvert with an acoustic detector and/or emergence counts to determine when bat activity ceases for the season. After bat activity ceases for the season, a federally permitted bat biologist will enter the culvert to confirm no bats are present. This will determine when construction activity may safely begin, and/or when it should end to avoid effects to MYGR that may use the culvert system for roosting.
- NCDOT will conduct sleeving or replacement of the 60" CMP adjacent to Courtland Ave. and the entrance to Dickson Elementary School (that conveys flow under Hill Street to the RCBC) between October 15 and April 1.
- NCDOT will monitor bat activity at the culvert before, during, and after construction. Acoustic monitoring and/or emergence surveys will be conducted between March and November.

Vegetation Removal

- An operational work pad area will be established near the culvert outlets to complete the culvert rehabilitation process, as well as at the inlet near Courtland Avenue where the 60" CMP will be replaced or lined. Vegetation must be cleared to allow room for the work pad. NCDOT will cut plants in the work pad area in a way that will minimize impacts to bats and their activity by implementing the following measures: vegetation will not be removed if the area will be left bare for many months prior to construction; cutting of vegetation will be coordinated with USFWS and will not occur until all bats have left the culvert for the winter. This will be determined through emergence counts and/or acoustic monitoring and a physical check of the culvert for remaining bats; and limiting cutting to only what is necessary to complete the work and no more than 50 feet from culvert inlet/outlets.

Additional Commitments

- An equipment staging area will also need to be established adjacent to the work pads near the culvert outlets and inlet areas near Courtland Avenue to complete the culvert rehabilitation process. NCDOT will attempt to use areas that are already cleared of vegetation whenever possible. This area will only be used for culvert rehabilitation activity staging and will not be used for any other project construction purposes.
- NCDOT will maintain water sources that provide baseflow to the culvert (non-stormwater sources) to provide a naturally occurring, continual water source.

- NCDOT will either replace or install a liner in the 60" CMP located adjacent to Courtland Ave. and the entrance to Isaac Dickson Elementary School that conveys flow under Hill Street to the RCBC. NCDOT will complete this activity between October 15 and April 1.
- NCDOT will install a barrier/baffle in the RCBC between the intersection with the 60" CMP (located adjacent to Courtland Ave. and the entrance to Isaac Dickson Elementary School that conveys flow under Hill Street) and the upstream end of the RCBC to buffer noise and light associated with the CMP replacements further upstream.

Measures to Avoid/Minimize Effects to Gray Bat during Road Construction

Preservation of Riparian Vegetation

- NCDOT will direct the contractor to preserve riparian buffer trees where practicable and feasible.

Roadway Construction Lighting

- Due to MYGR activity on the landscape, NCDOT will limit all construction-related lighting to whatever is necessary to maintain safety in active work areas closest to the French Broad River, Hominy Creek, Emma Branch, and Smith Mill Creek.
- Construction-related lighting will be indirect in nature and will not project into adjacent forested areas or over the water surface of the French Broad River, Hominy Creek, Emma Branch, or Smith Mill Creek, whenever practicable.

Measures to Avoid/Minimize Effects to Gray Bat during Bridge Construction

Access Roads

- NCDOT will revegetate all access roads created for bridge construction and replacement activities where practicable.

Nighttime Construction Activities

- NCDOT will limit the use of night time construction within 50' of the French Broad River, Hominy Creek, Emma Branch, or Smith Mill Creek between April 1 and October 15 to only the following activities: causeway construction, drilled shafts, concrete pours, beam setting, and traffic shifts.
- NCDOT shall commit to restrict the construction contractor to no night work at crossings of the French Broad River, Hominy Creek, Emma Branch, and Smith Mill Creek to minimize potential impacts to lactating females and their pups between June 1 and June 14. Between June 15 through August 1, NCDOT will also commit to restrict the construction contractor to no more than 28 total nights of work, with no more than four consecutive nights. Lighting used for construction will be limited to what is necessary to maintain safety standards and will only be directed toward active work areas.

Pre-Demolition Check for Bats

- If bridge demolition is required between April 1 and October 15, NCDOT will conduct a check of all subject bridges within 30 days of demolition to determine if bats are present. This will also apply to the culvert under Resort Drive that carries Smith Mill Branch.
- If bats are present, one of the following options will be implemented (options listed in order of preference). NCDOT will:
    1. Wait for bats to leave for the season (approximately mid-October to early November) before beginning work; or
    2. A biologist will monitor the bridge and work will begin after bats leave the bridge for the evening, or
    3. A permitted biologist will exclude bats from work area immediately prior to the start of work using acoustic deterrents, or

4. A permitted biologist will hand remove bats from work area immediately prior to the start of work.
5. If pre-demo check determines pups are present, NCDOT will refrain from bridge demolition until it can be determined by a biologist that the pups are volant, and then use the previous options to proceed with demolition.

Red Safety Lighting

- As part of NCDOT's Communication Plan specific to the construction/demolition of the bridges over the French Broad River, NCDOT will place solar-powered, steady-state red lights on the causeways to alert river users to their locations. Generators will not be used to provide power.

Measures to Avoid/Minimize Effects to Gray Bat and Appalachian elktoe during Bridge Construction

Contract language will include the following, or similar language as appropriate for bridges over the French Broad River

- The Contractor will be required to prosecute the work in a continuous and uninterrupted manner from the time work begins until completion of each phase of structure construction, demolition, and completion. The Contractor will not be permitted to suspend operations except for reasons beyond their control or except where the Engineer has authorized a suspension of the Contractor's operations in writing.

Causeways-French Broad River, Hominy Creek, and Smith Mill Creek

- Causeways will not restrict more than 50% of the existing channel width of the French Broad River, Hominy Creek, and Smith Mill Creek. Potential additional restrictions of the channel may be necessary for short durations, and these additional restrictions will be coordinated with USACE and USFWS prior to permitting.
- NCDOT will require the contractor to use clean rock (free of debris and pollutants) for the construction of the causeways to minimize unnecessary sediment input into the river.
- Causeway material will be removed to the extent practicable and either disposed of off-site or used in areas that require permanent stone protection after project completion. NCDOT will also require that concrete barriers (barrier rail) be placed along the downstream edge of each causeway to limit the downstream movement of causeway material during high flow events.
- If the final causeway plan is staged, causeway material will be added/removed as needed for each stage to minimize the causeway footprint over the length of the project.
- To minimize disturbance to the riverbed, all readily detectible causeway material will be removed, to the extent practicable, while removing as little of the original riverbed as possible.
- Construction fabric will not be used under the causeway material, as it tends to tear into tiny pieces and float downstream during removal.
- Any equipment that is placed on the causeways will be removed any time throughout a workday when the water level rises, or is expected to rise overnight, to a point where the equipment could be flooded, or during periods of inactivity (two or more consecutive days). The only exception to this measure is that the drill rig and crane may be left in place for periods of inactivity; however, they must also be removed if the water rises, or is expected to rise, to a point where the drill rig and crane could be flooded.
- NCDOT will require its contractor to have clean, non-leaking equipment, diapers on-site for each causeway, and spill kits located at each causeway.
- Causeways needed for the new bridges over the FBR will be designed so that during a 100-year storm event there will not be a rise in water surface elevation outside the Action Area greater than normal seasonal variation.

Containment

- All construction equipment shall be refueled above the 100-year base flood elevation plus a foot of freeboard and be protected with secondary containment. During crucial periods of construction and demolition, when the drill rig and crane cannot be moved, the drill rig and crane can be refueled while inside the 100-year floodplain provided that spill response materials (such as spill blankets and fueling diapers) are used during the refueling. Hazardous materials, fuel, lubricating oils, or other chemicals will be stored above the 100-year base flood elevation plus a foot of freeboard.
- Areas used for borrow or construction by-products will not be located within wetlands or the 100-year base flood elevation plus a foot of freeboard.
- When constructing drilled piers for the I-240, I-40 and I-26 French Broad River bridges, a containment system will be developed so that material does not enter the river. Material by-product will be pumped out of the shaft to an upland disposal area to the extent practicable and treated through a proper stilling basin or silt bag.
- Construction of all bridges will be accomplished in a manner that prevents uncured concrete from coming into contact with water entering or flowing in the river.
- Removal of existing bridges shall be performed so as not to allow debris to fall into the water. If debris is dropped in a waterway, it will be immediately removed.
- NCDOT will not place bridge bents in Smith Mill Creek or Emma Branch.

Avoidance/Minimization to Gray Bat and Appalachian elktoe during Road Construction and Bridge Replacement

Erosion Control Measures

- The SEC plan will be in place prior to any ground disturbance for all bridge replacements and construction. When needed, combinations of erosion control measures (such as silt bags in conjunction with a stilling basin) will be used to ensure that the most protective measures are being implemented.
- NCDOT standard procedures dictate that when a project has both Environmentally Sensitive Areas and a requirement to follow DSSW, and uses the GP NCG01 permit, NCDOT will default to the most-restrictive SEC measure requirement.

Agency Coordination (Post Biological Opinion Checkpoints)

- NCDOT will arrange, for each shortlisted team, a meeting with representatives of the USFWS and regulatory agencies prior to the due date for the submission of Technical and Price Proposals. The discussions and answers provided at these meetings are not contractually binding but intend to offer the shortlisted teams an opportunity to inquire as to the permitting process as well as specific team concepts.
- NCDOT will arrange a meeting with the selected Design-Build team to provide an opportunity for USFWS to convey their concern about potential effects to protected species.
- NCDOT will revisit CP4A with the Merger Team after the BA is submitted to discuss any new avoidance and minimization efforts for major crossings of the French Broad River and Hominy Creek including those in the Biological Assessment.
- The NCDOT Design-Build Team will adhere to project commitments within the ROD and the Biological Opinion relating to Section 7 of the Endangered Species Act. The NCDOT Design-Build Team will be required to prepare information required for any event in which NCDOT and FHWA reinitiate Section 7 consultation with the USFWS. It is possible that consultation be reinitiated prior to Concurrence Point 4B and again at Concurrence Point 4C.
- NCDOT will continue to identify avoidance and minimization measures to all Waters of the U.S. and ensure that major hydraulic structures associated with the project are designed and installed to minimize negative impacts to stream stability (and therefore, water quality) to the greatest extent

practicable. As part of this process, NCDOT and the NCDOT Design-Build Team will continue to coordinate with the Merger Team to identify avoidance and minimization measures and ensure that project impacts are minimized to every practicable extent, including impacts to federally protected species.

- The NCDOT Design-Build Team shall meet with NCDOT personnel and USFWS and regulatory agency representatives around the time of the 4C meeting to review the project and project commitments. At this time, the USFWS shall be afforded the opportunity to meet with key NCDOT Design-Build Team members and NCDOT employees to provide education on the effects of artificial lighting, noise, and construction on nearby wildlife habitat and behavior. The NCDOT Design-Build Team shall contact NCDOT Environmental Analysis Unit to schedule these meetings. Every effort shall be made to have this meeting prior to submitting the permit application.
- The NCDOT Design-Build Team will invite USFWS and regulatory agency representatives to the pre-construction meeting for the proposed project, as well as to all subsequent field inspections prior to construction, to ensure compliance with all special project commitments.
- The NCDOT Design-Build Team will provide USFWS with the sediment and erosion control plan and allow 15 days for review upon acknowledgement of receipt of notice.
- The NCDOT Design-Build Team will provide regulatory agency representatives with the demolition plan for all bridges and allow 15 days for review upon acknowledgement of receipt of notice. All agencies will be notified prior to start of demolition so they may have a representative on site.
- The NCDOT Design-Build Team will provide USFWS with the construction phasing plan for each bridge.
- The NCDOT Design-Build Team will provide USFWS with the final roadway lighting plans and allow 15 days for review upon acknowledgement of receipt of notice.
- The NCDOT Design-Build Team will contact USFWS if new information about MYGR is discovered, as it relates to the project.
- The NCDOT Design-Build Team will report any dead bats found on the construction sites to USFWS.
- The NCDOT Design-Build Team will include an Environmental Coordinator who will be invited to attend all design, merger, and preconstruction meetings, and who will consult bat and mussel experts, as needed.
- NCDOT will provide USFWS with the total size of bridge footings in the water as project design progresses and the information becomes available.
- NCDOT will provide USFWS with the results of the hydrology modeling (described below) as it becomes available, including change in French Broad velocity with causeways in place, and change in water surface elevation with causeways in place.

Measures to Avoid/Minimize Effects to Gray Bat and Appalachian Elktoe during Roadway Operation

Stormwater Control Measures

- NCDOT has developed stormwater commitment guidance, which will apply at the crossings of the French Broad River and any tributaries draining to the French Broad River, any portion of the NCDOT stormwater conveyance system draining to an outfall discharging to those waters within the right-of-way.
- NCDOT will prepare a stormwater management plan (SMP) that implements structural and non-structural post-construction stormwater best management practices (BMPs) to the maximum extent practical, which is consistent with the Department's National Pollutant Discharge Elimination System (NPDES) Post-Construction Stormwater Program.
- When preparing the SMP, NCDOT commits to using a hierarchical BMP selection process, which is optimized to treat silt, nutrients, and heavy metals.

- At each discharge location outside of the 100-year floodplain, the hydraulics engineer will evaluate the feasibility of installing either an infiltration basin or a media filter as described in NCDOT's BMP Toolbox. If neither is feasible, the hydraulics engineer will select another BMP that is feasible.
- NCDOT will commit to evaluating the use of emerging BMP technologies that the Department has not yet published in its BMP Toolbox. These emerging BMP technologies are as follows:
  - Bioswales
  - Bioembankments
  - Biofiltration conveyances
  - Soil improvement to maximize infiltration
- The NCDOT hydraulics design engineer will consult with the State Hydraulics Engineer and obtain prior approval before proposing one of these BMP technologies in the SMP.

Permanent Lighting

(Crossing numbers in this section refer to Table 2 in Section 2.1.2 and Figures 4A-4F in Appendix A).

- General CM's for the entire project:
  - NCDOT plans to install 3500K to 4000k LED fixtures wherever new or replacement lighting is required.
  - Using shorter poles which will provide an overall LED light fixture mounting height of 35' above the pavement surface.
  - Using LED light fixtures with a more rectangular light pattern as well as house side shields to minimize lighting outside of the pavement area.
  - Using LED light fixtures with a BUG rating of 1-0-3 or less
  - NCDOT is committed to changing the design standards to meet the AASHTO minimum requirements of 0.6 fc at 4:1 uniformity at all crossing locations identified in the lighting document, from the original design of 0.8 fc at 4:1 uniformity.
  - At all identified crossings, the proposed high mast poles and 45' poles with GE Cobrahead (GE) fixtures (3-0-3 BUG) were redesigned with 35' poles with Cooper Cobrahead (Cooper) fixtures (1-0-3 BUG).
- Hill Street Culvert Outlet – The current NCDOT design near Southern States property results in zero calculated change to the baseline light levels at the culvert opening and ditch leading to the FBR.
- Hill Street Culvert Outlet – NCDOT will meet with landowners adjacent to the roost culvert to discuss replacement or augmentation of existing lighting to reduce existing baseline conditions determined by the NCDOT Roadway Lighting Squad.
- Hill Street Culvert inlet – The original lighting design near the Hill Street culvert inlet had 80' high mast poles installed between the mainline and Hill Street behind the Isaac Dickson Elementary School. NCDOT is revising this design to remove the high mast poles and to replace them with GE light fixtures installed on twin arm poles on the mainline median barrier.
- New French Broad Crossing (NFBC) – Use of single arm light poles mounted on the bridge and flyover barriers in place of the 120' and 100' high mast poles.
- NFBC – 35' single arm poles with a narrow distribution light fixture and a house side shield will be used.
- FBR-1 – The GE fixtures were replaced with the lower BUG rated Cooper fixtures.
- FBR-1 – Fixtures were redesigned to have the outer ring (as shown in the figures within the lighting document) ending roughly 115' from the west bank of the FBR.

- FBR-2, FBR-3, & FBR-4 – All high mast poles within the connector interchange were removed and replaced with Cooper fixtures mounted on the outer and/or center bridge barrier rail.
- FBR-2, FBR-3, & FBR-4 – The Cooper fixtures are located so the crossings are centered between fixtures where the light level is the lowest.
- HC-1 – Replacing the GE fixtures with the Cooper fixtures.
- HC-1 - Replacing the 120' high mast pole with an 80' high mast pole.
- HC-2 & HC-3 – Removal of a 120' high mast pole and replaced with Cooper fixtures.
- HC-2 & HC-3 - The Cooper fixtures are located so the crossings are centered between fixtures where the light level is the lowest.
- HC-4 - The Cooper fixtures are located so the crossings are centered between fixtures where the light level is the lowest.
- HC-5 & HC-6 – Removal of 80' high mast pole and replacing with Cooper fixtures along the mainline and ramp in both directions.
- HC-5, HC-6, HC-7 - The Cooper fixtures are located so the crossings are centered between fixtures where the light level is the lowest.
- All SMC and EBC – Removal of all high mast poles within the connector interchange and replaces them with Cooper fixtures mounted on the outer and/or center bridge barrier.
- All SMC and EBC - The Cooper fixtures are located so the crossings are centered as best as possible between fixtures where the light level is the lowest.
- SMC culvert area – the existing high mast pole located within the interchange ramps will be removed.

Conservation Measures to Benefit Gray Bat

Monitoring for MYGR Return and Activity

- NCDOT will conduct acoustic monitoring (or emergence counts, as appropriate) for MYGR at some locations immediately before, during and up to two years after construction. This monitoring may help determine changes in bat activity due to construction. NCDOT will coordinate the locations and time frame for monitoring with USFWS.
- To determine whether MYGR avoid active construction zones at night, NCDOT will investigate the use of night-vision video recordings, or other methods, in an attempt to monitor bat activity at locations where they may be most susceptible to disturbance.
- NCDOT will conduct additional monitoring/research to potentially include additional telemetry, coordinated monitoring of roosts, monitoring of new panels, basin-wide acoustics to be conducted at key points during and after construction. This additional monitoring will be coordinated with USFWS, NCWRC and NCDOT.

Hill Street Culvert Roost Area

- NCDOT will replace most, if not all the CMP within the culvert system upstream from the RCBC with RCBC and/or concrete pipe, which will effectively create additional bat roosting habitat.
- NCDOT will meet with landowners adjacent to the roost culvert to discuss replacement or augmentation of existing lighting to reduce existing baseline conditions determined during by the NCDOT Roadway Lighting Squad.
- NCDOT will acquire a permanent drainage easement (PDE) or additional right of way at the culvert inlet (near Courtland Ave.) and outlets, where replanting with containerized, native, woody vegetation will occur. In addition, if NCDOT acquires additional right-of-way or conservation

easements along the French Broad River or adjacent to the culvert, NCDOT will replant with native, woody vegetation to provide, in time, a buffer for noise, light, and surface water runoff. NCDOT will coordinate with USFWS and NCWRC to develop a revegetation and invasive species management plan for these areas.

