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I-26 Bridge Over the French Broad River Proposed Construction and Demolition

I-26 Widening
STIP I-4400/I-4700
Henderson and Buncombe Counties

November 2018

HNTB

Summary

As part of the widening of I-26, STIP Project Nos. I-4400 and I-4700, the existing pair of two-lane bridges that carry I-26 over the French Broad River will be replaced with one new structure that will provide a total of eight travel lanes. These bridges lie within an area occupied by two federally protected species: gray bat (*Myotis grisescens*) and Appalachian elktoe (*Alasmidonta raveneliana*). Consequently, NC Department of Transportation (NCDOT) evaluated the various constraints associated with the bridges replacement, conducted preliminary coordination with the US Army Corps of Engineers (USACE), US Fish and Wildlife Service (USFWS), Federal Highway Administration (FHWA), NC Department of Water Resources (NCDWR), and the NC Wildlife Resources Commission (NCWRC) and accelerated the design process to better determine potential impacts on protected species within the Action Area as defined in the Biological Assessment.

NCDOT's preferred replacement structure is a three-span bridge, which will take approximately three to four years to build. Although the three-span bridge is NCDOT's preferred option, the preliminary design that was used to determine potential impacts is considered a worst-case scenario and will be refined as design progresses.

To build the bridge, access roads and causeways will be used. Access roads are required to transport materials and construction equipment to the worksite. The access roads will be built parallel to I-26, one in each quadrant of I-26 and the river. The access roads will require approximately 3.75 acres beyond the current slope stake limits for the project. This area will be cleared of trees and other vegetation; however, these areas would need to be cleared as part of the typical construction process for this project.

The access road design will use Design Standards in Sensitive Watersheds (DSSW) to mitigate the amount of sediment and erosion that enters the French Broad River. NCDOT has identified the French Broad River and streams that drain directly into the French Broad River as Environmentally Sensitive Areas (ESAs) due to the presence of the Appalachian elktoe. ESAs require that special procedures must be used for construction activities within a 50-foot zone on both sides of the stream measured from top of bank. The proposed access road in the southeast and northeast quadrants are within approximately 30 feet and 10 feet, respectively, of jurisdictional streams SEE and SFG. To reduce potential sediment and erosion caused by the access road, NCDOT shall temporarily pipe streams SEE and SFG during bridge construction and demolition. USFWS and USACE will have the opportunity to review the design of the SEC measures for Stream SEE. A revegetation and stream monitoring plan shall be developed for Streams SEE and SFG, to observe vegetation success and stream stability. The revegetation and stream monitoring plan shall be approved by the USACE and will commence once the bridge construction and demolition are complete and the pipe is removed.

Due to insufficient area between the toe of slope and the top of bank to allow construction vehicle passage under the bridge and the location of the interior bents within the river, a causeway is required to provide construction access. The causeways are illustrated in the Causeway Sketches, Appendix A. The size, width and length into the river, of the causeways varies from stage to stage depending on the work being performed.

Between 51 and 67 percent of the river will remain free-flowing depending upon the causeway stage. The bridge is anticipated to be built in four stages. Demolition of the existing bridge, including the superstructure and interior bents and the top of the center bent will occur in conjunction with construction of the new bridge. The first stage of construction comprises building the bridge to the west of the existing bridge. In the second stage, the existing eastbound I-26 bridge will be demolished and construction will then continue, adding four lanes to the new bridge structure. The third stage will

demolish the westbound bridge and then build the remainder of the structure. In the fourth stage the two center bents will be removed. This approach minimizes the restriction of the river created by the causeway.

The French Broad River was modeled using the US Army Corps of Engineers (USACE) Hydrologic Engineering Center's River Analysis System (HEC-RAS). The modeling was conducted for two scenarios, the first with the causeway that is anticipated to be in place for the entire construction time, shown as Stage 1A, 2A, 3A in the Causeway Sketches. The second scenario used the 'L' causeway extension (shown as Stage 4 in the Causeway Sketches) that will be in place for approximately four weeks at the end of construction. The modeling shows a rise in the water surface elevation (WSE) during a mean rain event and during a 100-year storm event for both scenarios. The rise in WSE under the mean event for the Stage 1A, 2A, 3A causeway is approximately 8.5 inches at approximately 0.02 mile (116 feet) upstream of the causeway, and returns to 0 inches, or no difference, 0.6 mile upstream. During a 100-year storm event a WSE rise of approximately 1.5 feet to 2.5 inches may occur between the causeway and approximately 2.1 miles upstream of the bridge before returning to a normal WSE for a 100-year flood event. Similar results were found for the Stage 4, 'L' causeway.

Using the Flood Risk Information System (FRIS) database, nine residential structures are within the 100-year floodplain from the I-26 bridge over the French Broad River to the Long Shoals Road bridge over the FBR, approximately 3.2 miles upstream. Aerial photography suggests an additional eight structures may also be in the 100-year floodplain. During a 100-year flood event all of the structures would be flooded under existing conditions (see Structures in Floodplain, Appendix A). Due to the temporary causeway (Stage 1A, 2A, 3A) an additional increase of 10 inches in flood water would occur to the structure located approximately 0.6 mile upstream. The temporary 'L' causeway (Stage 4) would increase the 100-year flood water elevation by an additional 3 inches for the structure located approximately 0.6 mile upstream. No additional structures are anticipated to be affected by a 100-year storm event while the causeways are in place.

NCDOT has committed to 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.

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 construction and demolition activities will be minimized to the extent possible. Red safety lighting will be used to alert river users to the location of the causeways.

Additional measures to protect the French Broad River during construction will be taken and are summarized in the Avoidance and Minimization Measures.

Because the French Broad River is regularly used for recreation, it cannot be closed for the life of construction (three to four years). There are no options for portage due to the location of the bridge. The nearest public river access is at Bent Creek River Park, 1 mile upstream of the bridge, and the next public river access is at Hominy Creek River Park. The distance by road between these two locations is 5.9 miles on NC 191 (Brevard Road). This is not a feasible portage option. It would be possible for NCDOT to coordinate with private land owners to provide output pull-out and put-in at the bridge; however, this would require users to walk through an active construction zone. This was deemed to be less safe than leaving the river open to water traffic throughout construction.

NCDOT shall commit to providing a safe passage lane for river users. To do so, NCDOT shall employ safety measures, including a catchment device on the overhead structure to prevent material from falling on river users, equestrians or bicyclists on Old River Road, or in the water. In addition, a floating navigational aid to guide river users to the safe passage lane and away from the causeways/construction zone. Red, steady-state, solar powered lights will be located on the causeways to alert river users to the presence of the causeways. 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. NCDOT has developed a Communication Plan specific to the construction/demolition of the I-26 bridge and will work with river users, businesses, and recreational river and civic groups to insure public notification of the temporary closures.

Avoidance and Minimization Measures

The avoidance and minimization measures are summarized here and are discussed throughout the document.

Topic	Measure
Bridge Design: Three-span bridge type	**Avoidance** • Choosing the three-span bridge avoids the existing substructure foundations, including the center bent. • Choosing the three-span bridge reduces the number of spans and, therefore, one additional bent in the center of the river. • No direct discharge of bridge deck drainage, design will direct discharge to stormwater structures. **Minimization** • Requires fewer bents. • Maximizes the hydraulic opening with smaller causeways. • Reduced time to construct. • With the exception of streams SEE and SFG, Design Standards in Sensitive Watersheds [15A NCAC 04B .0124 (b) – (e)] will be used for streams that drain directly to the French Broad River.
Access roads	**Minimization** • Temporary retaining walls will be used on the outer edges of the access roads to reduce impacts to adjacent forested land and jurisdictional features. • Footprint for access roads will not extend beyond permanent project footprint. • To reduce potential sediment and erosion caused by southeast and northeast access roads NCDOT shall temporarily pipe streams SEE and SFG, respectively, during bridge construction and demolition. USFWS and USACE will have the opportunity to review the design of the SEC measures for Streams SEE and SFG. A revegetation and stream monitoring plan shall be developed for Streams SEE and SFG. The revegetation and stream monitoring plan shall be approved by the USACE and will commence once the bridge construction and demolition are complete and the pipe is removed. Monitoring to

Topic	Measure
	observe vegetation success and stream stability will take place for a minimum of three years after construction.
Causeways	**Avoidance** • Causeways will be used instead of multiple work bridges that would require drilled piles, be time intensive, and add an additional obstacle in the air. **Minimization** • The design of the causeways has been refined to allow for a maximum free flow area of the French Broad River. The first causeway concept allowed for only a 28 percent free flow area of the river at its largest size. The design was refined and at its largest size the causeways will allow a 51 percent free flow area. • Causeway material will be added/removed as needed for each stage to minimize footprint over the length of the project. • To minimize disturbance to the riverbed, all readily detectable causeway material will be removed to the extent practicable, while removing as little of the original riverbed as possible. • Causeway extension (Stage 4) will be sloped to allow water to flow over top; reducing overall impact to channel flow • NCDOT shall require the contractor to use clean stone for the construction of the causeways. This will minimize unnecessary sediment input into the river. • All of the stone will be removed and disposed of off-site, or the stone can be used in areas that require permanent stone protection after project completion. NCDOT shall 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. • Construction fabric will not be used under the causeway material, because it tends to tear into pieces and float downstream during removal. • With the exceptions noted for the drill rig and crane, all construction equipment will be refueled outside the 100-year floodplain or at least 200 feet from all water bodies (whichever distance is greater) 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 outside the 100-year floodplain or at least 200 feet from all water bodies (whichever distance is greater), not in a Water of the U.S., and preferably at an upland site. Areas used for borrow or construction by-products will not be located in wetlands or in the

Topic	Measure
	100-year floodplain. • Equipment that is placed on the causeways will be removed any time throughout a work day 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, it 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 shall require the contractor to use brand new or steam cleaned equipment to access causeways that are underwater if these causeways are utilized for removal of existing bents in underwater conditions. • NCDOT shall commit to channel morphology monitoring.
Demolition	**Avoidance** • After removal of existing bents, natural substrate will not be used as backfill. **Minimization** • Removal of the existing bridge shall be performed so as not to allow debris to fall into the water. If debris is dropped in the river, it will be immediately removed. • All resource agencies will be invited to review the demolition plan and will be notified prior to start of demolition so they may have a representative on site. • NCDOT shall provide USFWS with the French Broad River bridge demolition plan and allow 15 days for review.
Construction	**Minimization** • NCDOT shall include language outlining the staged construction/ demolition in the construction contract. • NCDOT shall provide USFWS with the Sediment and Erosion Control plan and allow 15 days for review. • The Sediment and Erosion Control plan shall be in place prior to any ground disturbance. 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 has developed erosion control measures for the project, specifically to protect the Appalachian elktoe and its habitat. NCDOT shall commit to retain one dedicated inspector for each project section (I-4400, I-4700) to perform SEC inspections. Inspections of erosion control devices adjacent to the bridge will be completed on a daily basis by the Construction Project Inspector. • When constructing drilled bents, a containment system will be

Topic	Measure
	developed so that substrate material does not enter the river. Any material by-product will be pumped out of the shaft to an upland disposal area and treated through a proper stilling basin or silt bag. • Construction of new bridges will be accomplished in a manner that prevents uncured concrete from coming into contact with water entering or flowing in the river. • NCDOT shall commit to requiring its contractor to have clean, non-leaking equipment; diapers on-site for each causeway; and spill kits located at each causeway. • Activities in the floodplain shall be limited to those needed to construct the proposed bridge and remove the existing bridges. • All construction equipment will be refueled outside the 100-year floodplain or at least 200 feet from all water bodies (whichever distance is greater) 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 outside the 100-year floodplain or at least 200 feet from all water bodies (whichever distance is greater), not in a Water of the U.S., and preferably at an upland site. Areas used for borrow or construction by-products will not be located in wetlands or in the 100-year floodplain. • The Contractor shall be required to prosecute the work in a continuous and uninterrupted manner from the time they begin the work until completion of each phase of structure construction, demolition and completion. The Contractor will not be permitted to suspend his operations except for reasons beyond his control or except where the Engineer has authorized a suspension of the Contractor's operations in writing. • In the event that the Contractor's operations are suspended in violation of the above provisions or it is determined the Contractor is not deemed to be pursuing the work in a continuous manner in accordance with his submitted and approved schedule, the sum of $1,000 per day will be charged the Contractor for each and every calendar day that such suspension takes place. The said amount is hereby agreed upon as liquidated damaged due to extra engineering and maintenance costs and due to increased public hazard resulting from a suspension of the work. Liquidated damages chargeable due to suspension of the work will be additional to any liquidated damages that may become chargeable due to failure to complete the work on time. • NCDOT shall install a rainfall data logger at the French Broad River and other sensitive locations to continuously monitor and record rainfall events.

Topic	Measure
	• NCDOT shall commit to self-reporting SEC device failures to USFWS that result from excessive rainfall events (intensity that exceeds 25-year storm event).
Construction: Night Work	**Minimization** • Between June 1 and August 1, NCDOT shall commit to restrict the construction contractor to no more than 28 total nights of work, and no more than four consecutive nights within a two-week period. • Lighting used for construction will be limited to whatever is necessary to maintain safety standards, and will only be directed toward active work areas. • NCDOT shall place steady-state, solar-powered red lights on the causeway to alert river users to its location. Generators will not be used to provide power.
River Users	**Minimization** • Development of a Communication Plan to inform stakeholders of bridge construction/ demolition. • Use of a catchment system to avoid having construction/demolition debris fall on river users and equestrians and bicyclists using Old River Road. NCDOT shall specify that the contractor use a rigid, non-drooping system placed approximately 1 to 2 feet below the structure wherever construction/demolition is occurring. • NCDOT shall use a floating navigational aid to direct river users to the "safe zone" of the river, away from construction. • NCDOT shall place steady-state, solar-powered red lights on the causeway to alert river users to its location. Generators will not be used to provide power. • NCDOT shall place signs at upstream and downstream of the construction areas and at river inputs to alert river users of the I-26 bridge construction.

Contents

Appendix A

Proposed Access Roads for the Construction of the French Broad River Bridge

Construction Access Plan for I-26 over French Broad River

Causeway Sketch, Sheets 1 through 6

Structures in Floodplain

1 Introduction

As part of the widening of I-26, the pair of existing two-lane bridges crossing the French Broad River will be replaced with one new structure to provide a total of eight travel lanes. This bridge lies within an area occupied by two federally protected species, gray bat (*Myotis grisescens*) and Appalachian elktoe (*Alasmidonta raveneliana*). Consequently, NCDOT evaluated the various constraints associated with the bridge replacement, conducted preliminary coordination with USACE, USFWS, FHWA, and NCWRC and accelerated the design process to better determine potential impacts on protected species within the Action Area.

This document describes the preferred structure type, the construction and demolition staging, and additional challenges associated with construction and demolition. Avoidance and minimization measures are included where appropriate throughout the document.

2 Structure

2.1 Existing

The existing pair of I-26 bridges over the French Broad River are approximately 450 feet in length and 33.4 feet in width. There is a clear distance between the two structures of approximately 34.6 feet. Each structure consists of six spans of approximately 75 feet in length supported by four lines of steel girders. Interior bents are supported on spread footings and all but one of the ten interior bents are in the water. The river is approximately 253 feet wide at the crossing.

2.2 Proposed

This project is in the preliminary design phase, so detailed drawings are not currently available. Figures of the proposed access roads, proposed causeway sketches, and hydraulic cross sections are located in Appendix A.