NCDOT-Sponsored MYGR Research Project

- NCDOT, with the cooperation of the USFWS and NCWRC, committed to a three-year study on MYGR within the French Broad River Basin. This study will serve as a conservation measure for NCDOT projects within the Divisions 13 and 14 for a limited time. NCDOT will provide $900,000 in funding Indiana State University to conduct the research project, which will aid in the recovery and conservation of MYGR. The end goal is to gather the information needed to allow NCDOT and USFWS to enter a programmatic consultation to cover MYGR for NCDOT Divisions 13 and 14, as well as help to develop species-specific avoidance and minimization measures. This agreement was reached, in part, for the I-4400/I-4700 (I-26 widening) project in Buncombe and Henderson Counties, but also benefits this project.

Protection of Culvert Roost Entrance

- NCDOT will coordinate with USFWS to assess the need to deter trespassing/use of the culvert by humans, and install signage or barriers, as needed.

Gray Bat Conservation Funding

- NCDOT will provide $350,000 in funding to be utilized for measures that are consistent with the recovery objectives outlined in the recovery plan for the MYGR (Brady et al. 1982).

Installation of Temporary Bat Roost Panels on Bridges

- NCDOT will have Modern Bat roost panels or comparable structures temporarily installed on four bridges within the French Broad River basin that are currently or have recently been used by roosting bats. The sites will be selected by a team of USFWS and NCDOT personnel and will be installed as soon as possible. The panels will remain in place until project construction is complete; approximately 2026. The panels will be monitored for bat use while they are in place. The team will determine the appropriate number of panels for each bridge as well as the monitoring protocol.

<u>Conservation Measures to Benefit Appalachian Elktoe</u>

Appalachian Elktoe Conservation Funding

- NCDOT will provide $500,000 in funding to the North Carolina Nongame Aquatic Projects Fund for the French Broad River Conservation Plan (FBRCP) proposed by USFWS, which will aid in the recovery and conservation of Appalachian elktoe. The funding will be held by the NCWRC. A multi-agency/organization group of mussel species experts, including USFWS, will determine how to expend the funds.
- The French Broad River Conservation Plan proposes to improve aquatic habitat and diversity and to mitigate risks in the French Broad River. It may include the following:
    - Species Reintroduction: Developing a normal cohort of companion species will benefit long-term Appalachian elktoe recruitment and survival; mussel species are healthier in dense multi-species mussel beds (Vaughn et al 2008).
    - Early Warning and Emergency Capacity: A monitoring network and propagation facility devoted to species introduction pairs an early warning system with emergency production capacity to immediately mitigate unforeseen effects to the Appalachian elktoe population should the need arise.

- Genetic Management Program: A study of the genetic health/potential genetic drift of the population will provide feedback to the previous two program aspects and will fine tune management of Appalachian elktoe.
- Miscellaneous: Other projects could include development of technologies such as the use of passive integrated transponder (PIT) tags to passively locate mussels; radio tracking equipment to study movement of mussels during high flow events; development of techniques to artificially stabilize habitat for the placement of propagated mussels; and/or a cost-benefit study of watershed improvement options.

This agreement was reached, in part, for the I-4400/I-4700 (I-26 widening) project in Buncombe and Henderson Counties, but also benefits this project.

French Broad River Geomorphology Monitoring

- NCDOT is working with the US Geological Survey (USGS) to evaluate the impacts of construction and temporary causeways on river habitat. This monitoring project encompasses several Transportation Improvement Projects (I-2513, I-4400 and I-4700). Therefore, the monitoring project will span several years to accommodate the varying construction schedules.
  - Terrestrial Light Detection and Ranging (T-LiDAR) technology will be used annually to produce a laser scan of river banks. Bathymetric surveys will be conducted concurrently one to two times a year. Bathymetric data will be used to generate a gridded surface representation (digital elevation model, or DEM) of the channel bed for each survey. A similar approach will be applied to T-LiDAR data to evaluate stream bank position between successive surveys.
  - Water quality monitoring will include real-time (continuous) data collection of temperature, turbidity, and specific conductance. Discrete water-quality samples will be collected during a variety of flow conditions to measure total suspended sediment (TSS) and suspended sediment concentration (SSC).
  - Continuous streamflow, precipitation, and water-quality (temperature, conductance, and turbidity) data will be available online at http://waterdata.usgs.gov/nc/nwis/rt/ and via text and email alerts. Yearly summaries for each monitoring site will be available on demand from the USGS National Water Information System web interface (NWISWeb). Real-time alerts will be available to NCDOT via the NWISWeb when temperature or turbidity concentrations spike or exceed a predetermined threshold.
  - If monitoring at the French Broad River reveals excessive bank erosion, bank instability, or sedimentation associated with the bridge replacement, NCDOT will work to identify the cause and will make improvements to address the problems in a timely manner.

Avoidance and Minimization Measures to Benefit Northern long-eared bat

The following avoidance and minimization measures have been proposed to minimize adverse effects of the proposed action on Northern long-eared bat:

- No alterations of a known hibernacula entrance or interior environment if it impairs an essential behavioral pattern, including sheltering northern long-eared bats (January 1 through December 31);
- No tree removal within a 0.25-mile radius of a known hibernacula (January 1 through December 31); and
- No cutting or destroying a known, occupied maternity roost tree, or any other trees within a 150-foot radius from the known, occupied maternity tree during the period from June 1 through and including July 31.

6 RIVER USER SAFETY

Because the French Broad River, Hominy Creek, and Smith Mill Creek are regularly used for recreation, they cannot be closed for the life of construction. NCDOT shall commit to providing a safe passage lane for users of the French Broad River, Hominy Creek, and Smith Mill Creek. To do so, NCDOT shall employ safety measures, including catchment devices on overhead structures to prevent material from falling on river users. In addition, floating navigational aids will be used to guide river users to the safe passage lane and away from the causeways/construction zone. Certain activities, such as setting girders, will require temporary river closure to ensure the safety of river users. Most of these activities are anticipated to occur at night when working with existing bridges. For new bridges, most work is expected to take place during the day. NCDOT will work with river users, businesses, and recreational river and civic groups to insure public notification of the temporary closures.

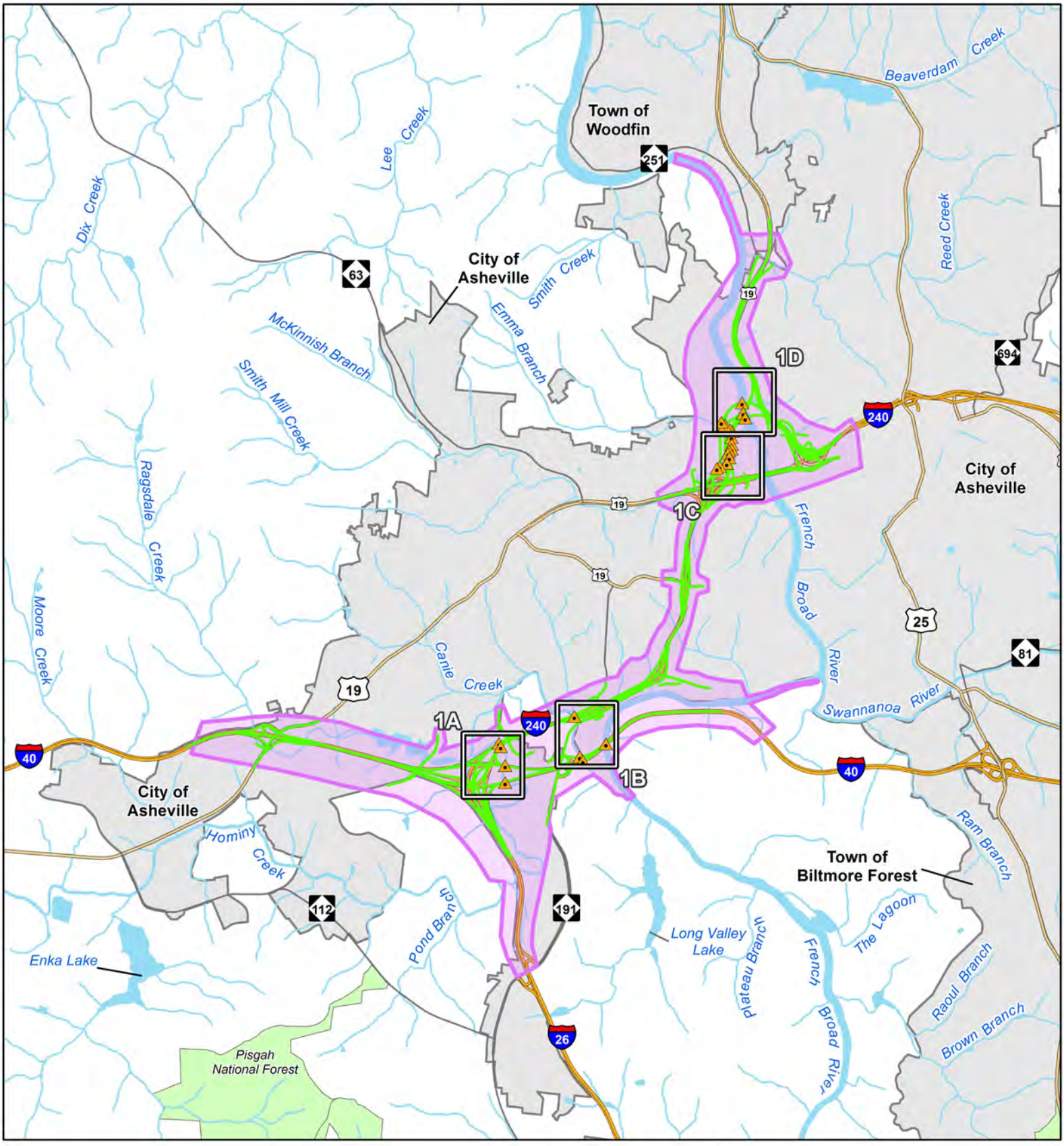
The safe passage lane for river users will be located in a portion of the river away from the causeways for the majority of the life of the project. NCDOT shall use a floating navigational aid to guide river users to the safe passage lane.

NCDOT shall commit to including a rigid, non-drooping, catchment device on the overhead structures to prevent material from falling on river or greenway users, or in the water. NCDOT shall place steady-state red lights that are solar-powered on the causeway to alert river users to its location. Generators will not be used to provide power. These lights will be atop permanent structures, such as a pole, on each causeway for the duration of the project. The contractor will be responsible for maintaining these lights at all times during construction, replacing them as necessary.

It is expected that there will be times when the river, creeks or greenways must be closed for the safety of recreational users due to the type of work being done (e.g. setting girders, removal of bent caps). These closures are not expected to last more than two days and are expected to occur predominantly at night. Care will be taken to not close the waterways or greenways during known peak user times, particularly the Memorial Day, Fourth of July, and Labor Day weekends.

NCDOT will develop a Communication Plan for the Construction of the I-26 Connector Bridges. This plan focuses on specific activities to alert recreational users to the hazards of bridge construction and will be appended to larger communication plan for the entire I-26 project.

Communication plans include holding small group meetings; placing signage upstream of the construction zone at river access points; and alerting greenway and river users through various traditional and social media outlets of construction schedules, including closures and other pertinent information.



NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

I-26 Asheville Connector

TIP Project I-2513

Buncombe County, NC

Legend

- Crossing Location
- Map Tile
- Action Area
- Detailed Study Alternative
- Federal Land
- Municipal Boundary
- Waterbody
- Stream
- Interstate
- US Route
- NC Route
- Major Road

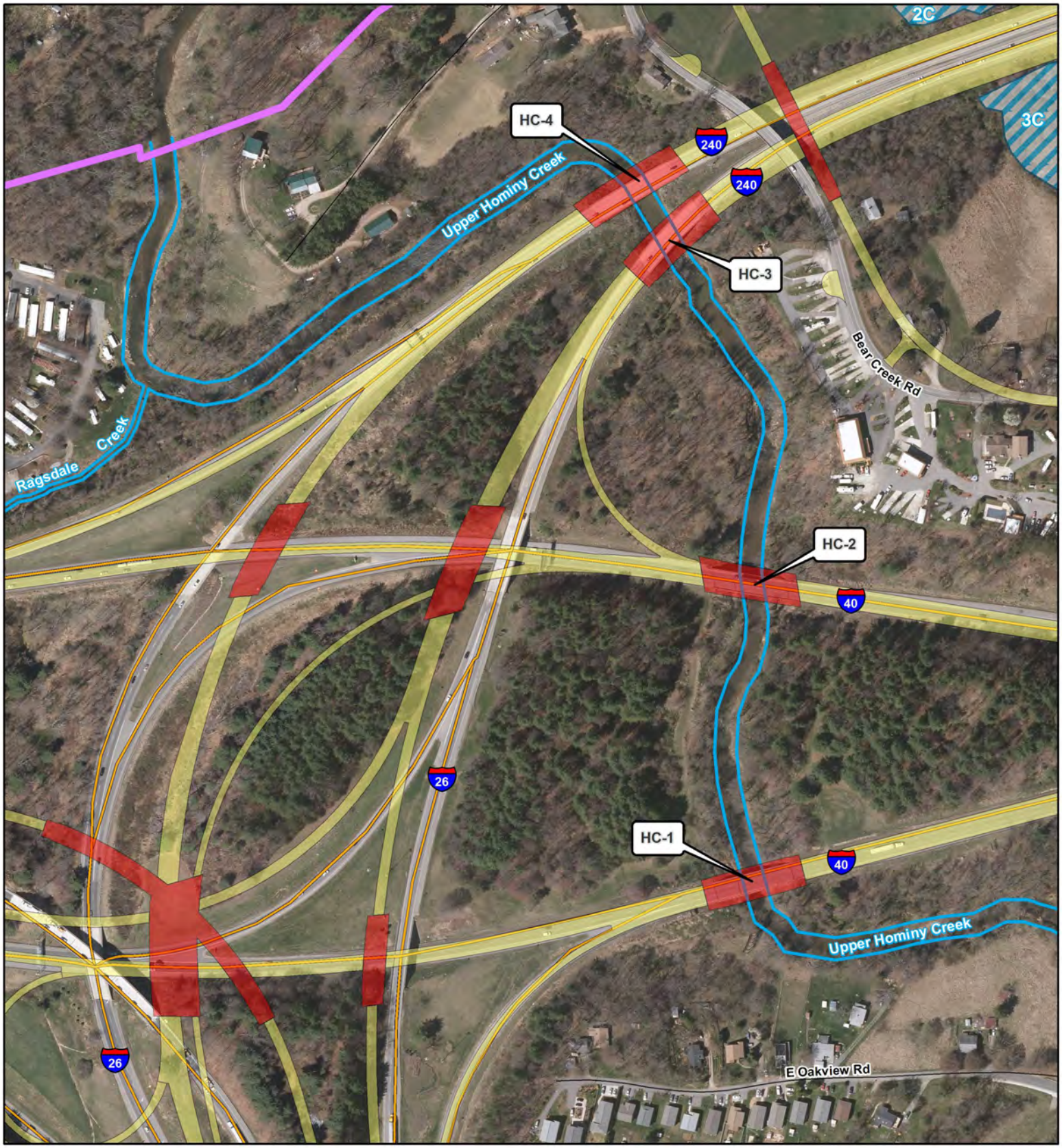
0 0.5 1 2 Miles

1 in = 1 miles

Figure 1

Crossing Locations Overview

Source: NC OneMap, CALYX Engineers and Consultants
Map Date: 2/20/2019



NORTH CAROLINA
DEPARTMENT OF TRANSPORTATION

I-26 Asheville Connector

TIP Project I-2513

Buncombe County, NC

Legend

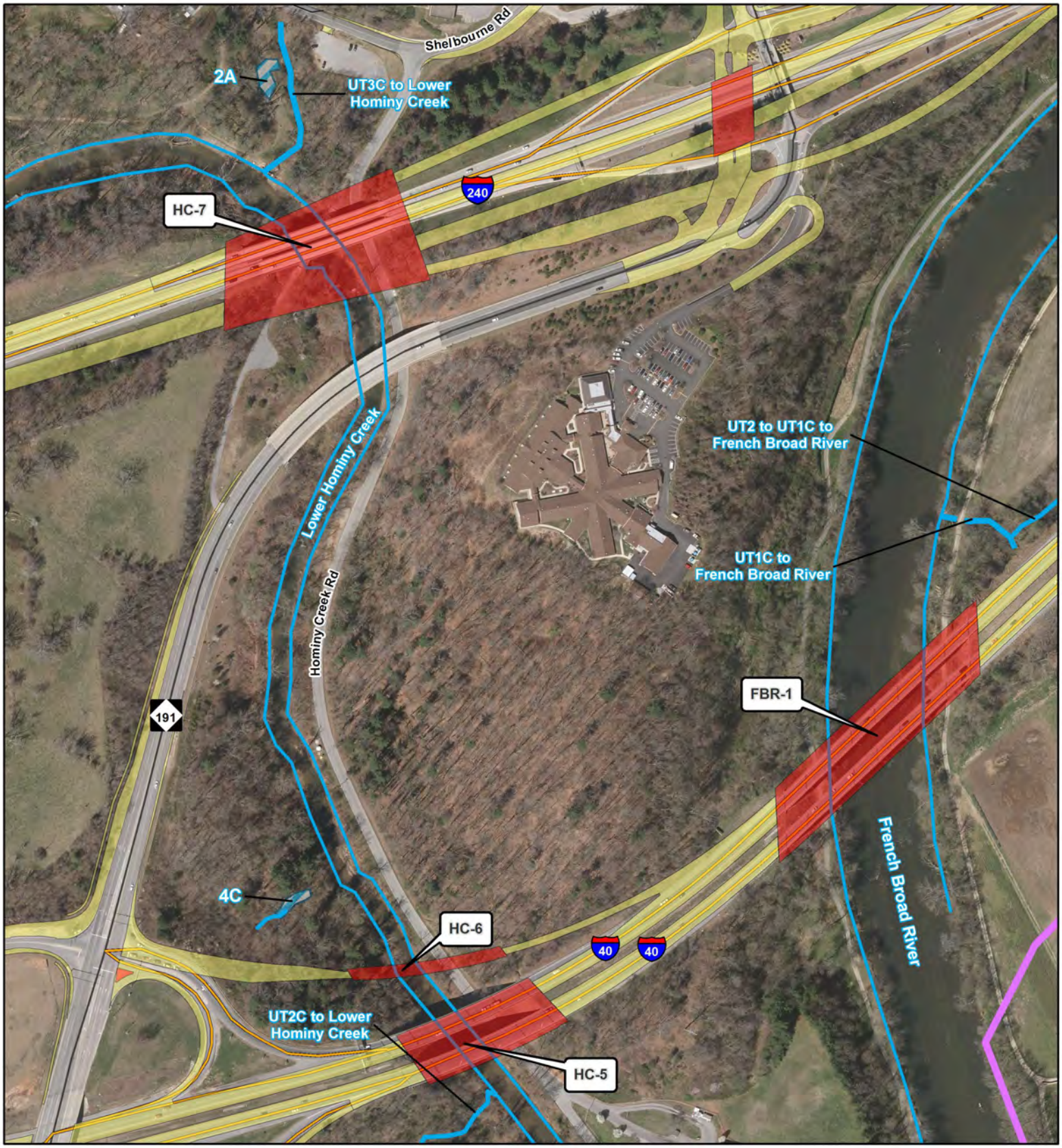
- Action Area
- HC-1 Crossing
- Proposed Bridge
- Proposed Roadway
- Delineated Wetland
- Delineated Stream
- Interstate
- US Route
- NC Route
- Major Road
- Local Road