Designs for the I-26 bridge over the French Broad River propose a single bridge with a deck approximately 464 feet in length and 153.3 feet in width. Two bridge designs were proposed: a four-span structure and three-span structure. Both designs would maintain the same approximately 15.4-foot vertical clearances over Old River Road and the water surface of the river as the current structure. Due to the surrounding topography, the existing and proposed bridges are higher on the western side. To accommodate the bridge construction and maintenance of traffic, the new I-26 centerline will be shifted approximately 12.5 feet to the south of the existing centerline.

NCDOT has chosen to move forward with the three-span design. The three spans for this design are anticipated to have lengths of approximately 151 feet, 170 feet, and 143 feet from east to west, and will require two bents in the river. Each bent will require ten drilled shafts. Assuming ten, 5-foot diameter shafts for each bent, the drilled shaft area is approximately 200 square feet, per bent, for a total of 400 square feet for both bents. The unequal span arrangement avoids all existing foundations, including the center bent. This design reduces impacts to the river by using fewer bents than the four-span arrangement; maximizes the hydraulic opening with smaller causeways; and speeds construction. The center span length exceeds the standard concrete girder length typically utilized by NCDOT, so it is likely that final design specifications will call for steel girders. It is expected that this bridge will require approximately three to four years to complete.

The current barrier on the bridge is a one bar metal rail on concrete parapet with retrofitted guardrail. It will be replaced with concrete barrier rail, a 42-inch solid, concrete “Jersey barrier” style guard wall.

Bridge Deck Drainage

NCDOT makes every attempt to eliminate direct deck drainage into water bodies whenever federally protected aquatic species or sensitive habitats are present. Currently, drainage from the deck of the existing structure flows directly into the river. The proposed design for the bridge over the French Broad River will include shoulders sufficient to convey runoff into adjacent stormwater control devices and eliminate direct discharge into the river.

3 Construction and Demolition of the I-26 Bridge

The location of the I-26 bridge over the French Broad River presents certain challenges to its construction and demolition. These include the proximity of wetlands and streams adjacent to the existing roadway, mountainous topography, and right of way restrictions. The substrate of the French Broad River is largely bedrock in this area. Consequently, NCDOT shall construct access roads and causeways from which to construct the new structure and demolish the existing one.

3.1 Access Roads

Access road locations are illustrated on the Proposed Access Roads and Construction Access Plan figure (Appendix A). The access roads will be placed in all four quadrants of I-26 and the French Broad River. These temporary access roads will be located parallel and adjacent to the proposed shoulders of I-26. The size of access roads and construction staging areas will be minimized wherever practicable. The access roads and construction staging areas will be established from the start of the project and designed with sediment and erosion-control measures. Temporary retaining walls will be used on the outer edges of the access roads to reduce impacts to adjacent land and jurisdictional features. The approximate area required for the access roads beyond current slope stake limits is shown in Table 1.

Table 1. Tree Clearing Area for Access Roads

Access Road Location	Approximate Area of Clearing (ac)
I-26 WB, southeast quadrant	0.25
I-26 WB, northeast quadrant	0.5
I-26 EB, southwest quadrant	0.5
I-26 EB, northwest quadrant	2.5
Total:	3.75

It is anticipated that this area will be cleared of trees and other vegetation. However, these areas would need to be cleared as part of the typical construction process for this project.

The proposed bridge will be constructed in stages beginning on the upstream side of the existing bridge that carries east-bound traffic. The access roadways will tie to rock causeways located on the corresponding side of the river. The causeways at each bridge end will traverse from one edge of the proposed superstructure to the other, under the existing bridges. These causeways will be used as work pads for the construction cranes and other equipment needed during demolition and construction activities.

3.2 Causeways

Due to insufficient area between the toe of slope and the top of bank to allow construction vehicle passage under the bridge and the location of the interior bents within the river, NCDOT reviewed using either a work bridge or causeway to provide construction access. Work bridges were ruled out for several reasons. The bedrock that makes up the riverbed of the French Broad River in this location prohibits the use of driven piles that would be required to set the foundations of temporary work bridges. The piles would need to be drilled, which would increase the length of time it would take to construct the work bridge by approximately three months. In addition, work bridges would require a larger pile size drilled into rock and backfilled with concrete. The piles would be drilled every 30 feet. Consequently, driven piles that would typically be utilized for work bridges cannot be used and drilled piles are costly, time intensive, and difficult to remove. Therefore, causeways are the preferred option to access the river so that construction equipment can operate safely.

Causeways will be constructed along each side of the river in stages mirroring the construction of the bridge. The design of the causeways has been refined to maximize the free flow area of the river at all times. This refinement increased the free flow area of the French Broad River by 23 percent for the largest causeway, when compared to the original causeway design.

Causeway size will be reduced to the extent practicable during each stage of the construction, and the contractor will be required to use clean stone for the causeway material, to minimize additional sediment input to the river. Pipes will not be used in causeway construction due to safety concerns for river users. The top causeway elevation (assumed to be 2,000 feet) will provide 2 feet or more clearance above the mean flow (discussed in more detail in the Hydraulics section).

In the first stage of construction, the causeway along the east bank of the river near End Bent 1 will be constructed in full (Causeway Sketch, Sheet 1 of 6, Appendix A) in Stage 1A. This causeway will be approximately 318.4 feet in length along the eastern river bank allowing for the required tie-ins to the access road, in addition to allowing cranes and other construction vehicles to traverse under the existing bridges. The east bank causeway will extend approximately 52.5 feet into the river. During Stage 1B this causeway will extend out an additional approximately 10 feet into the water for approximately 74.8 feet of causeway length to drill the new shafts. Once the shafts have been drilled, this Stage 1B causeway will be removed. Stage 1B is expected to be in place for approximately six weeks. On the west bank of the river, at End Bent 2, Stage 1A will construct a causeway for approximately 151 feet along the river bank, extending approximately 62.5 feet into the water. During Stage 1C this causeway will extend out an approximately 10 feet into the water for 77.4 feet of causeway length to drill the new shafts. Once the shafts have been drilled, this Stage 1C causeway will be removed. Stage 1C is expected to be in place for approximately six weeks. Without the causeways in place, the cross-sectional area of free flow is approximately 803 square feet. Under “normal” conditions (Stage 1A), with no additional extensions of the causeway, approximately 462 square feet, or 58 percent, of free flow cross-sectional area is expected between the two causeways. During Stage 1B or Stage 1C, free flow cross-sectional area will be 435 square feet, or 54 percent.

During Stage 2A construction (Causeway Sketch, Sheet 2 of 6, Appendix A) an additional approximately 72.8 feet of causeway will be added to the downstream portion of the Stage 1A causeway on the west bank of the river to facilitate removal of the existing eastbound bridge and construction of the Stage 2 new bridge construction. This Stage 2A causeway will also extend approximately 62.5 feet into the river. Stages 1A and 2A total approximately 224 feet in length adjacent to the west river bank. As Stage 2A is added to Stage 1A on the west bank, a portion of Stage 1A will be removed from the east bank. This will decrease the length of the east bank Stage 1A causeway to approximately 244.5 feet. A temporary layer

of rock will be left behind to protect the riverbank from scour. No rock will be permanently left on the riverbed.

The west and east bank causeways are temporarily extended into the river to permit demolition of the existing bridge (Causeway Sketch, Sheet 2 of 6, Appendix A). Stages 2B and 2C are temporary and expected to be constructed, used for demolition, and removed over an approximately three-week period. These causeways will extend approximately 21 feet into the river and extend approximately 59 feet along each river bank. This will leave approximately 406 square feet, or 51 percent, of free flow cross-sectional area.

Stages 2D and 2E (shown on Causeway Sketch Sheet 3 of 6, Appendix A) are similar in that they extend out from each side of the bank for approximately 10 feet in the water. These temporary stages are necessary to drill the shafts for the proposed bents. These stages will not occur simultaneously and are expected to be in place approximately five weeks each before removal. Stage 2E is located on the east river bank and is 65.4 feet in causeway length. Stage 2D is located on the west river bank and is approximately 65.3 feet in causeway length. Once the existing eastbound bridge is removed and the Stage 2 construction is complete, Stage 3 will begin.

During Stage 3A (Causeway Sketch, Sheet 4 of 6, Appendix A) an additional approximately 96 feet of causeway will be constructed along the western bank of the river, downstream of the section constructed during Stages 1A and 2A, and will again extend 62.5 feet into the river. As Stage 3A is added to Stages 1A and 2A on the west bank, another portion of Stage 1A will be removed from the east bank. This will decrease the length of the east bank Stage 1A causeway to approximately 207 feet. A layer of rock will be left behind to protect the riverbank from scour.

Stages 3B and 3C are necessary to demolish the existing westbound bridge. Stages 3B and 3C are temporary and expected to be constructed, used for demolition, and removed over an approximately three-week period. Stage 3B and Stage 3C will not occur at the same time. Stages 3B and 3C causeways will also extend approximately 21 feet into the river and extends approximately 59 feet along the east river bank. This will leave approximately 406 square feet, or 51 percent, of free flow cross-sectional area, while Stages 3B and 3C are in place.

Stages 3D and 3E are temporary stages necessary to drill the shafts for the proposed bents. These stages are expected to be in place approximately nine weeks each before removal. Stage 3D will be constructed on the west bank causeway and Stage 3E will be constructed on the east bank causeway (shown on Causeway Sketch, Sheet 5 of 6, Appendix A). Both Stage 3D and 3E will extend approximately 10 feet into the water for approximately 126 feet of causeway length. While Stages 3D and 3E are in place free flow cross-sectional area will be 435 square feet, or 54 percent.

Following the staging sequence provided later in this document, the Stage 1A causeway on the east bank will be removed in its entirety (Causeway Sketch, Sheet 6 of 6, Appendix A). On the west bank, near End Bent 2, Stages 2A and 3A will be removed. Stage 1A will be partially removed leaving 91.5 feet of causeway along the river bank. From this causeway an extension will slope down into the water approximately 38.8 feet and an approximate 36-foot width. This will lead to a causeway in the water that is approximately 225.3 feet parallel to the riverbank and approximately 26 feet wide. This 'L'-shaped extension is necessary to remove the bents of the existing bridge from the center of the river. While this final Stage 4 is in place the free flow cross-sectional area will be approximately 382 square feet, or 64 percent.

The area of the causeway along the east bank, near End Bent 1, is approximately 13,522 square feet (Stage 1A) at its largest size, without the temporary extensions. The east bank causeway will be

temporarily extended to between approximately 654 square feet to 1,260 square feet to construct the new interior bent 1 and to remove the existing bents.

The area of the causeway along the west bank, near End Bent 2, when constructed in its entirety, though not including any temporary extensions, is approximately 16,822 square feet (Stages 1A, 2A, and 3A). The west bank causeway will be temporarily extended to between approximately 656 square feet and 1,273 square feet to construct the new interior bent 2 and to remove the existing bents.

During Stage 4, when the east bank causeway is completely removed, the west bank causeway will be reduced along the bank and extend out into the river. This causeway will be approximately 10,650 square feet.

NCDOT shall make the following commitments where causeways are concerned:

- NCDOT shall require the contractor to use clean stone for the construction of the causeways. This will minimize unnecessary sediment input into the river.
- All of the stone will be removed and disposed of off-site, or the stone can be used in areas that require permanent stone protection after project completion. NCDOT shall 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.
- To minimize disturbance to the streambed, care will be taken to remove all readily detectable causeway material to the extent practicable, while removing as little of the original streambed as possible.
- Construction fabric will not be used under the causeway material, as it has a tendency to tear into pieces and float downstream during removal.
- Equipment that is placed on the causeways will be removed any time throughout a work day 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, it 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 shall commit to requiring its contractor to have clean, non-leaking equipment; diapers on-site for each causeway; and spill kits located at each causeway.
- With the exceptions noted below for the drill rig and crane, all construction equipment will be refueled outside the 100-year floodplain or at least 200 ft. from all water bodies (whichever distance is greater) 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 outside the 100-year floodplain or at least 200 ft. from all water bodies (whichever distance is greater), not in a Water of the U.S., and preferably at an upland site. Areas used for borrow or construction by-products will not be located within wetlands or the 100-year floodplain.

The proposed causeway construction and phasing will allow free-flow of 138 feet, or a cross-sectional free flow area of 462 square feet or 58 percent under “normal” conditions (Stage 1A, 2A, 3A) for the

duration of the project. Table 2 summarizes the duration of each phase, the width of free-flowing river, the cross-sectional free flow area, and the percentage of the area.

Table 2. Summary of Causeway Construction Phases, Duration and Free Flow

Stage	Duration (weeks)	Water Surface Elevation[1]	Free Flow	Free Flow (Cross Section)	
			Distance (ft)[2]	Area (sq ft)	Percent
Existing	n/a		253	803	100
1A, 2A, 3A	130[3]	1994.01	138	462	58
1B[4]	6	1994.03	128	435	54
1C	6	1994.03	128	435	54
2B	3	1994.06	117	406	51
2C	3	1994.03	128	435	54
2D	5	1994.03	128	435	54
2E	5	1994.03	128	435	54
3B	3	1994.06	117	406	51
3C	3	1994.03	128	435	54
3D	9	1994.03	128	435	54
3E	9	1994.03	128	435	54
4	4	1994.11	129	534	67

[1]Water Surface Elevation measured at the causeways.
[2]Distance between the two causeways, where the causeways are widest.
[3]Total time for construction is approximately 3 – 4 years. This duration only includes the time when Stages 1A, 2A, and 3A are in place (no extensions).
[4]The 10-foot extensions (Stages 1B, 1C, 2D, 2E, 3D, and 3E) may occur at the same time at the contractor's discretion.

3.3 Hydraulics

The replacement structure for the I-26 bridge over the French Broad River will result in a positive hydraulic effect on the river and the river users. The three-span bridge will only have two bents in the river and they will be located away from the middle of the river. The current structure includes a total of 5 bents for each bridge, with one bent located in the center of the river. Fewer bents in the river will reduce the potential for debris to become lodged at the bents and provide less obstructions for river users.

FEMA Compliance

A review of flood map data upstream of the I-26 bridge reveals that there are several residential structures that are currently located within the 100-year floodplain. During the construction of the proposed bridge the causeways will create a constriction in the flow of the river and the water surface elevation (WSE) upstream of the causeways will increase. The maximum increase in WSE occurs immediately upstream of the causeways and decreases to the natural WSE further upstream.

The increase in the 100-year flood elevation for residential structures varies from 0 to 10 inches depending on the location upstream from the causeway. No additional structures have been identified that would be in the 100-year floodplain due to the causeways. NCDOT understands the risk for additional inundation of properties that could occur if a 100-year storm event happens while the causeways are in place. WSE gages will be added to North Carolina Emergency Management's (NCEM)

Flood Inundation Mapping and Alert Network (FIMAN) web application to provide real-time alerts about flooding risk and to be better identify concerns during construction and into the future.

River Analysis

Impacts of placing causeways in the river were 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 and two-dimensional unsteady flow calculations, sediment transport/mobile bed computations, and water temperature/water quality modeling." For this project, HEC-RAS models were constructed to represent conditions during mean hydraulic events and during 100-year flood events at stations along the French Broad River, predominantly upstream of the I-26 bridge. The cross-section locations for each river station (RS) used in HEC-RAS are shown in the River Station and Structure figure in Appendix A. The HEC-RAS models were used to determine the approximate WSE and the velocity of the river without the causeways (existing), with the causeways in place (Stages 1A, 2A, and 3A), and with the temporary 'L' causeway (Stage 4).