0 150 300 600 Feet

1 in = 300 ft

Figure 1A
Crossing Locations

Source: NC OneMap, CALYX Engineers and Consultants
Map Date: 2/20/2019



NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

I-26 Asheville Connector

TIP Project I-2513

Buncombe County, NC

Legend

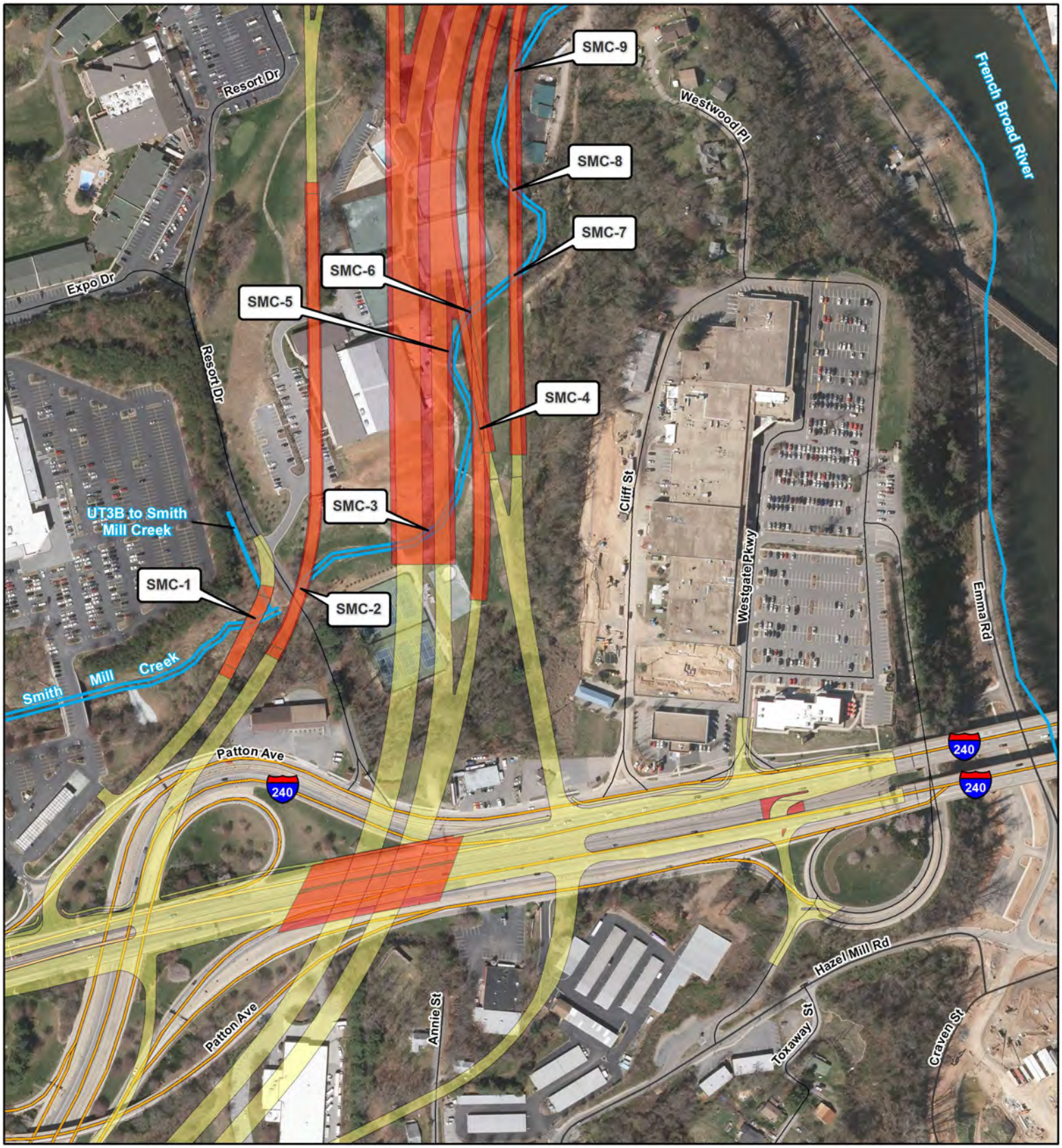
- Action Area
- HC-1 Crossing
- Proposed Bridge
- Proposed Roadway
- Delineated Wetland
- Delineated Stream
- Interstate
- US Route
- NC Route
- Major Road
- Local Road

0 150 300 600 Feet

1 in = 300 ft

Figure 1B
Crossing Locations

Source: NC OneMap, CALYX Engineers and Consultants
Map Date: 2/20/2019



NORTH CAROLINA
DEPARTMENT OF TRANSPORTATION

I-26 Asheville Connector
TIP Project I-2513
Buncombe County, NC

Legend

- Action Area
- HC-1 Crossing
- Proposed Bridge
- Proposed Roadway
- Delineated Wetland
- Delineated Stream
- Interstate
- US Route
- NC Route
- Major Road
- Local Road

0 150 300 600 Feet
1 in = 300 ft

Figure 1C
Crossing Locations

Source: NC OneMap, CALYX Engineers and Consultants
Map Date: 2/20/2019

NORTH CAROLINA
DEPARTMENT OF TRANSPORTATION

I-26 Asheville Connector

TIP Project I-2513

Buncombe County, NC

Legend

- Action Area
- HC-1 Crossing
- Proposed Bridge
- Proposed Roadway
- Delineated Wetland
- Delineated Stream
- Interstate
- US Route
- NC Route
- Major Road
- Local Road

0 150 300 600 Feet

1 in = 300 ft

Figure 1D
Crossing Locations

Source: NC OneMap, CALYX Engineers and Consultants
Map Date: 2/20/2019

APPENDIX G. WATERSHED CONDITIONS BASELINE TABLES

Table A. EPT Scores for Water Bodies within Five Miles of the Action Area

Water Body	Location	Date	Rating
UT to Little Pole Creek	Off SR 1223	6/3/2010	Excellent
Beaverdam Creek	SR 3449	5/12/2002	Good
Moore Branch	Amboy Road	5/23/2006	Poor
French Broad River	NC 146	8/15/2007	Good-Fair
		9/10/2002	Good-Fair
		7/8/1997	Good-Fair
		7/8/1992	Good
		7/26/1990	Good-Fair
		8/4/1987	Good-Fair
Swannanoa River	US 25	7/25/2012	Good
		8/15/2007	Good-Fair
		11/29/2004	Fair
		8/28/2002	Good-Fair
		7/09/1997	Good-Fair
		7/08/1992	Good-Fair
		7/27/1989	Fair
		3/24/1988	Poor
		10/05/1987	Fair
		7/24/1987	Good-Fair
		8/12/1985	Poor
Swannanoa River	Thompson St near Stoner Rd	3/24/1988	Fair
Swannanoa River	Haw Creek	3/24/1988	Fair
	Azalea Park	8/27/2002	Good-Fair
Dingle Creek	Blue Ridge Parkway	2/10/87	Fair
Wesley Branch	“AB riprap”	11/6/2001	Not Impaired
Bent Creek	Forest Service Rd 479	8/29/2007	Good
	Wolf Branch	8/6/2014	Good
	AB Wolf Branch	8/5/2014	Good
	Ledford Branch	8/6/2014	Good
	BE Lake Powhatan	8/5/2014	Good-Fair
	AB Lake Powhatan	8/5/2014	Good
	BE Boyds Branch	11/7/2001	Excellent
	Bent Creek Gap Road	6/2/2010	Excellent

Table A. EPT Scores for Water Bodies within Five Miles of the Action Area

Water Body	Location	Date	Rating
Hominy Creek	SR 3412	7/24/2012	Good-Fair
		8/16/2007	Fair
		5/16/2002	Fair
		9/9/1997	Fair
		10/7/1997	Fair
		09/7/1992	Poor
Hominy Creek	SR 1123	7/23/2012	Good
		8/17/2007	Good-Fair
Hominy Creek	NC 112	5/16/2002	Good-Fair
		9/09/1997	Fair
		09/7/1992	Fair
Hominy Creek	NC 151	5/14/2002	Good
		9/10/1997	Good-Fair
		7/09/1992	Good
UT to French Broad	SR 1332	5/23/2006	Good-Fair
French Broad River	SR 1348	8/16/2007	Good-Fair
		7/10/2002	Good
		7/09/1997	Good-Fair
		7/23/1992	Good-Fair
		8/03/1987	Good-Fair
		8/13/1985	Fair
		8/18/1983	Fair

Table B. Individual NPDES Permitted Dischargers within Five Miles of the Action Area

Permit #	Facility	Type	Flow (gpd)*	Waterbody
NC0062634	Wedgefield Acres MHP** WWTP***	Minor	25,000	Pond Branch
NC0020478	Lake Powhatan Recreation Area	Minor	20,000	Bent Creek
NC0036684	Bent Creek WWTP	Minor	100,000	Wesley Creek (Bent Creek Ranch Lake)
NC0069957	Laurelwood Mobile Home Park	Minor	2,000	Beaverdam Creek
NC0086088	Girmes Site remediation	Minor	108,000	Gashes Creek (Cedar Mountain Lake)
NC0075388	Pleasant Cove Home WWTP	Minor	12,000	Pole Creek
NC0060283	Ridgeview Acres Mobile Home Park	Minor	7,800	Smith Mill Creek
NC0024911	French Broad River WRF^	Major	40,000,000	French Broad River
NC0029882	Briarwood WWTP	Minor	7,500	Dix Creek

*gpd = gallons per day; **MHP = mobile home park; ***WWTP = wastewater treatment plant; ^WRF = wastewater reclamation facility

Table C. General NPDES Permitted Dischargers within Five Miles of the Action Area

Permit #	Facility	Type	Waterbody
NCG550306	93 Hidden Falls Drive	*SFD	Reems Creek
NCG500627	Adams Products Company	**CBBWW	Swannanoa River
NCG550346	18 Terrace Drive	SFD	Reems Creek
NCG550425	648 Macedonia Road	SFD	Lee Creek
NCG551146	58 Massey Road	SFD	UT to French Broad River
NCG550710	840 Emma Road	SFD	UT to Smith Mill Creek
NCG550429	594 Cowan Cove Road	SFD	Smith Mill Creek
NCG551061	Silver Creek Apartments	SFD	Pole Creek
NCG550653	1109 Newfound Road	SFD	Jones Branch
NCG551216	218 Kirk Way	SFD	Pole Creek
NCG551217	220 Kirk Way	SFD	Pole Creek
NCG551228	224 Kirk Way	SFD	Pole Creek
NCG550413	21 Shackleford Drive	SFD	Wesley Creek (Bent Creek Ranch Lake)

*SFD = Single family domestic; **CBBWW = Non-contact cooling, boiler blowdown wastewater

Table D. Rare Aquatic Species in the Upper French Broad River Subbasin in North Carolina

Scientific Name	Common Name	NC Status*	Federal Status
Acipenser fulvescens	Lake sturgeon	SC	FSC
Alasmidonta raveniliana	Appalachian elktoe	E	E
Alasmidonta viridis	Slippershell mussel	E	FSC
Cambarus reburrus	French Broad River crayfish	SR	FSC
Carpiodes carpio	River carpsucker	SC	~
Carpiodes cyprinus	Quillback	SR	~
Cottus carolinae	Banded sculpin	T	~
Cryptobranchus alleganiensis	Hellbender	SC	ARS
Erimystax insignis	Blotched chub	SR	~
Etheostoma jessiae	Blueside darter	SC	~
Etheostoma simoterum	Tennessee snubnose darter	SC	~
Etheostoma vulneratum	Wounded darter	SC	FSC
Fusconaia subrotunda	Longsolid	SR	FSC
Hiodon tergisus	Mooneye	SC	~
Ichthyomyzon bdellium	Ohio lamprey	SR	~
Ictiobus bubalus	Smallmouth buffalo	SR	~
Ictiobus niger	Black buffalo	SR	~
Lampsilis fasciola	Wavy-rayed lampmussel	E	~
Lethenteron appendix	American brook lamprey	T	~
Luxilus chrysocephalus	Striped shiner	SC	~
Moxostoma breviceps	Smallmouth redhorse	SR	~
Necturus maculosus	Mudpuppy	SC	~
Notropis micropteryx	Highland shiner	SR	~
Notropis volucellus	Mimic shiner	SR	~
Noturus eleutherus	Mountain madtom	SC	~
Noturus flavus	Stonecat	E	~
Percina caprodes	Logperch	T	~
Percina squamate	Olive darter	SC	FSC
Percina williamsi	Sickle darter	SC	FSC
Pleurobema oviforme	Tennessee clubshell	E	FSC
Polyodon spathula	Paddlefish	E	FSC
Potamilus alatus	Pink heelsplitter	SR	~
Sander canadensis	Sauger	SR	~
Strophitus undulatus	Creeper	T	~

* E=Endangered; T=Threatened; FSC=Federal Species of Concern; SC=Special Concern; SR = Significantly Rare; ARS =At Risk SPecies; ~ = no federal status.

APPENDIX H. DESIGN STANDARDS FOR SENSITIVE WATERSHEDS & ENVIRONMENTALLY SENSITIVE AREAS

Erosion control measures that exceed standard BMPs, as outlined in DSSW (15A NCAC 04B .0124 (a) – (e)), are implemented by NCDOT for projects within WS-I or WS-II water supply watersheds, Critical Areas, or any waters designated by NCDWR as HQW. When projects occur in watersheds that contain federally-listed aquatic species, NCDOT incorporates erosion control measures that meet DSSW, regardless of the NCDWR stream classification. DSSW apply for portions of projects within one mi. and draining to streams where aquatic threatened or endangered species are present.

Table A lists the I-2513 waterways where the following DSSW will be applied:

- Uncovered areas shall be limited to a maximum total area of 20 acres.
- Erosion and sedimentation control measures shall be designed and constructed to provide protection from the runoff of the 25-year storm event, instead of a 10-year storm.
- Sediment basins will have a settling efficiency of at least 70 percent for the 40-micron (0.04mm) sized soil particle transported into the basin by the runoff of a two-year storm.
- Newly constructed open channels shall be constructed with side slopes no steeper than two horizontal to one (2:1) vertical if a vegetative cover is used for stabilization. The angle for side slopes shall be sufficient to restrain accelerated erosion.

Table A. I-2513 Waterways Where DSSW Will Apply

Jurisdictional Stream Description	NRTR Map ID	Classification[a]	River Miles to Occupied Habitat	Stream Impacts based on SS+25 ft
French Broad River	SA	P	-	0
UT1C to French Broad River	SAB	I	0.03	18
UT1C to Lower Hominy Creek	SAC	I	0.57	79
UT2 to UT1C to French Broad	SAG	I	0.05	224
UT2C To French Broad River	SE	P	0.11	20
UT2C to Lower Hominy Creek	SAJ	P	0.44	0
UT1A to French Broad River	SD	P	0.002	238
UT2A to French Broad River	SF	P	0.04	164
UT3C to Lower Hominy Creek	SH	P	0.98	7
Moore Branch	SC	P	0.83	188
Lower Hominy Creek	SB	P	0.46	43
Smith Mill Creek	SR	P	0.33	348
UT1B to Smith Mill Creek	SG	I	0.93	1,355
UT2B to Smith Mill Creek	SU	P	0.93	299
UT3B to Smith Mill Creek	SS	P	0.45	0
UT1B to French Broad River	SN	I	0.02	0
UT2B to French Broad River	SI	I	0.08	120
UT3B to French Broad River	SO	P	0.10	17
UT4B to French Broad River	SK	P	0.03	32
UT5B to French Broad River	SL	I	0.11	0
UT6B to French Broad River	SM	I	0.06	0
UT7B to French Broad River	ST	I	0.14	0
UT3C to French Broad River	SAM	P	0.12	0
UT4C to French Broad River	SAP	I	0.05	0
UT5C to French Broad River	SAQ	P	0.04	0

Jurisdictional Stream Description	NRTR Map ID	Classification[a]	River Miles to Occupied Habitat	Stream Impacts Based on SS+25 ft
UT1 to UT5C to French Broad River	SAA	I	0.08	0
Reed Creek	SJ	P	0.07	0
UT4B to Smith Mill Creek [Emma Branch]	SP	P	0.17	0
UT1 to UT4B to Smith Mill Creek [Emma Branch]	SQ	I	0.30	0

a: P=Perennial stream; I=Intermittent stream

For I-2513, Environmentally Sensitive Areas (ESAs) will be defined by a 50-ft. buffer zone on both sides of the French Broad River, measured from top of the bank, in which the following shall apply:

- The Contractor may perform clearing operations, but not grubbing operations until immediately prior to beginning grading operations.
- Once grading operations begin, work shall progress in a continuous manner until complete.
- Erosion control devices shall be installed immediately following the clearing operation.
- Seeding and mulching shall be performed on the areas disturbed by construction immediately following final grade establishment.
- Seeding and mulching shall be done in stages on cut and fill slopes that are greater than 20 ft. in height measured along the slope, or greater than 2 acres in area, whichever is less.
- All sedimentation and erosion control measures, throughout the project limits, must be cleaned out when half full of sediment, to ensure proper function of the measures.

APPENDIX I. STORMWATER TREATMENT

STATE OF NORTH CAROLINA
DEPARTMENT OF TRANSPORTATION

ROY COOPER
GOVERNOR

JAMES H. TROGDON, III
SECRETARY

DATE: June 20, 2019

TO: Marissa Rodman Cox
NCDOT Biological Surveys Group Supervisor

FROM: Stephen Morgan, PE
NCDOT State Hydraulics Engineer DS SRM

SUBJECT: Biological Assessment for the STIP I-2513 Asheville I-26 Connector Project – Clarification of NCDOT's commitment to treat post-construction stormwater discharges to the French Broad River to protect endangered species

Background:

NCDOT is proposing to connect I-26 in southwest Asheville to US 19/23/70 in northwest Asheville. The project has been divided into three sections which include upgrades to sections of interstate highway, improvements to several interchanges, and building interstate on new location. Because the planned improvements will result in an increase in built upon area, the Department's Post-Construction Stormwater Program (PCSP) will apply as defined in NPDES stormwater permit NCS000250.