Using the Flood Risk Information System (FRIS) database provided by NCEM, nine residential structures are within the 100-year floodplain from the I-26 bridge over the French Broad River to the Long Shoals Road bridge over the FBR, approximately 3.2 miles upstream. Aerial photography suggests an additional eight structures may also be in the 100-year floodplain. During a 100-year flood event all structures would be flooded under existing conditions. Due to the temporary causeway (Stage 1A, 2A, 3A) an additional increase of approximately 10 inches in flood water would occur to the structure located approximately 0.6 mile upstream. The temporary 'L' causeway (Stage 4) would increase flood water by approximately 3 inches for the structures located approximately 0.6 mile upstream.

The results of the HEC-RAS models are shown in Tables 3 and 4. The structure placed in the HEC-RAS models at RS 8279.2 is intended to represent the causeways (Stages 1A, 2A, 3A) and temporary 'L' causeway (Stage 4), while the adjacent upstream (RS 8279.6) and downstream (RS 8277.9) locations are intended to represent the outer reaches of the bridge itself. Depictions of the cross sections at RS 8279.2 with Stage 1A, 2A, 3A and Stage 4 in place are found in Appendix A. Table 2 reports the WSE, from the HEC-RAS model, under existing conditions and the change in WSE with the Stage 1A, 2A, 3A causeway in place and the Stage 4 "L" causeway in place at various RSs. Similarly, Table 3 reports the velocities at various RSs under existing conditions and the change with the Stage 1A, 2A, 3A causeway in place and the Stage 4 "L" causeway in place.

The HEC-RAS outputs for WSE and velocity can be best understood in terms of the "continuity for fluids" concept (Q=VA), where flow (Q) is measured in cubic feet per second, velocity (V) is measured in feet per second, and area (A) is measured in square feet. The flow of the river is considered a constant because it is a function of the drainage area leading into the river and the flow return period/flood event, not the geometry of the river itself. The flow return period is the probability that a flood event will occur. For example, the return period of a flood might be 100 years, or have a 1 percent chance of occurring in any given year.

Table 3. Change in Water Surface Elevation[1] for Proposed Construction of the I-26 Bridge over the French Broad River

River Station	Approximate Distance from Bridge (miles)	Flow Return Period					
		Mean			100-YR Flood Event		
		Existing WSE	Stages 1A, 2A, & 3A	Stage 4	Existing WSE	Stages 1A, 2A, & 3A	Stage 4
		Change in Water Surface Elevation (feet)					
8277.9 (DS RS)[2]	Bridge	1993.88	-0.01	0.02	2011.00	-0.19	-0.12
8279.2 BR D (DS Face)[3]	Causeway	1993.99	0.02	0.12	2011.08	-0.14	-0.05
8279.2 BR U (US Face)[4]	Causeway	1994.17	0.58	0.53	2011.48	1.06	0.30
8279.6 (US RS)[5]	Bridge	1994.22	0.67	0.56	2011.73	1.19	0.20
8280	0.02	1994.29	0.72	0.60	2012.20	1.52	0.47
8311	0.57	1997.46	-0.18	-0.35	2015.63	0.83	0.24
8329	0.91	1999.62	0	0	2018.06	0.55	0.15
8338	1.1	2000.44	-0.01	-0.01	2018.49	0.49	0.14
8369	1.7	2004.72	0	0	2021.20	0.30	0.08
8390	2.1	2007.47	0	0	2022.60	0.20	0.05
8448	3.2	2014.27	0	0	2031.42	0	0.00

[1] Approximate water surface elevation as determine by the HEC-RAS model.
[2] Refers to downstream side of the bridge
[3] Refers to downstream side of the causeway
[4] Refers to upstream side of the causeway
[5] Refers to upstream side of the bridge

Table 4. Change in Velocity[1] for Proposed Construction of the I-26 Bridge over the French Broad River

River Station	Approximate Distance from Bridge (miles)	Flow Return Period					
		Mean			100-YR		
		Existing	Stages 1A, 2A, & 3A	Stage 4	Existing	Stages 1A, 2A, & 3A	Stage 4
		Change in Velocity (ft/s)					
8277.9 (DS RS)[2]	Bridge	2.45	1.08	1.13	8.67	1.69	1.09
8279.2 BR D (DS Face)[3]	Causeway	2.64	1.80	1.20	8.91	2.17	1.02
8279.2 BR U (US Face)[4]	Causeway	2.50	1.17	0.68	8.70	1.16	0.75
8279.6 (US RS)[5]	Bridge	2.23	0.54	0.49	8.36	0.75	0.81
8280	0.02	1.89	-0.30	-0.26	7.00	-0.51	-0.16
8311	0.57	2.81	0.15	0.14	9.18	-0.46	-0.14
8329	0.91	2.08	0	0	5.94	-0.19	-0.05
8338	1.1	2.35	0	0	7.71	-0.21	-0.06
8369	1.7	2.42	0	0	5.29	-0.11	-0.03
8390	2.1	2.73	0	0	10.61	-0.16	-0.05
8448	3.2	2.66	0	0	7.29	0	0

[1] Approximate velocity as determine by the HEC-RAS model.
[2] Refers to downstream side of the bridge
[3] Refers to downstream side of the causeway
[4] Refers to upstream side of the causeway
[5] Refers to upstream side of the bridge

As the area under the bridge is reduced by the causeway and temporary causeway extensions, the velocity of the water passing through the bridge opening is expected to increase. This is observed in Table 3 for all models at every bridge and causeway RS. The most notable increase in velocity, as well as the greatest velocities in general, occurs at RS 8279.2 BR D (downstream of the causeway) for all models. Also at RS 8279.2 BR D, an increase in WSE is observed during each construction stage for the mean flow return period, while a decrease in WSE is observed for the 100-year flood event. Because this RS experiences the greatest velocities and volatile WSEs, care will be taken not to disturb the area downstream of the causeways any more than necessary. The WSE at RS 8277.9 (downstream of the bridge) decreases in all models because water is making its way through the bridge opening more quickly, while the WSE at RS 8279.6 (upstream of the bridge) increases in all models because of the reduced area through which water can travel (Table 2).

It is noted that the HEC-RAS outputs are more consistent in demonstrating expected channel behavior for higher flows (i.e. 100-year flood event). The mean flow return period represents normal conditions, and related output values are more impacted by variables other than flow. Values for the slope of this energy grade line are observed to be much more variable for the mean flow return period.

By definition, there is a 1 percent probability that a 100-year flood will occur during any one year period. It is not possible to predict the duration of the water level for a flood event since there are an infinite number of precipitation durations and intensities that can cause the water level to rise. For these reasons, smaller variations to the mean WSE with the causeway in place are more likely to have an effect on French Broad River habitat over the projected three to four years of construction. As shown in Table 4, a mean hydraulic event would cause an increase in WSE 0.02 miles (approximately 106 feet) upstream of the causeway (RS 8280) of approximately 9 inches for the majority of the construction duration (Stages 1A, 2A, 3A). This increase is less than the average seasonal WSE, which varies by more than 1 foot at this location on the French Broad River. Consequently, the 9-inch rise is considered insignificant in its effect on the Appalachian elktoe and its habitat. At RS 8280, as WSE increases, the velocity decreases. During mean hydraulic conditions the velocity decreases less than 1 foot per second, which is also considered insignificant in its effect on the mussel.