The PCSP describes a process by which decisions are made to treat post-construction stormwater runoff to the maximum extent practical (MEP). The MEP standard is intended to be flexible and is allowed to vary between projects and over time. However, given the presence of two endangered species within the project area – the gray bat and the Appalachian elktoe mussel – it is prudent for the Department to clarify the MEP stormwater treatment standard for discharges to the French Broad River in the context of the STIP I-2513 project.

Due to project documentation requirements and associated scheduling constraints the following stormwater treatment commitment language was developed prior to final drainage design information being available. Hence, it is not appropriate at this time to make commitments for implementation of specific stormwater treatment best management practices (BMPs) at any given location. Instead the commitment language is intended to lead the hydraulic engineer through a thought process for selecting the maximum extent practical stormwater treatment options for a discharge to the French Broad River.

Mailing Address:
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1590 MAIL SERVICE CENTER
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Telephone: (919) 707-6700
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Customer Service: 1-877-368-4968

Website: www.ncdot.gov

Location:
1000 BIRCH RIDGE DRIVE
RALEIGH, NC 27610

The following commitment guidance is intended to apply to STIP I-2513 at the crossings of the French Broad River and any tributaries draining to the French Broad River and any portion of the NCDOT stormwater conveyance system draining to an outfall discharging to those waters within the right-of-way.

Post-Construction Stormwater Treatment Commitment:

NCDOT will prepare a stormwater management plan (SMP) that implements structural and non-structural post-construction stormwater BMPs to the MEP, which is consistent with the Department's NPDES Post-Construction Stormwater Program. The goal of the SMP is to provide long term protection for federally listed species which depend on the French Broad River. To demonstrate attainment of the MEP standard NCDOT commits to the following set of guidelines for preparation of the SMP:

1. NCDOT recognizes that the Appalachian elktoe and the gray bat are sensitive to excessive amounts of silt, nutrients, and heavy metals. Therefore, when preparing the SMP NCDOT commits to using a hierarchical BMP selection process that is optimized to treat the above three pollutant categories. At each discharge location, outside of the 100-year floodplain, the hydraulics engineer will evaluate the feasibility of installing either an infiltration basin or a media filter as described in NCDOT's BMP Toolbox. If one of these BMP types are a feasible option, then NCDOT commits to including such BMP in the SMP. If an infiltration basin or a media filter is not feasibledue to site constraints (e.g. topography, high water table, etc) then NCDOT commits to providing a description of these constraints in the SMP as supporting information for the MEP BMP selection decision. In such cases the hydraulics engineer will select another BMP type from NCDOT's Toolbox that is feasible. Preference will be given to water quality swales, vegetative conveyances, vegetated filter strips, and preformed scour holes (PSHs). In flat, bottomland terrain PSHs will be used to the MEP to eliminate outfalls by converting concentrated flow into distributed flow thus maximizing infiltration and evapotranspiration of the runoff.

2. NCDOT recognizes forests as important habitat for the gray bat and therefore will consider the detrimental effects to forest habitat when making BMP selections. Where maintenance and access of traditional BMPs would necessitate permanent clearing beyond the minimum limits needed for roadway construction and erosion control, traditional BMPs may be alternatively designed to minimize or avoid permanent clearing and designed to minimize or avoid maintenance of the BMP.

3. NCDOT recognizes the presence of two endangered species - one aquatic and one terrestrial, but aquatic dependent – within the project area presents unique stormwater management challenges. Optimizing BMP selection for one species may be suboptimal or even detrimental to the other. Because of this unique situation, NCDOT will commit to evaluating the use of emerging BMP technologies that the Department has or is currently researching, but has not yet published in its BMP Toolbox. These emerging BMP technologies are as follows:

    - ✓ Bioswales
    - ✓ Bioembankments
    - ✓ Biofiltration Conveyances
    - ✓ Soil improvement to maximize infiltration

Because design standards have not yet been formally approved by NC Department of Environmental Quality (NCDEQ) for inclusion in the BMP Toolbox, the hydraulics design engineer will be required to consult with the State Hydraulics Engineer and obtain prior approval before proposing one of these BMP technologies in the SMP. In consultation with the State Hydraulics Engineer, the hydraulics design engineer will use the following guidelines, in addition to an evaluation of site constraints, to determine the appropriateness of one of these emerging BMP technologies:

Bioswale Guidelines – for typical sections that include a vegetated median, a bioswale may be considered. For vegetated conveyances in other areas of the project where swale criteria can be met (refer to the BMP Toolbox for criteria) the hydraulics engineer should evaluate if a bioswale would be feasible in lieu of a traditional swale. If a bioswale is not feasible then the engineer should document in the SMP the constraints as justification for the MEP decision.

Bioembankment Guidelines – bioembankments can be used on slopes 4:1 or flatter and outside of the clear recovery zone. Discharges of treated runoff should be to a stable conveyance or energy dissipator. A geotechnical engineer should be consulted in the design of the bioembankment to ensure the stability of the side slope.

Biofiltration Conveyance Guidelines – biofiltration conveyances may be used along steep conveyances provided it is outside of the 100-year floodplain. A maintenance access road should be provided in compliance with clearing requirements in guideline #1.

Soil Improvement Guidelines – soil improvement practices may be considered in areas where compacted soil is not required for the structural integrity of the roadway facility. Improved areas should be planted with native, pollinator-friendly plants in consultation with the Division Roadside Environmental Engineer.

These commitments will meet the need for more stringent guidance for the area of environmental concern for the project. It is expected during the design phase additional coordination and clarification of these stormwater best management practices will occur through consultation with the Stormwater group in Hydraulics.

cc: Brian Burch, Division 14
Wanda Austin, Division 14
Randy McKinney, Division 13
David Harris, REU
Kat Bukowy, HNTB
Mary Frazer, Three Oaks Engineering

SRM/ahm

APPENDIX J. LIGHTING SUMMARY

Lighting Summary

Roadway lighting is beneficial in the reduction of nighttime accidents and in the identification of conflict points along the roadway by motorists. Because it is not economically feasible to light every conflict point along the roadways of the State, it is the policy of the Department to construct and maintain lighting systems at interchanges and along continuous sections of fully controlled access roadways which meet specific criteria established by the American Association of State Highway Transportation Officials (AASHTO) and the NCDOT Roadway Lighting Committee.

Engineers within the Lighting and Electrical Team apply the lighting evaluation techniques detailed in the Total Design Process (TDP), as defined in National Cooperative Highway Research Program (NCHRP) Report 152, to all interchanges and continuous sections of fully controlled access roadways that may warrant lighting. The TDP generates a Priority Index based on a numerical weighting and scoring process. The TDP incorporates roadway geometrics, nighttime average daily traffic and the annual cost of providing lighting to develop the Priority Index for an interchange or continuous section of roadway. If the Priority Index meets or exceeds the Base Priority Index established by the Roadway Lighting Committee, the Lighting and Electrical Team Leader submits a request to the Lighting Committee to include lighting in the roadway contract.

There is existing lighting throughout the I-26 corridor that is being widened or relocated as part of the I-2513 project. The Department's practice is to upgrade and relocate existing services, such as lighting, when those services are in conflict with the construction of the roadway project. Because of this practice, a TDP was not performed for this corridor.

In most cases, the Department maximizes the use of high mast light poles of varying heights (80', 100' or 120') to flood interchange areas with lighting. Shoulder mounted single arm poles or median mounted twin arm poles, both having a 'cobrahead' style LED light fixture mounting height of 45' above the pavement surface, are used to supplement the high mast lighting at the interchange tie in and taper points, and along continuously lit corridors of roadways.

The Department's lighting designs are initially optimized using GE cobrahead style fixtures and Holophane high mast style fixtures.

Lighting Mitigation at Culvert

Existing Baseline Conditions

On February 26th, members of the Roadway Lighting Squad (RLS) traveled to Asheville to measure the light levels near the culvert where the gray bats are present. Measurements began at 7:20 and were taken at various points around the fence of the property at Southern States. On this property there are seven light fixtures, of which, four are LED, two are high pressure sodium (HPS) and one is an old NEMA fixture which is probably metal halide. The measurement points are shown as the numbered blue dots in Figure 1 below. The dashed blue line shows the approximate culvert opening and ditch line that runs to the French Broad River (FBR).

Figure 1: Southern States store property with light measurement locations

It was conveyed to the RLS that measurements at points 1-3 would be the most critical due to their location near the culvert opening. The measurements, in foot-candle (fc), conducted at all points can be seen in Table 1. Also contained in Table 1 is the calculated light level at each point based on the types of light fixtures installed in the Southern States property. Calculations were performed using photometric analysis software (AGi32).

***Table 1**: Measured and Calculated Values of light in the Southern States property.*

Location	Measured Value	Calculated Value
Point 1	0.524	0.342
Point 2	0.413	0.300
Point 3	0.362	0.264
Point 4	0.002	0.002
Point 5	0.009	0.004
Point 6	0.008	0.004

**NOTE: light from a full moon is 0.01 fc.*

As shown, in nearly all cases, the calculated light levels are lower than the measured light levels. This is likely due to atmospheric conditions, including pollution from other light sources in the area that cannot be captured for inclusion in the calculations. For points 1-3, the calculated values are, on average, 31% lower than the measured values.

Due to site conditions, the RLS was unable to physically take light measurements at the culvert opening or along the ditch. AGi32 was again used to calculate the light levels at those areas. The calculated light levels were increased by 31% to match the delta between the measured and calculated light levels at points 1-3 above. Calculated values are shown in Figure 2.

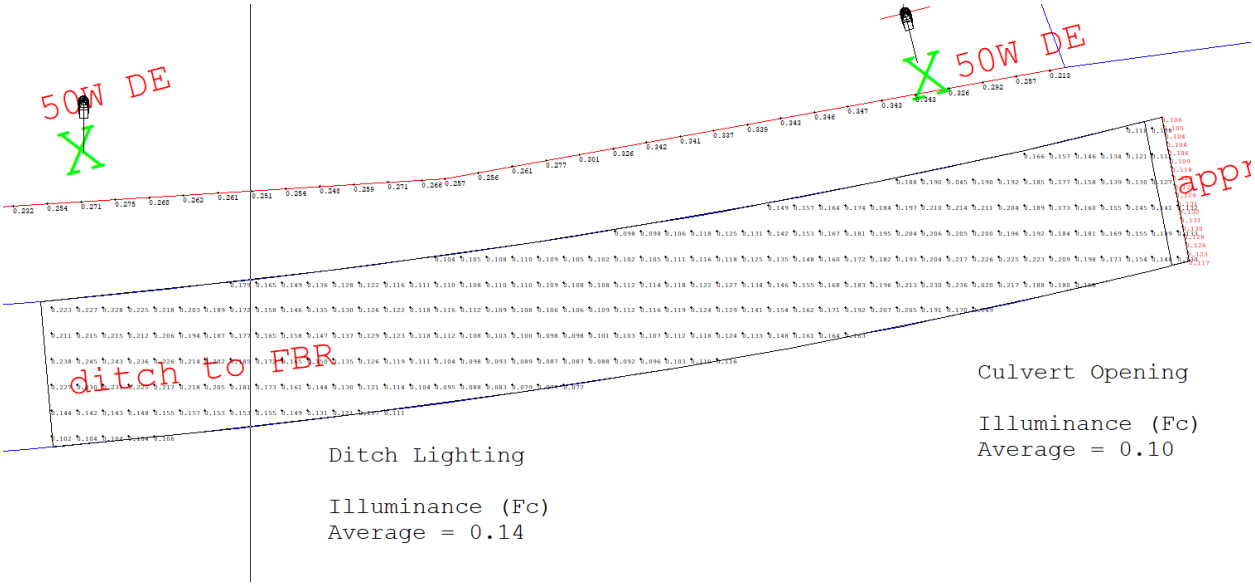


Figure 2: Calculated light levels at the culvert and the ditch

Increasing these calculated light levels by 31% results in an average of 0.18 fc in the ditch and 0.13 fc at the culvert opening. It can be reasonably assumed that these levels are likely not this high given the amount of vegetative overgrowth around the ditch and culvert.

Proposed Lighting for New French Broad River Crossing (Initial Conceptual Design)

Existing I-26 has continuous roadway lighting from the Woodfin Road interchange (Exit 23) south to the Brevard Road (NC 191) interchange (Exit 33). As part of the upcoming I-26 widening projects (I-2513A/B/C) the existing lighting will have to be modified. The intention of the RLS is to provide lighting that is as good or better than what is currently installed. In most cases, this will mean removing the existing single arm light poles that are currently installed on the outside shoulder of the roadway and installing twin arm light poles on the proposed median barrier. At interchanges throughout the corridor, a combination of single arm poles, twin arm poles and high mast poles will be used.

At the new FBR crossing, the intent of the RLS was to provide high mast lighting on 120’ poles to flood the entire area, including all flyover and interstate bridges, with light. High mast lighting is preferred because this type of lighting is installed far from traffic, eliminates the addition of roadside obstacles and can be maintained without requiring lane closures. Figure 3 below depicts the desired conceptual lighting design using high mast poles exclusively at the FBR crossing. The circular iso foot-candle templates show the varying foot-candle levels distributed from each high mast pole. The outer iso foot-candle ring is 0.1 fc. Two single arm poles were also needed on one of the flyover bridges to complete the lighting design.

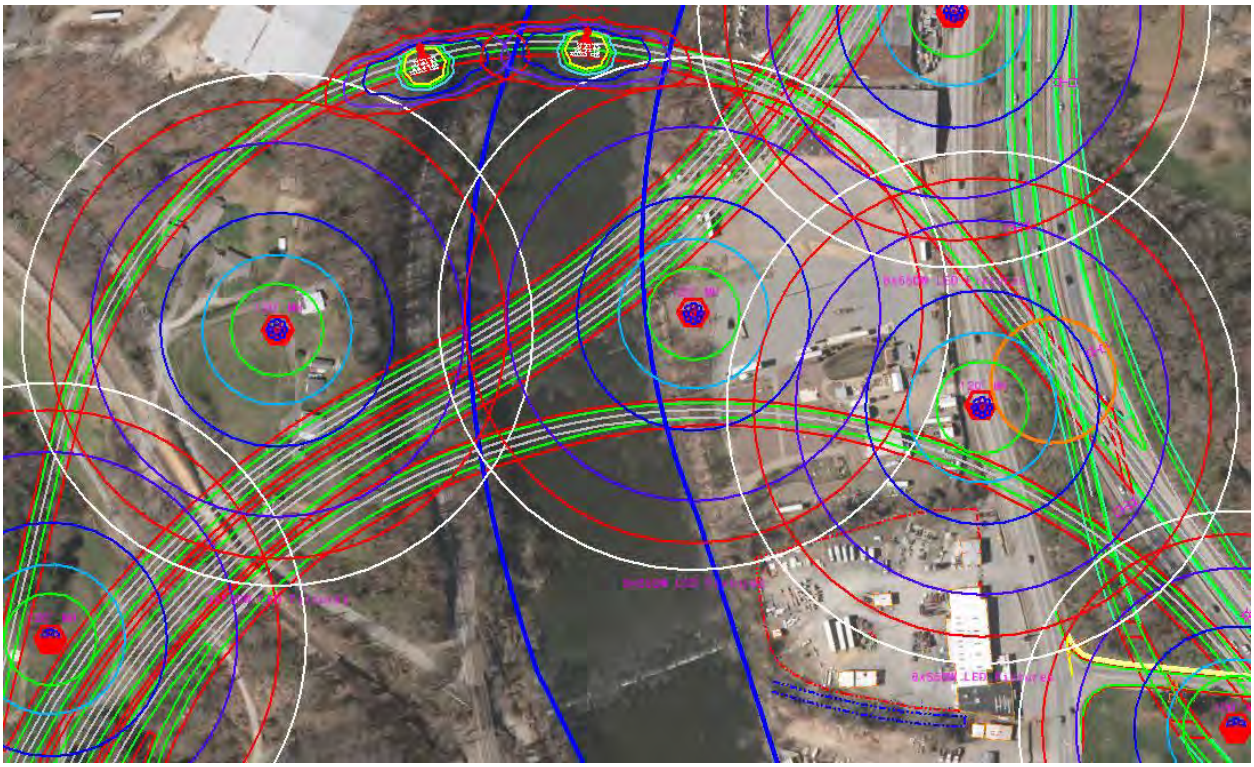


Figure 3: Proposed FBR crossing with conceptual lighting design layout.

At the time this design was conceptualized, the RLS was not aware of the gray bat population located in the culvert. In meetings with the Environmental Analysis Unit, the RLS was informed that the lighting in the area near the FBR could have a detrimental effect on gray bats. We were asked what, if any, mitigation efforts could be made to the lighting design to reduce impacts to gray bats, particularly in terms of the amount of light being cast onto the FBR. The RLS committed to investigate what lighting mitigation measures could be taken.

In the initial design shown in Figure 3 there is a significant amount of light being dispersed onto the FBR. This design was imported into AGi32 to calculate the impact on the FBR. The overall project layout and zoomed in areas over the FBR and the culvert and ditch area are shown in Figures 4, 5 and 6 below.

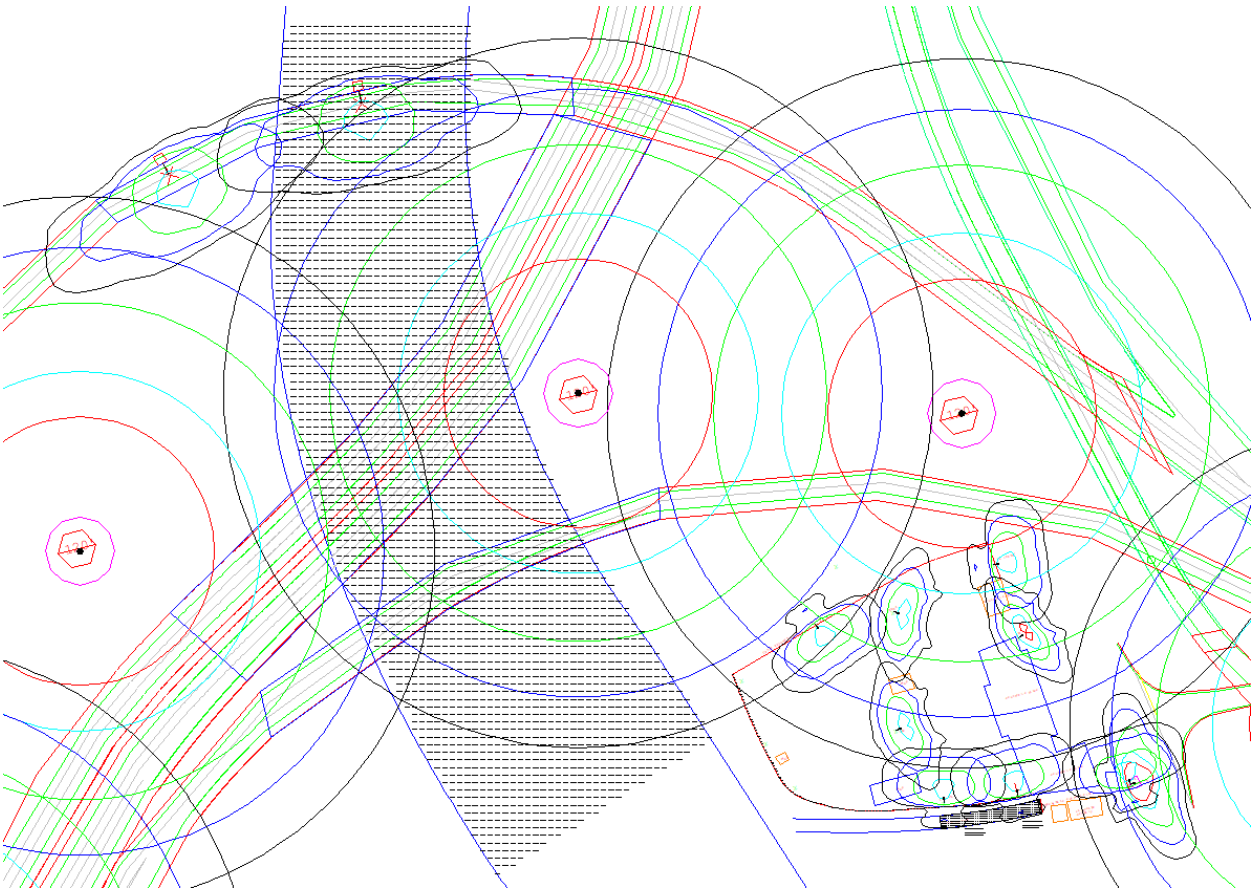


Figure 4: Conceptual lighting design layout in AGi32. The Southern States property is in the lower right.