3.4 Stormwater and Erosion Control

The access road design will use DSSW to mitigate the amount of sediment and erosion material that enters the French Broad River. NCDOT has identified the French Broad River and streams that drain directly into the French Broad River as Environmentally Sensitive Areas (ESAs) due to the presence of the Appalachian elktoe. ESAs require that special procedures must be used for construction activities within a 50-foot zone on both sides of the stream measured from top of bank. The proposed access roads adjacent to I-26 westbound in the southeast and northeast quadrants are within approximately 10 and 30 feet of jurisdictional streams SEE and SFG, respectively. Therefore, there is insufficient space for the 50-foot buffer. To reduce potential sediment and erosion caused by the access roads NCDOT shall temporarily pipe streams SEE and SFG during bridge construction and demolition. USFWS and USACE will have the opportunity to review the design of the SEC measures for streams SEE, SFG, and SFO. A revegetation and stream monitoring plan, to observe vegetation success and stream stability, shall be developed for Streams SEE and SFG. The revegetation and stream monitoring plan shall be approved by the USACE and will commence once the bridge construction and demolition are complete and the pipe is removed.

NCDOT shall provide USFWS with the Sediment and Erosion Control (SEC) plan and allow 15 days for review. The SEC plan will be in place prior to any ground disturbance. 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 has committed to monitoring all SEC devices for the life of the project by retaining one dedicated inspector for each project section (I-4400, I-4700) to perform SEC inspections. Inspections of erosion control devices adjacent to the bridge will be completed on a daily basis by the Construction Project Inspector. The Roadside Environmental Unit of NCDOT also has Field Operations Engineers that perform compliance inspections of the erosion control devices a minimum of twice a month during the life of any project. These inspections are generally more frequent on projects within an endangered species habitat.

In addition, NCDOT shall install a rainfall data logger at the French Broad River and other sensitive locations to continuously monitor and record rainfall events. NCDOT shall also commit to self-reporting

SEC device failures to USFWS that result from excessive rainfall events (intensity that exceeds a 25-year storm event).

3.5 Staged Construction of the Proposed Structure

As previously mentioned, the proposed bridge installation and demolition of the existing bridges over the French Broad River will occur in four stages, following the construction of the access roads. Required causeways, as discussed above, will be constructed preceding each bridge stage. Each stage is described in detail below. Language outlining the staged construction/demolition will also be included in the construction contract. The total time for replacement of the existing structure is estimated to be three to four years.

Stage 1

Stage 1 consists of construction of the portion of the proposed bridge upstream of the existing bridge carrying eastbound traffic (as shown on Causeway Sketch, Sheets 1 and 2 of 6, Appendix A). While traffic is maintained in the existing pattern, the following steps are proposed for bridge construction:

- With causeways in place, construct three drilled piers (anticipated to be approximately 5 feet in diameter) at each of the two proposed interior bent locations within the river. Once the piers are complete, cast concrete columns and a bent cap at each bent.
- Drive steel sheet piling near the south side of existing End Bent 1 and End Bent 2. Then excavate soil and provide foundation (driven steel piles) at both End Bent 1 and End Bent 2. Cast concrete bent caps at end bents.
- Erect four lines of girders from cranes (two anticipated) located on the causeways. It is anticipated that girders would be delivered at night and picked from a temporary lane closure on the adjacent, existing eastbound I-26 bridge.
- Using stay-in-place metal forms or concrete pre-cast panels to support the new deck, pour the approximately 33-foot wide concrete deck. Then pour the barrier and approach slabs.
- This stage of the construction is anticipated to take approximately 9 months.

Stage 2

Stage 2 consists of construction of the portion of the proposed bridge that will occupy the space of the existing eastbound bridge (Causeway Sketch, Sheets 3 and 4 of 6, Appendix A). I-26 eastbound traffic will be shifted to the Stage 1 constructed portion of the proposed bridge from the existing eastbound bridge while maintaining I-26 westbound traffic on the existing westbound bridge. Stage 2 construction may follow the proposed steps:

- Construct two drilled piers at each of the two proposed interior bent locations within the river. Once this is complete, cast concrete columns and continue bent cap construction at each bent.
- Excavate soil and provide foundation (driven steel piles) to extend both End Bent 1 and End Bent 2. Cast concrete bent cap extensions at end bents.
- Erect four lines of girders from cranes (two anticipated, one on each side) located on the causeways. Girders are anticipated to be delivered at night and picked from a temporary lane closure on the adjacent, new I-26 eastbound bridge portion constructed during Stage 1.
- Pour the approximately 34-foot wide concrete deck followed by the barrier and approach slabs.
- This stage of the construction is anticipated to take approximately 9 months.

Stage 3

Stage 3 consists of constructing the final portion of the new bridge adjacent to the section constructed in Stage 2 (as shown on Causeway Sketch, Sheet 5 of 6, Appendix A). I-26 westbound traffic will be shifted to the new bridge portion constructed in Stage 2 from the existing bridge while maintaining I-26 eastbound traffic in the Stage 2 configuration. Stage 3 construction may follow the proposed steps:

- Construct five drilled piers at each of the two interior bent locations within the river. Once complete, cast concrete columns and bent caps at each bent.
- Excavate soil and provide foundation (driven steel piles) to extend both End Bent 1 and End Bent 2. Cast concrete bent cap extensions at end bents.
- Erect nine lines of girders from cranes (two anticipated, one on each side) located on the causeways. Girders are anticipated to be delivered at night and picked from a temporary lane closure on the adjacent, new I-26 westbound bridge portion constructed in Stage 2.
- Pour the approximately 87-foot wide concrete deck followed by the barrier and approach slabs.
- This stage of the construction is anticipated to take approximately 17 months.

Stage 4

Stage 4 consists of removing the remaining Stage 1A causeway on the End Bent 1 side of the river, removing Stages 2A ,3A, and a portion of 1A on the End Bent 2 side of the river, and constructing the Stage 4 causeway to demolish the center bents from the existing bridge (as shown on Causeway Sketch, Sheet 6 of 6, Appendix A). I-26 westbound traffic will be shifted to the 2 outside lanes on the new bridge portion constructed in Stage 3. The center lanes of the bridge will be closed to traffic in order to complete median work in the roadway approaches.

- Remove the Stage 1A causeway adjacent to End Bent 1 and the Stage 2A, 3A, and a portion of 1A causeways adjacent to End Bent 2. Construct the temporary 'L' causeway (shown as Stage 4 on Causeway Sketch Sheet 6 of 6, Appendix A). Remove the center bents in the river. This temporary 'L' causeway is expected to be in place for approximately 4 weeks.
- Once the center bents are demolished, remove all remaining causeways and access roads.
- Once median work is complete, open I-26 traffic to final configuration.

3.6 Construction Activities

Night Work

During construction of the I-26 bridge over the French Broad River, some work will need to be completed at night. The following 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. 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.

- 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. 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 night time 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.
- 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.
- 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.

There are other operations that may occur at night; however, this would be unusual and evaluated on a case-by-case basis. The previously listed operations are not operations that occur on a regular schedule. In addition, NCDOT shall place solar-powered, steady-state, red, safety lights on the causeways for river user safety. Generators will not be used to provide power.

NCDOT shall make the following commitments where construction of the access roads, causeways, and bridge is concerned:

- Between June 1 and August 1 each year, NCDOT shall commit to restrict the construction contractor to no more than 28 total nights of work, and no more than four consecutive nights within a two-week period.