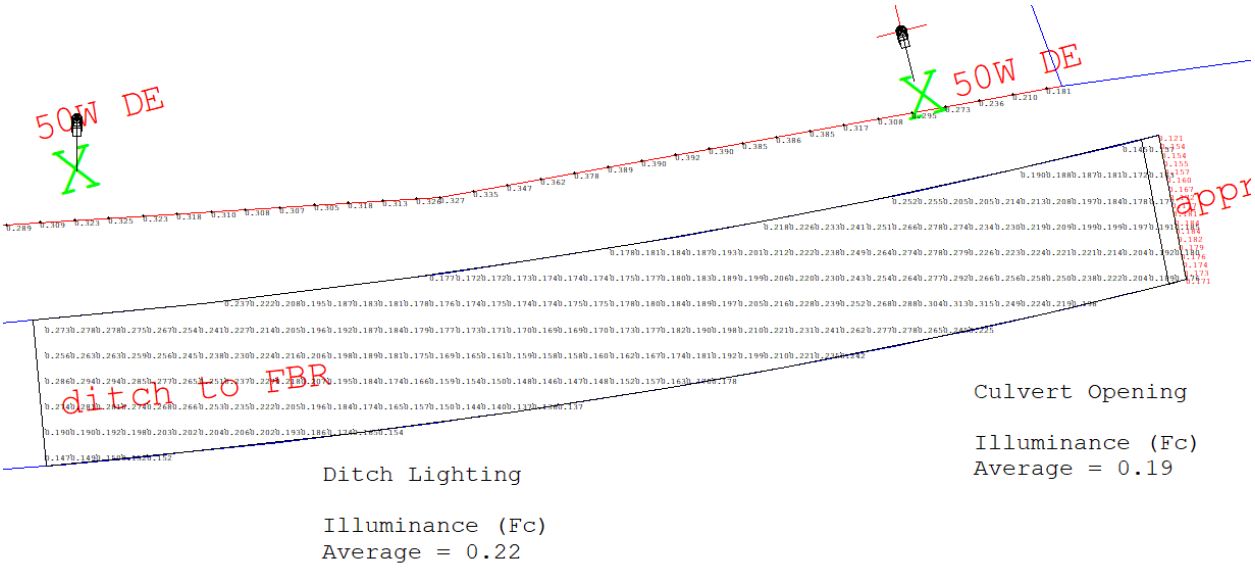


Figure 5: Calculated light levels at the culvert and ditch using the conceptual lighting design layout.

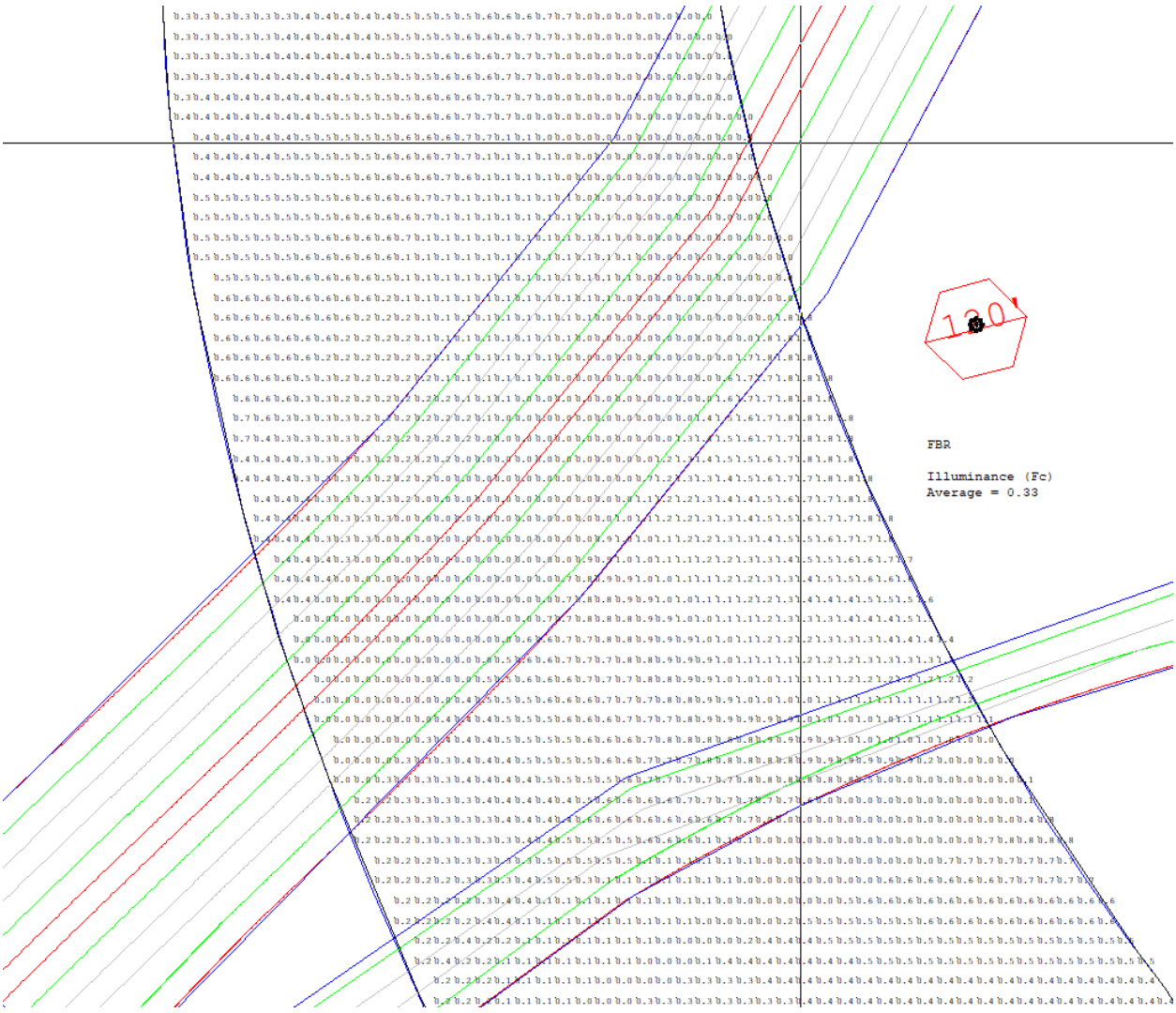


Figure 6: Calculated light levels on the FBR using the conceptual lighting design layout.

Using the same 31% increase over calculated values from before, the assumed effective lighting in foot-candle for the culvert, ditch and FBR would be as shown in Table 2.

***Table 2**: Calculated and Assumed Measured Values of Light in the Culvert and Ditch*

Area	Calculated Value	Assumed Measured Value	Percent Change from Baseline
Culvert Opening	0.19	0.25	+92.3%
Ditch	0.22	0.29	+61.1%
FBR	0.33	0.43	N/A

Proposed Lighting for New French Broad River Crossing (Mitigation Design)

The most effective mitigation effort that can reduce the amount of light cast onto the FRB and the culvert while still providing adequate lighting for the driving public is to use single arm light poles mounted on the bridge and flyover barriers in place of the 120' and 100' high mast poles. To reduce impacts further, a light fixture with a very narrow distribution pattern can be used. This will keep more light on the bridges and flyovers and spill less light onto the FRB and the culvert.

Figure 7 shows the lighting layout using 35’ single arm poles with a narrow distribution light fixture and a house side shield. The house side shield aids in preventing excessive light from being distributed behind the luminaire. The large iso foot-candle templates present when using high mast poles have been replaced with much tighter iso foot-candle templates showing the narrow distribution of the fixture used in the calculations. Figures 8 and 9 show the zoomed in images of the lighting at the culvert area and FBR crossing.

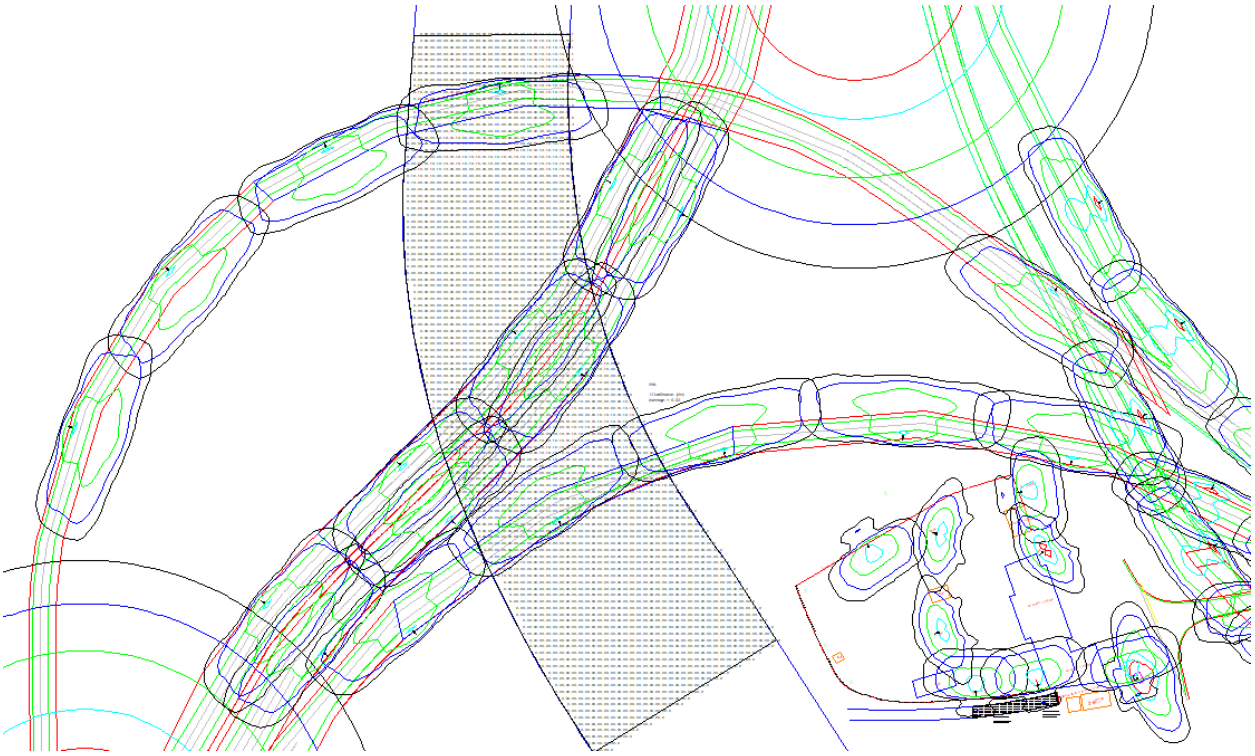


Figure 7: Mitigation lighting design layout in AGi32. The Southern States property is in the lower right.

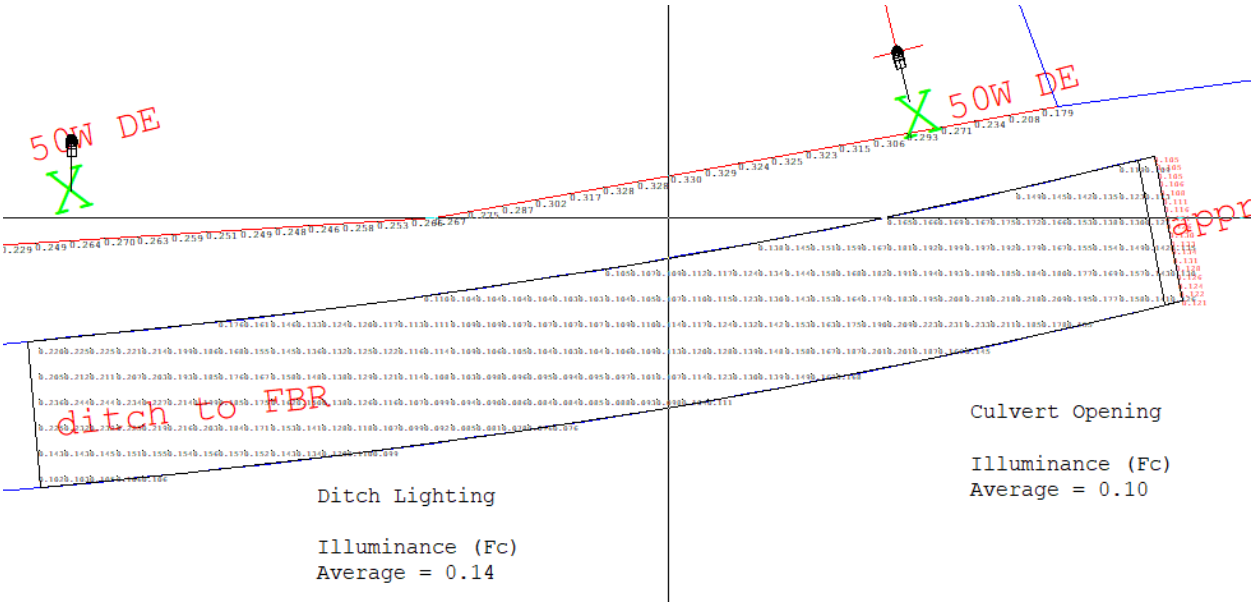


Figure 8: Calculated light levels at the culvert and ditch using the mitigation lighting design layout.

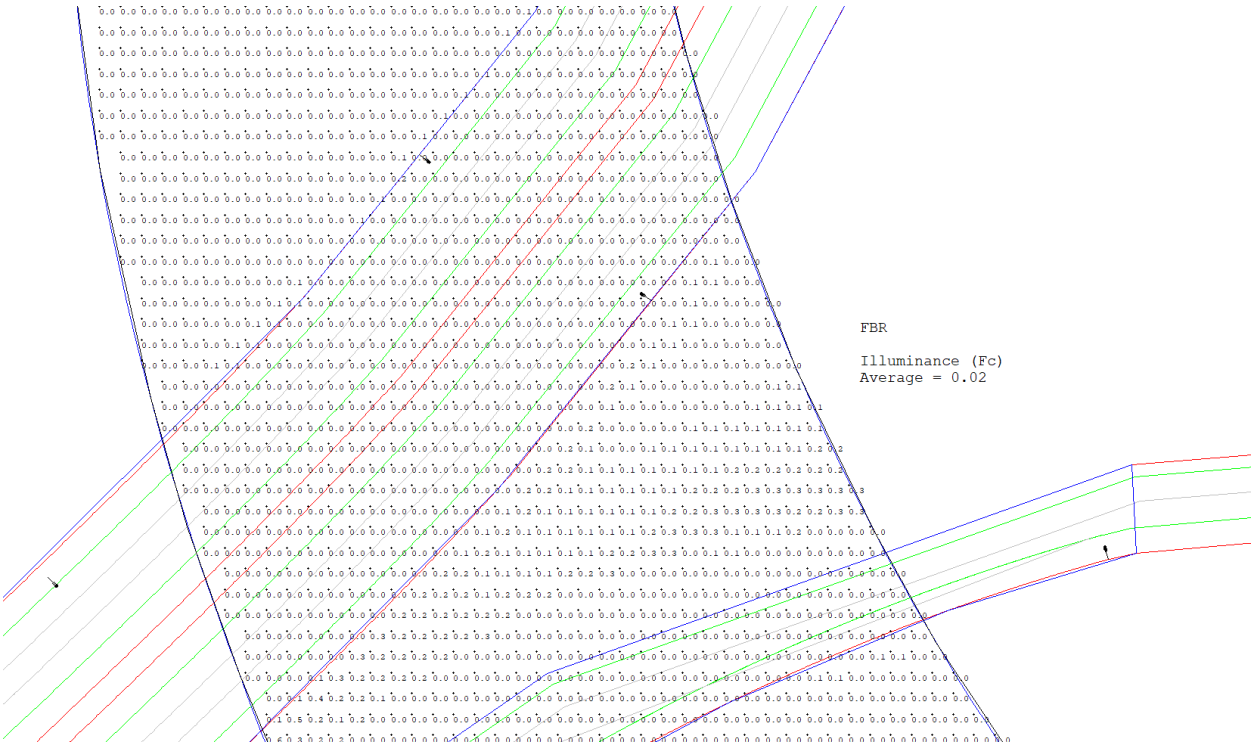


Figure 9: Calculated light levels on the FBR using the mitigation lighting design layout.

Using the same 31% increase over calculated values from the initial conceptual design, the assumed effective lighting in foot-candle for the culvert, ditch and FBR would be as shown in Table 3.

***Table 3**: Comparison of Conceptual and Mitigation Values of Light in the Culvert and Ditch*

Area	Calculated Value	Assumed Measured Value	Percent change from conceptual design	Percent change from baseline
Culvert Opening	0.10	0.13	-48%	0%
Ditch	0.14	0.18	-38%	0%
FBR	0.02	0.026	-94%	N/A

Results

Using the mitigation design results in zero calculated change to the baseline light levels at the culvert and the ditch near the Southern States property. Additionally, the levels of light that are calculated to be cast onto the FBR are reduced by 94% to a value of roughly 2x that of the light from a full moon.

There are potential drawbacks to using the mitigation lighting design. The largest of those drawbacks is that the mitigation design requires that single arm poles be installed on the barrier rail of the interstate and flyover bridges and beside the shoulder of the interstate and ramps. These poles introduce roadside obstacles that are not present in the conceptual lighting design. Additionally, these poles will require lane closures when maintenance is required. Lane closures introduce another obstacle to drivers, particularly on the narrow flyover bridges.

It should be noted that all light calculations were performed with LED light fixtures having a 4000 degree Kelvin (4000K) color temperature. 4000K is considered natural white in color. The existing lighting installed on I-26 has already been upgraded to 4000K LED. The local utility in Asheville is in the process of upgrading all lighting to 4000K LED as well. While a few high pressure sodium (HPS) fixtures remain in the area, the vast majority have already been upgraded to 4000K LED.

Lighting Mitigation Efforts at Crossings

In order to achieve maximum pole spacing along continuously lit roadway corridors, the Department traditionally uses single arm and twin arm light poles with LED light fixtures mounted at a height of 45' above the pavement surface. The specification that the Department has for LED light fixtures states that the low level 'cobrahead' fixtures may have a Backlight-Uplight-Glare (BUG) rating of 3-0-3. The light pattern from these fixtures is somewhat football shaped which leads to some light falling outside of the travel lanes. In most installations, this is a desired affect because lighting outside of the travel lanes can assist motorists in identifying hazards on the shoulder.

In an effort to reduce the amount of light projected outside of the roadway, the Department has committed to the following at all crossings identified in this Appendix:

- using shorter poles which will provide an overall LED light fixture mounting height of 35' above the pavement surface
- using LED light fixtures with a more rectangular light pattern as well as house side shields to minimize lighting outside of the pavement area. See Figure 11 on the following page for an image of a house side shield installed on a LED fixture.
- using LED light fixtures with a BUG rating of 1-0-3 or less
- Use LED light fixtures with a lower lumen output, reducing overall brightness

The Department reached out to various lighting vendors in an attempt to find identify LED light fixtures with a Backlight rating of 0. Through our research, it was determined that only lower power LED light fixtures have a Backlight rating of 0. These low power fixtures are not designed to be used on interstate facilities. They may work on small, low speed local roadways or in parking areas.

Lighting designs for interchanges or continuous sections of roadway that are approved for lighting by the Roadway Lighting Committee are designed to an average of 0.8 foot-candle (fc) at a 4:1 uniformity ratio (average fc to minimum fc). The 2018 AASHTO Roadway Lighting Design Guide recommends interstate lighting facilities be designed to an average of 0.6 fc (down from a range of 0.6 fc to 0.8 fc in previous versions of the Guide) at 3:1 or 4:1 uniformity ratio, but also gives member States the option to design to higher values. The NCDOT has designed around 0.8 fc at 4:1 uniformity ratio for many years based on previous AASHTO guidance. In an attempt to enhance the mitigation efforts to the gray bats as part of this project, the NCDOT is committed to lowering the design standards to meet the AASHTO minimum requirements of 0.6 fc at 4:1 uniformity at all crossing locations identified in this Appendix. This represents a 25% reduction in the average light on the pavement surface and should reduce the amount of light reaching the various crossings.

At all identified crossings, the proposed high mast poles and 45' poles with GE Cobrahead (GE) fixtures (3-0-3 BUG) were removed and replaced with 35' poles with Cooper Cobrahead (Cooper) fixtures (1-0-3 BUG). Both the GE and Cooper fixtures have a Type 2 light distribution pattern, however the house side shield on the Cooper fixture significantly changes the backlight and overall shape of the light. From outer to inner, respectively, the rings of light shown emitting from the GE and Cooper fixtures are 0.1 fc, 0.2 fc, 0.4 fc, 0.8 fc, 1.0 fc and 1.2 fc. See the figures on the following page for generic distribution types and specific GE and Cooper distribution patterns.

Lighting Distribution Types, Shields and Patterns

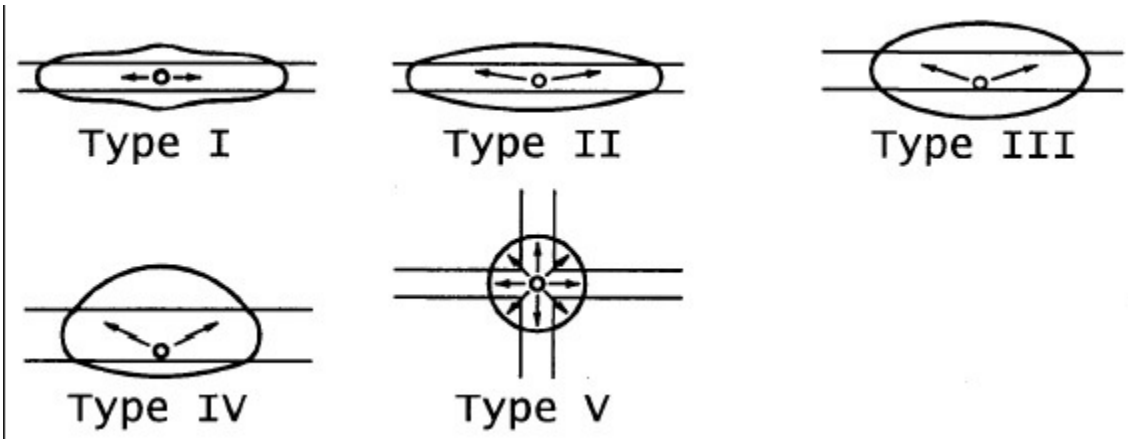


Figure 10: Light Distribution Types.

Figure 11: House side shield installed on LED fixture to limit backlight.

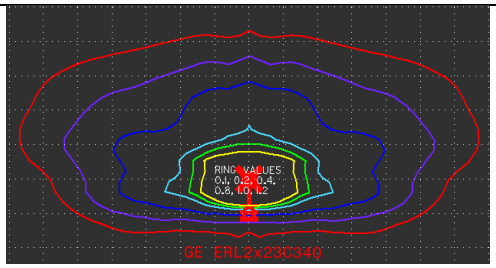
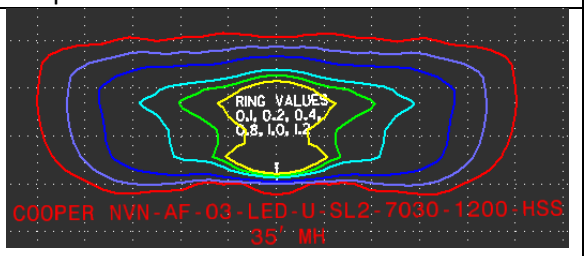
GE Distribution	Cooper Distribution
	

Figure 12: Light distribution patterns. Note the gridlines for each fixture are 25' x 25'.

French Broad River Crossings

FBR-1 Original

The original design had GE cobrahead fixtures to the west of the crossing with the outer 0.1 foot-candle ring being located roughly even with the west bank of the FBR. There were no proposed fixtures east of the crossing. See Figure 13 below.

Figure 13: Original lighting layout at FBR-1, HC-5, HC-6 & HC-7 crossings.

FBR-1 Mitigation

In the mitigation design, all GE fixtures west of FBR-1 to HC-5 and HC-6 were changed to Cooper fixtures. The outer 0.1 fc ring from the Cooper fixture ends roughly 115' from the west bank of the FBR. See Figure 14 below.

Figure 14: Mitigation lighting layout showing new 1-0-3 BUG fixtures at FBR-1, HC-5, HC-6 & HC-7 crossings.

FBR-2, FBR-3 & FBR-4 Original

As detailed in the "Lighting Mitigation at Culvert" section above, the original design flooded these crossings with light from 120' high mast poles installed east and west of the FBR. In addition to the 120' high mast poles flooding the connector interchange with light, two GE fixtures were needed directly over the FBR-4 crossing to adequately light the flyover bridge.

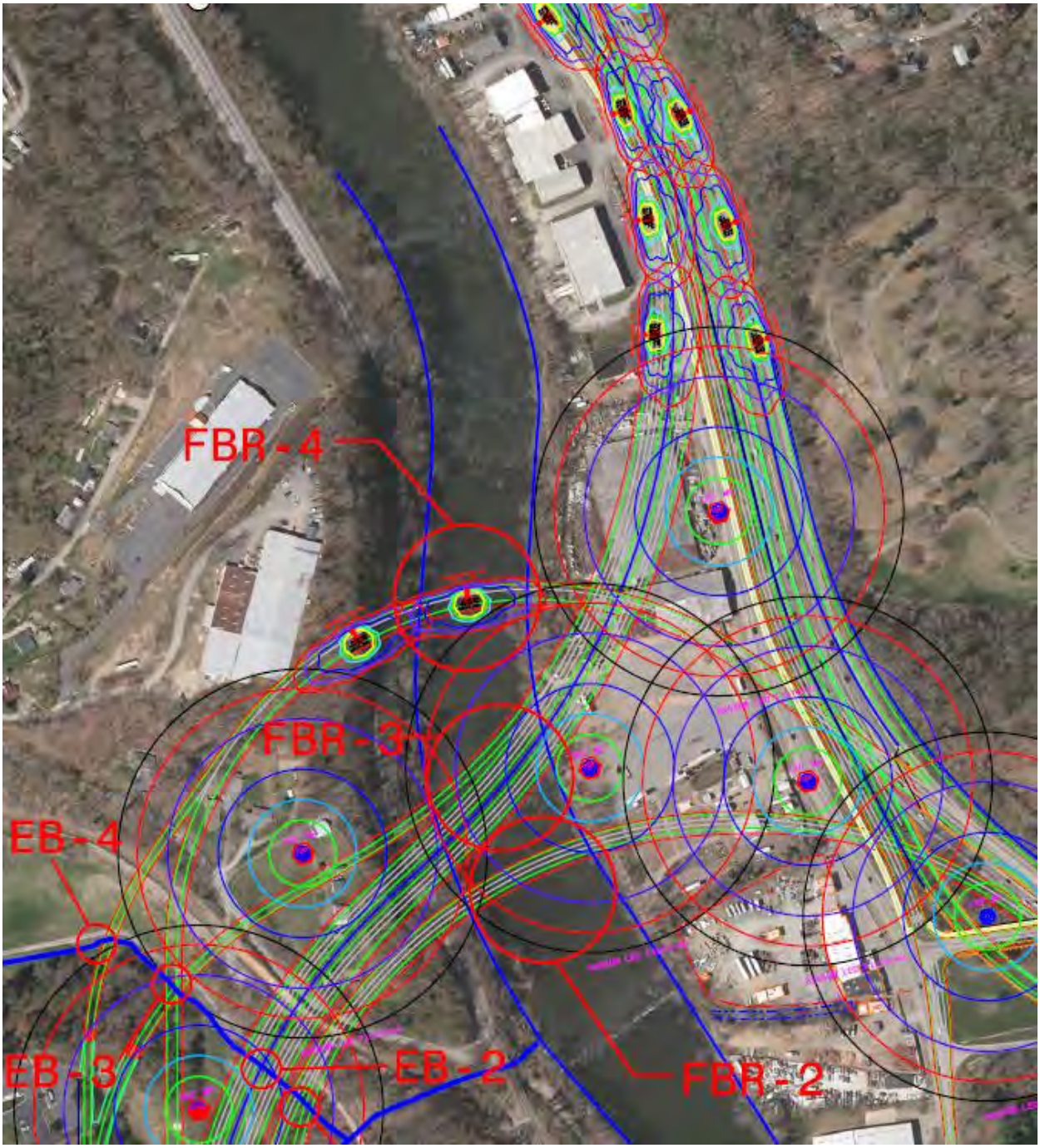


Figure 15: Original lighting layout at FBR-2, FBR-3 & FBR-4 crossings.

FBR-2, FBR-3 & FBR-4 Mitigation

The mitigation design removes all high mast poles within the connector interchange that crosses the French Broad River and replaces them with Cooper fixtures mounted on the outer bridge barrier rail and/or on the center bridge barrier. After receiving feedback from the USFWS the crossings were centered between the Cooper fixtures as best as possible.

Where I-26 and I-40 mainline structures with median barrier between the travel lanes is proposed, 45' poles were required in order to provide reasonable pole spacing. In these instances, the Cooper fixture was still used, so there was no change to the BUG rating of the fixture.

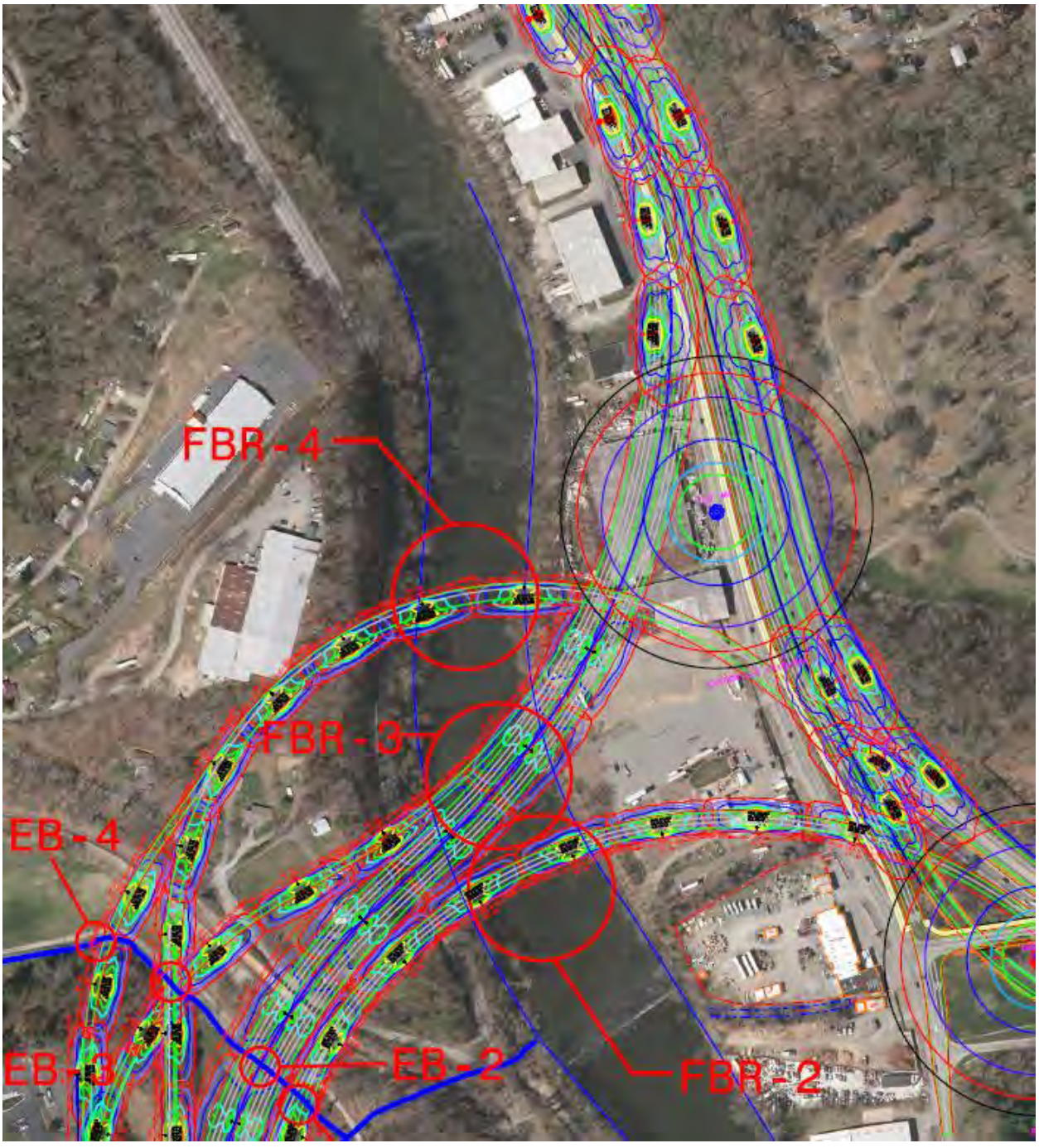


Figure 16: Mitigation lighting layout showing removed high mast poles at FBR-2, FBR-3 & FBR-4 crossings.

Hominy Creek Crossings

HC-1, HC-2, HC-3 & HC-4 Original

The original design at HC-1 had the crossing centered between GE fixtures and a had a 120' high mast located approximately 700' west of the crossing. The original design for HC-2 and HC-3 had GE fixtures east of HC-2, a 120' high mast pole west of HC-2 and HC-3 and a GE fixture directly over HC-3. The original design for HC-4 had a GE fixture directly over the east bank of the crossing and continued the GE fixtures in the east and west directions.

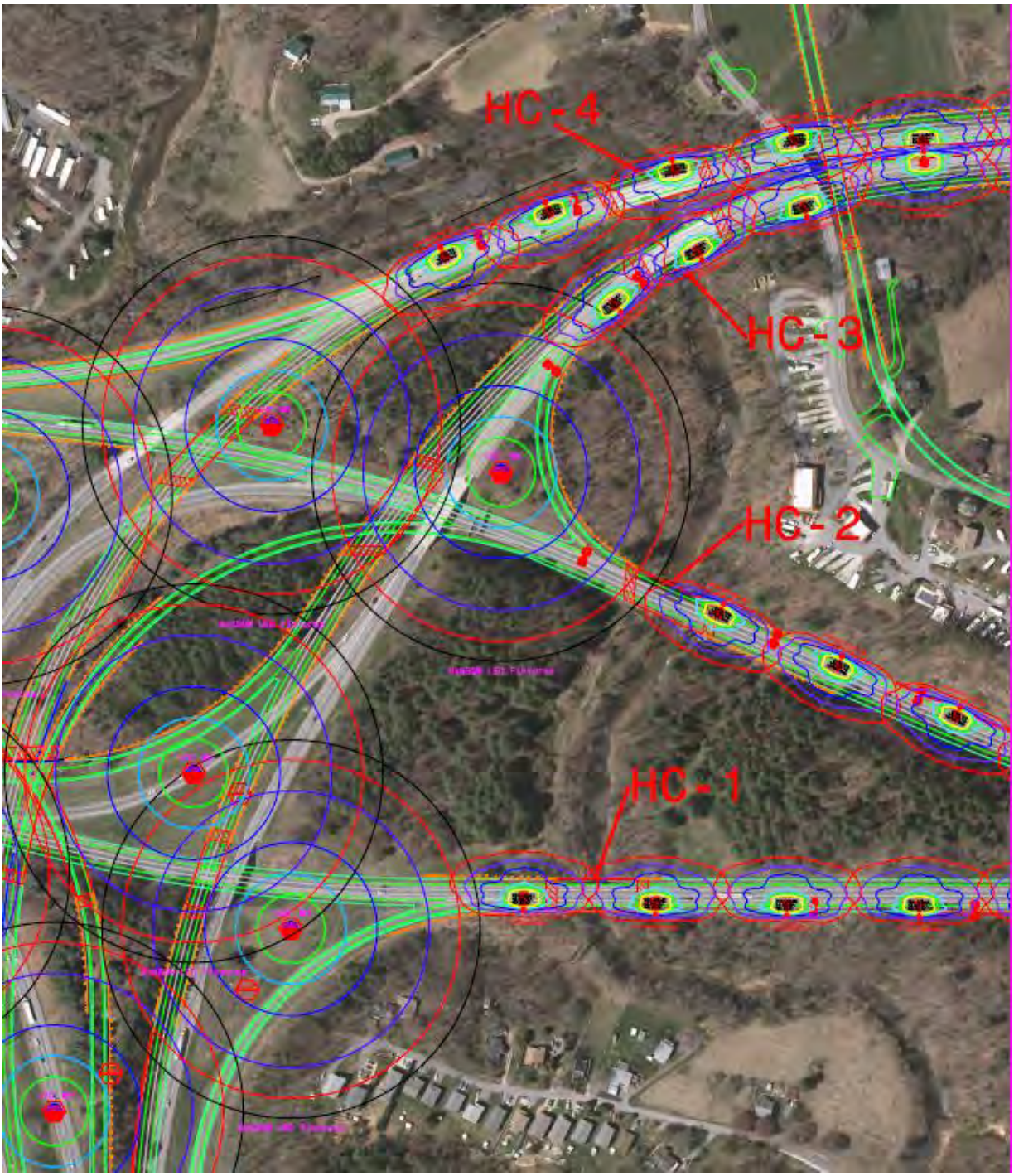


Figure 17: Original lighting layout at HC-1, HC-2, HC-3 & HC-4 crossings.