Other Techniques

- When constructing drilled bents, a containment system will be developed so that substrate material does not enter the river. Any material by-product will be pumped out of the shaft to an upland disposal area and treated through a proper stilling basin or silt bag.
- The SEC plan will be in place prior to any ground disturbance. 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.
- Construction of new bridges will be accomplished in a manner that prevents uncured concrete from coming into contact with water entering or flowing in the river.
- The Contractor will be required to prosecute the work in a continuous and uninterrupted manner from the time he begins the work until completion of each phase of structure construction, demolition and completion. The Contractor will not be permitted to suspend his operations except for reasons beyond his control or except where the Engineer has authorized a suspension of the Contractor's operations in writing.
- In the event that the Contractor's operations are suspended in violation of the above provisions or it is determined the Contractor is not deemed to be pursuing the work in a continuous manner in accordance with his submitted and approved schedule, the sum of $1,000 per day will be charged the Contractor for each and every calendar day that such suspension takes place. The said amount is hereby agreed upon as liquidated damaged due to extra engineering

and maintenance costs and due to increased public hazard resulting from a suspension of the work. Liquidated damages chargeable due to suspension of the work will be additional to any liquidated damages that may become chargeable due to failure to complete the work on time.

3.7 Demolition of the Existing Structure

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, 1 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. According to existing bridge plans, the structure is supported by spread footings (no piles underneath). The new structure will place the bents directly adjacent to the existing bents. No loose portion of the existing bents can remain in the streambed.

Removal of the existing bridge shall be performed in a manner that prevents debris from falling into the water. The Contractor shall remove the bridge 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.

NCDOT shall provide USFWS with copies of the bridge demolition plan and allow 15 days for review. Other resource agencies will also be invited to review the demolition plan. USFWS and other resource agencies 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.

4 River User Safety

Because the French Broad River is regularly used for recreation, it cannot be closed for the life of construction (three to four years). There are no options for portage due to the location of the bridge. The nearest public pull-out is at Bent Creek River Park, 1 river mile upstream of the I-26 bridge, and the next public put-in is at Hominy Creek River Park, approximately 5.2 river miles downstream of the bridge. The distance by road between these two locations is 5.9 miles on NC 191 (Brevard Road). This is not a feasible portage option. It would be possible to provide a pull-out and put-in at the bridge; however, this would require users to walk through an active construction zone. This was deemed to be less safe than leaving the river open to water traffic throughout construction.

NCDOT shall commit to providing a safe passage lane for river users. As shown in the rendering on the next page, thishis lane will be located in the center of the river away from the causeways for the majority of the life of the project. In the final stage, Stage 4, the safe passage lane will shift to the right side of the river, near end bent 1, away from the center bents being removed. This stage is expected to last approximately four weeks. 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 structure from south of Old River Road to the opposite side of the river to prevent material from falling on river users, equestrians, bicyclists, 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 and Old River Road must be closed for the safety of river users, equestrians, and bicyclists 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 river during known peak business times, particularly the Memorial Day, Fourth of July, and Labor Day weekends.

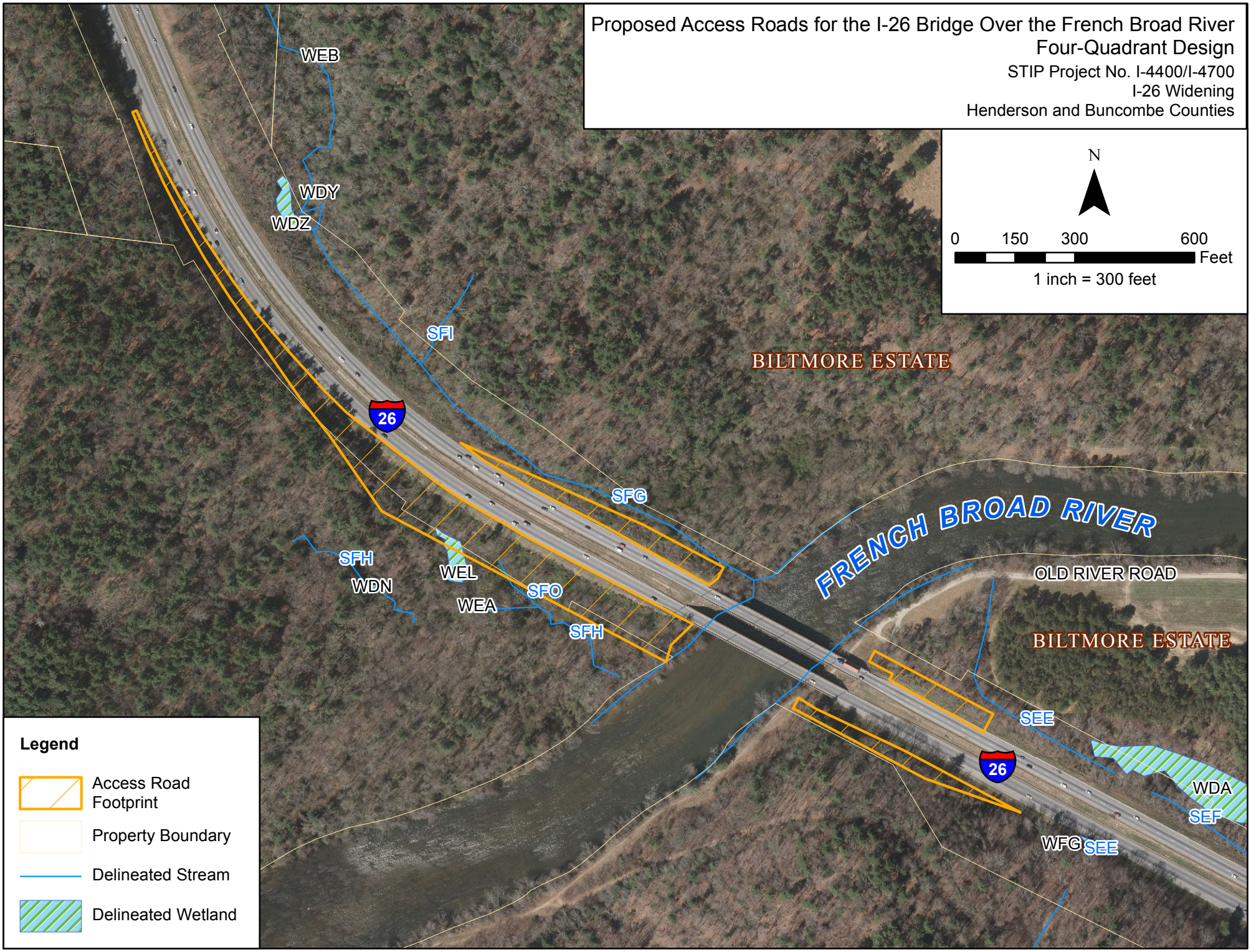
NCDOT has written a Communication Plan for the Construction of the I-26 Bridge over the French Broad River. This plan focuses on specific activities to alert river users to the hazards of bridge construction and will be appended to larger communication plan for the entire I-26 widening project. Communication plans include holding small group meetings; placing signage upstream of the construction zone at river inputs; and alerting river users, equestrians, and bicyclists through various traditional and social media outlets of construction schedules, including closures and other pertinent information.

River User Safety, Concept Drawing

Photo Credit: CALYX

I-26 Bridge Over the French Broad River Proposed Construction and Demolition

APPENDIX A


Proposed Access Roads for the I-26 Bridge Over the French Broad River
Four-Quadrant Design
STIP Project No. I-4400/I-4700
I-26 Widening
Henderson and Buncombe Counties
N
0 150 300 600
Feet
1 inch = 300 feet
WEB
WDY
WDZ
SFI
BILTMORE ESTATE
26
SFG
FRENCH BROAD RIVER
SFH
WDN
WEL
SFO
WEA
SFH
OLD RIVER ROAD
BILTMORE ESTATE
SEE
26
WDA
SEF
WFG
SEE
Legend
Access Road Footprint
Property Boundary
Delineated Stream
Delineated Wetland

8/7/2017

HNTB NORTH CAROLINA, P.C.
343 E. Six Forks Road, Suite 200
Raleigh, North Carolina 27609
NC License No: C-1554