HC-1, HC-2, HC-3 & HC-4 Mitigation

The mitigation design for HC-1 replaces the GE fixtures with the Cooper fixtures, extends the Cooper fixtures further east and west and replaces the 120' high mast with an 80' high mast in the same approximate location. The crossing is still centered between the Cooper fixtures. The mitigation design for HC-2 and HC-3 removes the 120' high mast pole and includes Cooper fixtures from approximately 300 east of HC-2, along the proposed ramp to a point approximately 350' east of HC-3. Additionally, HC-2 and HC-3 are centered between the Cooper fixtures. The mitigation design for HC-4 centers the crossing between two Cooper fixtures and extends the Cooper fixtures approximately 380' to the west and 350' to the east.

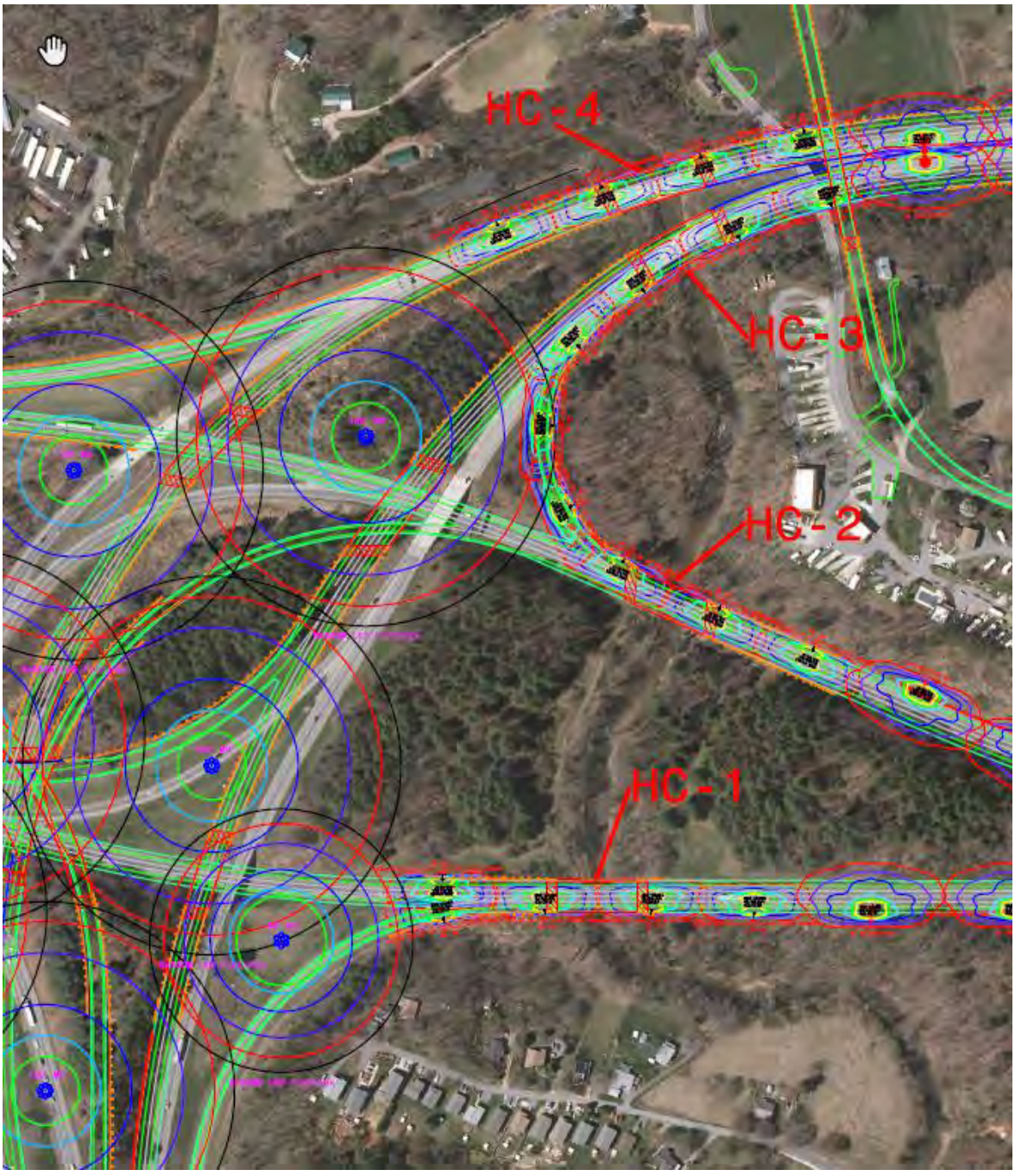


Figure 18: Mitigation lighting layout at HC-1, HC-2, HC-3 & HC-4 crossings.

HC-5, HC-6 & HC-7 Original

The original design at the HC-5 and HC-6 locations had an 80' high mast pole approximately 170' west of HC-5 and 110' west of HC-6 and GE fixtures east of both crossings. The original design at HC-7 had a twin arm pole with GE fixtures installed on the mainline barrier directly over the crossing. See Figure 13 above.

HC-5, HC-6 & HC-7 Mitigation

The mitigation design at HC-5 and HC-6 removes the 80' high mast pole, adds Cooper fixtures along the mainline and ramp in both directions and centers both crossings between the Cooper fixtures. The mitigation design for HC-7 may ultimately wind up adding more light on the crossing. Because the GE fixtures have more forward throw to them, the twin arm pole mounted on the mainline barrier is able to adequately light both ramps as well as the mainline, with very little light making to the crossing. In the mitigation design, since the Cooper fixtures do not throw the light forward like the GE fixtures do, in addition to the Cooper fixture mounted to a twin arm pole on the mainline barrier a Cooper fixture also had to be in included on each ramp to prevent the ramps from being too dark in these locations. The crossing is centered between the Cooper fixtures on the ramps and the mainline and the Cooper fixtures were extended for approximately 360' to the west and 640' to the east. See Figure 14 above.

Smith Mill Creek and Emma Branch Crossings

Similar to the FBR-2, FBR-3 and FBR-4 crossings, in the original design these crossing were all flooded with light from 120' high mast poles. See Figure 15 above for all original Emma Branch crossings. The existing lighting at the Patton Avenue interchange will be redesigned due to the significant interchange reconfiguration. The existing lighting east of the interchange and on the Captain Jeff Bowen Bridges are the GE fixtures as shown on the right in Figure 19.

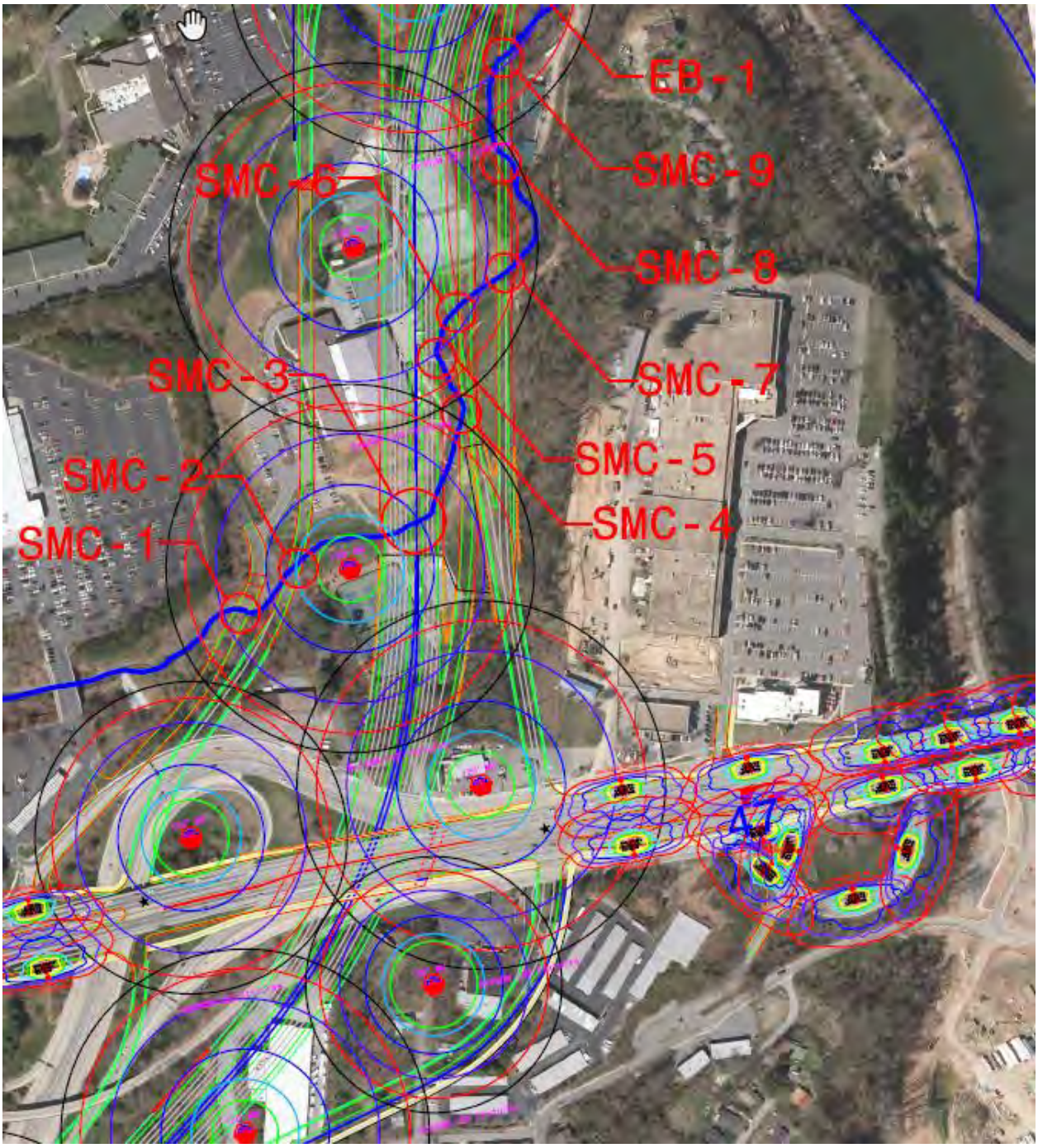


Figure 19: Original lighting layout at Smith Mill Creek and Emma Branch crossings.

The mitigation design removes all high mast poles within the connector interchange and the northern most high mast pole from the Patton Avenue interchange and replaces them with Cooper fixtures mounted on the outer bridge barrier rail and/or on the center bridge barrier. The crossings were centered between the Cooper fixtures as best as possible. See Figure 16 above for all Emma Branch mitigation crossings. The lighting east of the Patton Avenue interchange and on the Captain Jeff Bowen Bridges was not modified from the existing configuration.

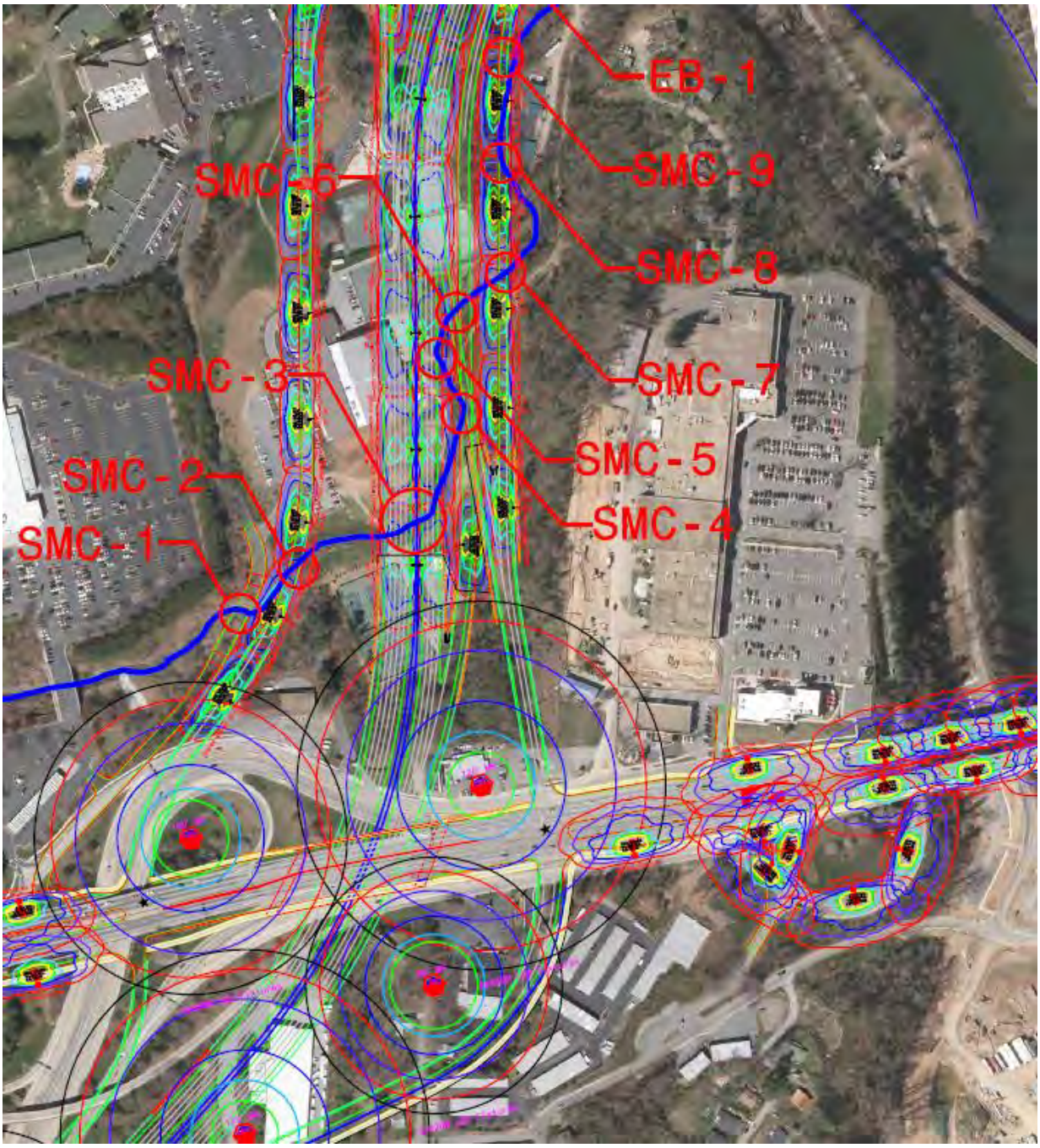


Figure 20: Mitigation lighting layout at Smith Mill Creek and Emma Branch crossings.

I-26/I-240/Patton Avenue Connector

This interchange is currently partially lit using a combination of high mast and single arm poles. The existing interchange will be redesigned as part of the I-2513 projects. Full interchange lighting which seamlessly ties into the existing lighting on I-240, Patton Avenue and the Captain Jeff Bowen Bridges will be included in the project as shown below. Since there were no stream crossings identified in this area, there were no lighting mitigation efforts.

Figure 21: I-26/I-240/Patton Avenue Connector lighting layout.

Hill Street Culvert Inlet

The original lighting design near the Hill Street culvert inlet had 80' high mast poles installed between the mainline and Hill Street. These high masts flooded the mainline, Hill Street and the surrounding area with light.

Figure 22: Original lighting layout at Hill Street culvert inlet.

To address mitigation efforts and better align with the NCDOT Roadway Lighting Policy of NCDOT owned lighting inside of the controlled access (C/A) area, the high mast poles were removed and were replaced with GE light fixtures installed on twin arm poles on the mainline median barrier.

Currently the city has installed LED lighting on Houston Street north of the culvert inlet, as well on the unnamed road that leads to the back entrance of Isaac Dickson Elementary School just south of the culvert opening.

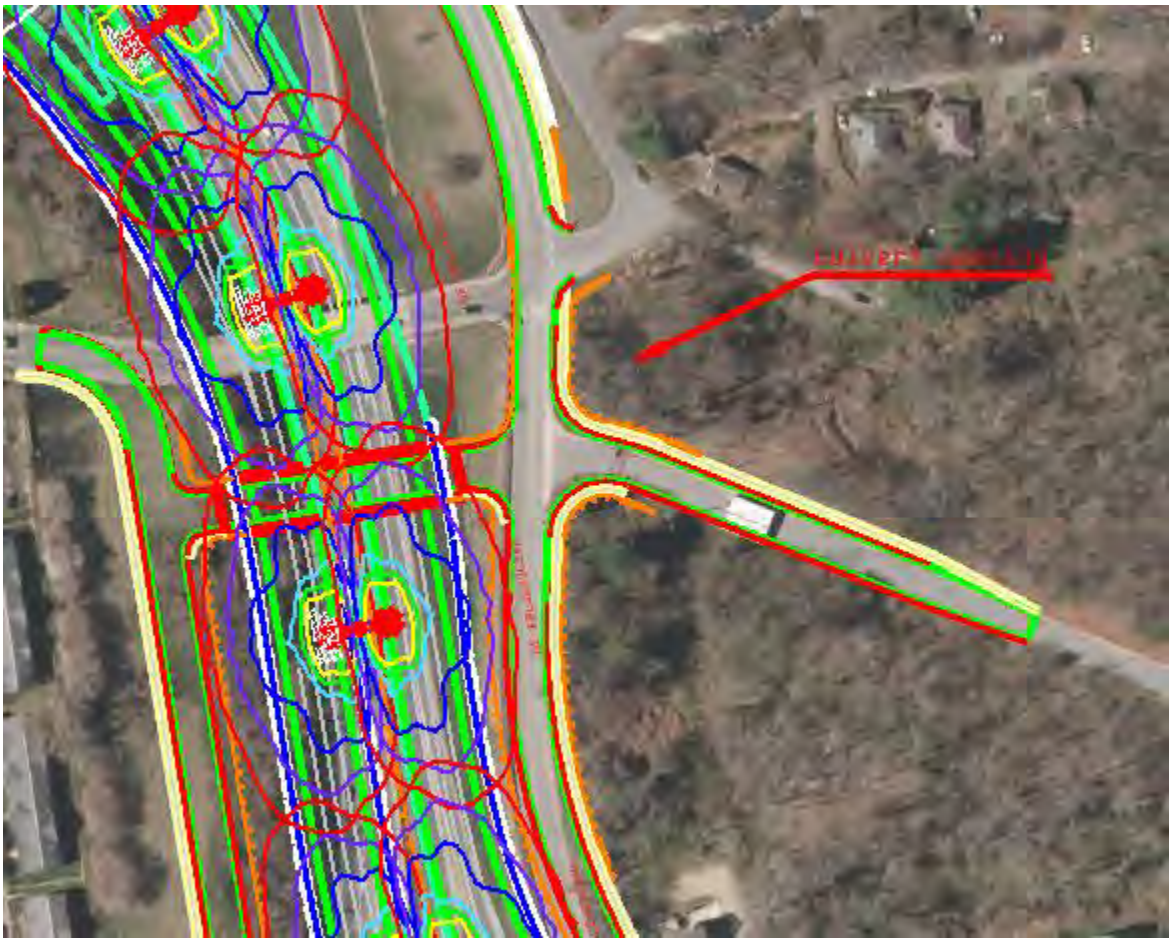


Figure 23: Mitigation lighting layout at Hill Street culvert inlet.

Smith Mill Creek Culvert at I-26/Patton Avenue Interchange

There is a culvert entrance approximately 40' from the existing overhead sign structure crossing the ramp from Patton Avenue to I-26 East. In the current configuration, the last roadway lighting pole on the ramp is approximately 300' from the overhead sign structure. Additionally, there is also a high mast pole in the center of the loop from I-26 East to Patton Avenue. Due to the distances from the culvert and the existing vegetation, the existing installed roadway lighting should provide little to no light at the culvert inlet. The existing lighting system is currently not operational and is under repair, with full functionality expected by the end of 2019.

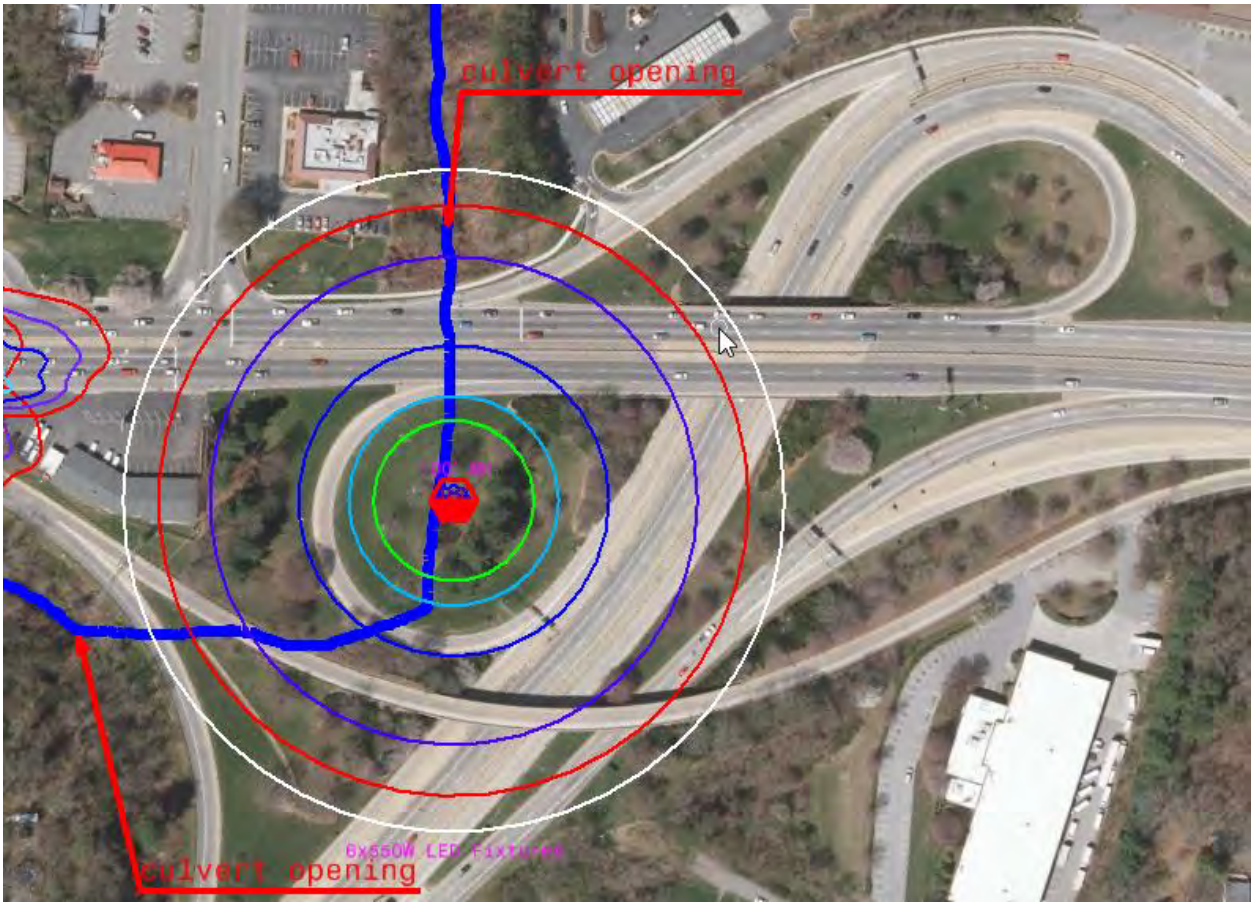


Figure 24: Existing lighting layout at Smith Mill Creek culvert at I-26/Patton Avenue Interchange.

This interchange will be completely reconfigured as part of the I-2513 project, with the existing ramps and loop at the culvert being removed. As a result of the reconfiguration, the existing lighting closest to the culvert opening will be removed. The proposed lighting system transitions the roadway light further away from the culvert opening.

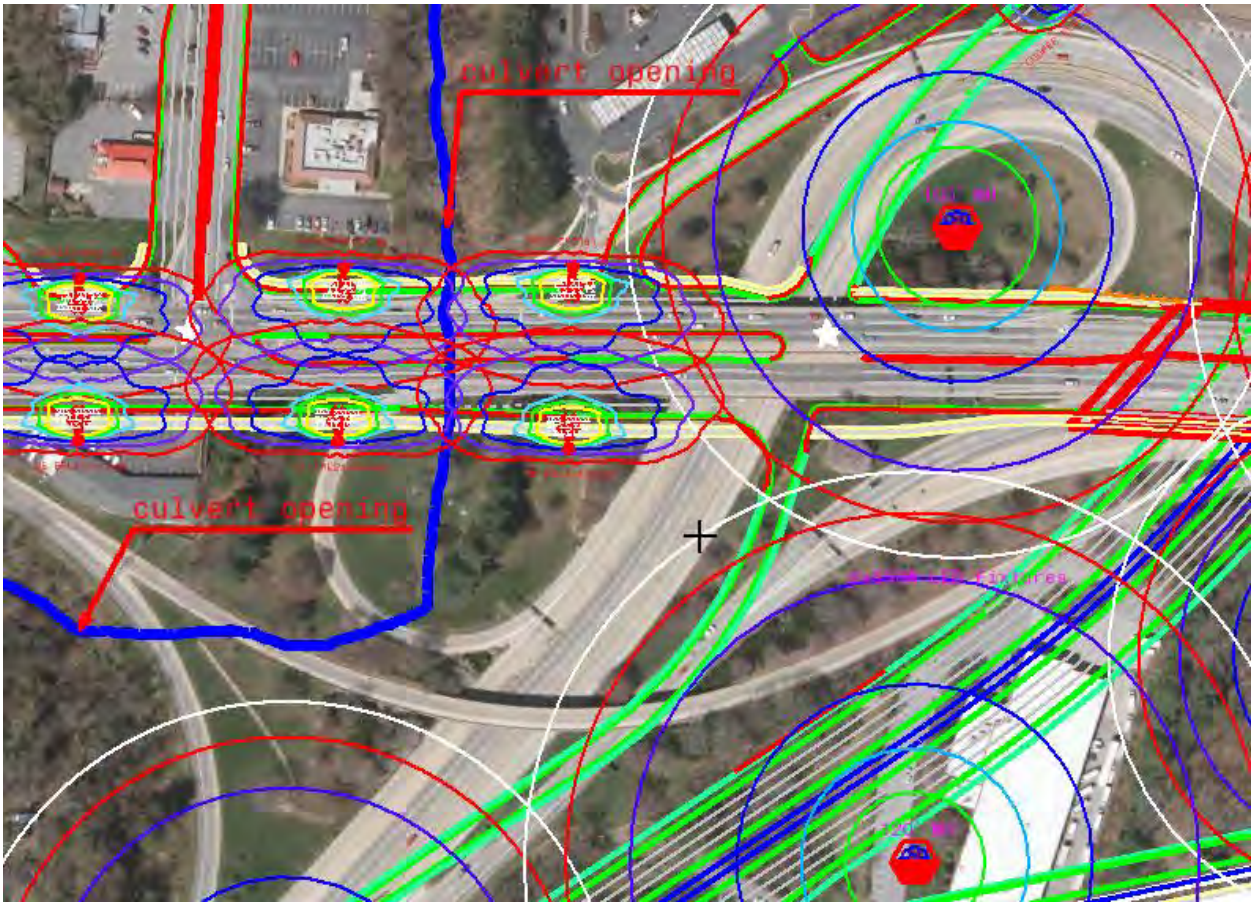


Figure 25: Proposed lighting layout at Smith Mill Creek culvert after interchange reconfiguration.

Appendix K. Light and Noise at bridge construction/demolition

Bridge Construction

There are many construction activities associated with bridge replacement and construction. However, some construction activities associated with bridge replacement and construction will take place after sunset and will not occur on a regular schedule. NCDOT will limit the use of nighttime construction lighting within 50' of the French Broad River, Hominy Creek, Emma Branch, or Smith Mill Creek between April 1 and October 15 to only the following activities: causeway construction, drilled shafts, concrete pours, beam setting, and traffic shifts. These activities, their likelihood of occurrence, and the type of light generated may include:

Anticipated light from activities is listed in red, noise is listed in blue.

- Causeway construction – *Will occur* – Access road and causeway construction and removal may take place at night throughout the life of the project. This will allow the contractor to utilize the lower traffic volume to access the site. Installing the access roads and causeways at night allows longer-term operations to be constructed during daylight hours. Due to the easier site access the contractor may be able to construct the access roads and causeways more quickly. Constructing the access roads and causeways will be at the discretion of the contractor and not required at night.
    - Lighting for this operation will likely consist of one to two light plants that will be used to directly light up the construction area. Care will be taken to not shine light directly out into the river or into the adjacent forest.
    - Noise will be created by mainly by dump trucks and generators used to power light plants.
- Drilled shafts – *Possible* – This is dependent upon construction schedule, contract, and availability of the concrete plant.
    - Lighting for this operation will be at water level. Lights on the drill rig will be used, and one light plant may be used if needed. Only the active work area (where the hole is currently being drilled) will be lit. No lights will be shining down from the bridge deck during this operation.
    - Noise for this operation will be at water level, and will be created by generators used to power light plants and drill rigs.
- Concrete pours during hot weather – *Will occur* – Night pours of concrete are required during hot weather to achieve the proper cure. These pours may include elements such as bent caps, end bents, and barrier rail wall.
    - The use of lights for this operation will be minimal. Because these will be small area and short duration (six hours or less) pours. Lights will generally be set up on the causeway, shining upward at the bridge member being poured. Small lights, such as headlights, will be used on the structure. There will be pump truck and concrete trucks with headlights either on the bridge deck or on the causeway.
    - Noise will be produced by pump trucks and concrete trucks on the bridge deck or on the causeway.
- Deck concrete pours from May to November (summer) – *Will occur* – Deck concrete pours are generally larger, more complex, and more time consuming than other types of concrete pours. Consequently, they will need to occur at night between May and November depending on temperature and weather. These pours may be able to begin at midnight and pour into the morning hours.

    - Of all potential nighttime operations, this will be the operation with the most lighting. It is important to note that these operations will consist of one night of activity at a time; there will be no long-term consecutive nights of operation. The majority of lighting will be at bridge deck level, with lights shining toward the bridge rather than down toward the river. Any lighting that shines down toward the river or adjacent woods will be indirect and minimal.
    - A pump truck will be positioned either at the end of the bridge at road surface elevation, or on the causeway. The vehicle's headlights will be used. Headlights on concrete delivery trucks will also be used.
    - Two to four light plants will be used on the bridge deck, depending on the size of the pour. These will most likely be positioned at either end of the pour shining down toward the deck and in toward the bridge; not facing toward the river. Small lights, similar to headlights, may be used to illuminate the screed (concrete surface), if needed.
    - It is important to note that these operations will consist of one night of activity at a time; there will be no long-term consecutive nights of operation. The majority of noise will be at bridge deck level, and will be created by pump trucks, concrete trucks and generators used to power light plants.
- Beam setting – *Will occur* – Setting beams at night is required due to the volume of daytime traffic and the need to maintain traffic.
    - Cranes sitting on either of the causeways or on the new or existing bridges will be used to set the beams for the new bridges. There will be a light plant on the structure where the truck with the beams is parked, either on the new or existing structure. These lights will be shining toward the truck. There will also be lights shinning toward each structure where the beam ends sit.
    - It is difficult to determine if the lights will be placed on the causeway shining up toward the structure, or on the bridge deck shining down. This decision will need to be made on site at the time of the activity.
    - It is important to note that this operation will happen once every 1-2 months only during certain periods of construction. For each new span, this operation will occur for one to two nights, and for roughly six hours or less.
    - Cranes sitting on either of the causeways or on the new or existing bridges will be used to set the beams for the new bridges. Trucks carrying the beams, and light plants will be positioned on the bridge. Light plants and associated generators may also be placed on the causeways.
- Traffic shifts – *Will occur* – Traffic shifts will be necessary to construct the new bridge.
    - These shifts will occur at night and be of short duration and will likely require minimal lighting on the bridge. All other activities with traffic shifts will occur beyond the end bents of the bridge and will not be part of the work on the bridge or in the area of the river.
    - This operation is expected to create minimal additional noise beyond ambient levels.
- Bridge demolition – *Possible* – As described in Section 2.1.2, replacement of seven bridges will be necessary in order to accommodate roadway widening and/or other improvements associated with the project. Nighttime demolition activities will require

lighting associated with construction equipment and light plants. A tractor trailer truck, up to two cranes, and possibly a track hoe are needed for bridge demolition.

- This equipment will have integrated lighting. Lights will be at deck height, shinning on the deck. The timing (night versus day) of bridge demolition will be at the discretion of the contractor and is not required to occur at night.
- This equipment will have integrated engines which will generate noise. The timing (night versus day) of bridge demolition will be at the discretion of the contractor and is not required to occur at night. Noise levels associated with bridge demolition is expected to be moderate; slightly louder than ambient traffic noise.

Appendix L. Summary of events at the Hill Street Culvert

Timeline of notable events associated with the Hill Street culvert roost

- August 24, 2017: CLAYX biologists discover 10-15 bats flying inside culvert and staining on culvert walls. The bats were tentatively identified as MYGR. Biologists chose to quickly exit the culvert upon unexpectedly disturbing the bats.
- September 7, 2017: NCWRC and USFWS conducted an emergence count at the culvert. Two bats were seen flying from one of the culvert inlets and approximately 200 bats were seen flying from the culvert outlet. Results of acoustic recordings were inconclusive, probably due to the nature of the (social) calls being produced by the bats as they left the roost.
- September 13, 2017: NCWRC and USFWS enter culvert and identify a MYGR. To avoid further disturbance to the colony, they did not proceed deeper into the culvert.
- December 13. 2017: NCWRC and CALYX/NV5 checked the culvert for bats, and none were found. Guano and staining were not concentrated in any particular area.
- February 15, 2018: NCDOT contractors inspected culvert system. No bats were present.
- Week of March 15, 2018: Over 100 calls identified as MYGR were recorded at the culvert outlets. Previous weeks of call data had fewer than 10 calls per week.
- April 19, 2018: Trapping yielded 6 adult male MYGR
- April 27, 2018: Trapping yielded 10 adult male MYGR
- Week of May 28, 2018: Substantial flooding; backwater from river left approximately one foot of open space at the top of the culvert outlets.
- June 4, 2018: Emergence survey yielded no bats
- July 3, 2018: Emergence survey yielded no bats
- July 26, 2018: Trapping yielded 5 adult female, 27 adult male, and 7 juvenile MYGR
- August 6, 2018: Trapping yielded 2 adult female, 17 adult male, and 8 juvenile MYGR
- August 15, 2018: Trapping yielded 8 adult female, 40 adult male, and 2 juvenile MYGR
- September 16-20, 2018: Substantial flooding from Hurricane Florence; backwater from French Broad River
- September 13, 2018: Emergence survey yielded 35 bats
- October 1, 2018: Trapping yielded 4 adult female and 33 adult male MYGR
- October 8, 2018: Trapping yielded 12 adult male MYGR
- October 10, 2018: Trapping yielded 1 adult female and 20 adult male MYGR
- October 11, 2018: Substantial flooding; backwater from French Broad River
- October 19, 2018: Trapping yielded 4 adult male MYGR
- October 25, 2018: Trapping yielded 1 recapture adult male MYGR
- Week of October 18, 2018: Notable decline in the number of MYGR calls recorded at the culvert outlet. Low numbers of calls were recorded through the middle of November.
- January 16, 2019: NCDOT used a crawler system to inspect the culvert and produce a video recording of the interior for purposes of determining the integrity of the structure. No bats were observed inside the culvert on the recording.
- March 22, 2019: ISU, NCWRC & USFWS entered the culvert and observed five MYGR roosting in the RCBC section of the culvert system. No other bats were present.
- April 16, 2019: One male MYGR captured during trapping and tagged with a radio-transmitter.
- April 26, 2019: Trapping at culvert yielded no MYGR
- May 5, 2019: No bats observed leaving culvert during emergence survey.

- July 3, 2019: No bats observed leaving culvert during emergence survey.
- July 15, 2019: 47 bats of both sexes and age classes were trapped at the culvert. Individuals were captured flying both into and out of the culvert.
- August 1, 2019: Twelve adult MYGR (males and females) were captured flying both into and out of the culvert.
- August 28, 2019: Nine bats flew from the culvert outlet during an emergence survey.
- September 16, 2019: Three female and 5 male MYGR were captured during harp trapping. One male was a recapture
- September 26, 2019: One female and 12 male MYGR were captured during harp trapping. Two males were recaptures.
- October 5, 2019: 29 male (six recaptures) were captured during harp trapping.