PROJECT REFERENCE NO.	SHEET NO.
14400-4700	87

ROADWAY DESIGN ENGINEER

HYDRAULICS ENGINEER

INCOMPLETE PLANS
DO NOT USE FOR R/W ACQUISITION

DOCUMENT NOT CONSIDERED FINAL UNLESS ALL SIGNATURES COMPLETED

–L3–

–L3– EB

PI = 1162+00.00
EL = 2,017.96'
VC = 1,000'
K = 325
V = 80+ MPH

PI = 1168+00.00
EL = 2,031.70'
VC = 200'
K = 177
V = 65 MPH

PI = 1176+45.00
EL = 2,060.57'
VC = 700'
K = 758
V = 80+ MPH

(–)0.7873%
(–)0.7873%
(+)2.2895%
(+)2.2895%
(+)3.4171%
(+)3.4171%

BM31
ELEV. = 2008.55
N 661119 E 933222
–L3– STA 1161+78.78, 117.27' RT.
R/R SPIKE IN BASE OF 15" POPLAR

CAUSEWAY (2000')

NORMAL WATER SURFACE (UNOBSTRUCTED) (1993.5')

FOR –L3– EB PLAN, SEE SHEETS 38 & 39

2,080 2,070 2,060 2,050 2,040 2,030 2,020 2,010 2,000 1,990

1160+00 1161+00 1162+00 1163+00 1164+00 1165+00 1166+00 1167+00 1168+00 1169+00 1170+00 1171+00 1172+00 1173+00 1174+00

–L3–

–L3– WB

PI = 1162+00.00
EL = 2,017.96'
VC = 1,000'
K = 325
V = 80+ MPH

PI = 1168+00.00
EL = 2,031.70'
VC = 200'
K = 676
V = 80+ MPH

PI = 1176+45.00
EL = 2,053.55'
VC = 1,000'
K = 2065
V = 80+ MPH

(–)0.7873%
(+)2.2895%
(+)2.2895%
(+)2.5852%
(+)2.5852%

BM31
ELEV. = 2008.55
N 661119 E 933222
–L3– STA 1161+78.78, 117.27' RT.
R/R SPIKE IN BASE OF 15" POPLAR

CAUSEWAY (2000')

NORMAL WATER SURFACE (UNOBSTRUCTED) (1993.5')

FOR –L3– WB PLAN, SEE SHEETS 38 & 39

2,080 2,070 2,060 2,050 2,040 2,030 2,020 2,010 2,000 1,990

1160+00 1161+00 1162+00 1163+00 1164+00 1165+00 1166+00 1167+00 1168+00 1169+00 1170+00 1171+00 1172+00 1173+00 1174+00

8/7/2017
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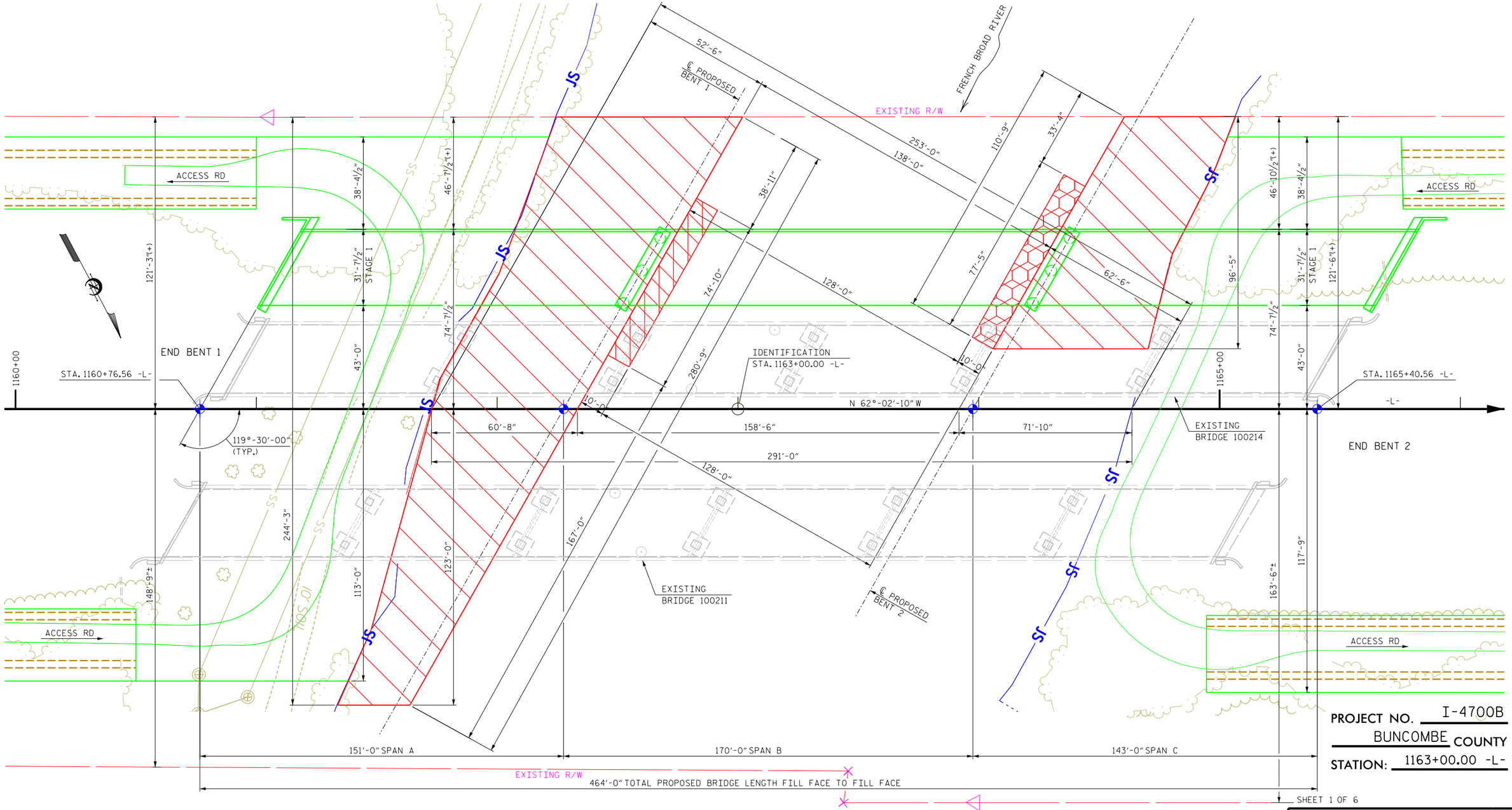

LEGEND

- STAGE 1A (35 MONTHS*)
- STAGE 1B (6 WEEKS)
- STAGE 1C (6 WEEKS)
- PROPOSED ACCESS ROAD CONSTRUCTION
- PROPOSED BRIDGE CONSTRUCTION
- EXISTING BRIDGE

* STAGE 1 OF THE CONSTRUCTION IS ANTICIPATED TO TAKE APPROXIMATELY 9 MONTHS; HOWEVER, STAGE 1A CAUSEWAY WILL REMAIN IN PLACE THROUGH SUBSEQUENT STAGES.

PLAN - STAGE 1A, 1B, & 1C

NOTES: STAGING BASED ON 10' AVERAGE DEPTH OF CAUSEWAY.

ROCK SLOPES ASSUMED TO BE 1:1.

STAGE 1B & 1C ARE SHORT DURATION CAUSEWAY PORTIONS PLACED TO CONSTRUCT DRILLED SHAFTS.

TIME RANGES SHOWN IN LEGEND ARE APPROXIMATE.

DOCUMENT NOT CONSIDERED FINAL UNLESS ALL SIGNATURES COMPLETED

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NC License No. C-1554
343 E. Six Forks Rd., Suite 200, Raleigh, N.C. 27609

DRAWN BY M. WRIGHT DATE 11/18
CHECKED BY P. BARBER DATE 11/18
DESIGN ENGINEER OF RECORD P. BARBER DATE 11/18

DWG. NO. 1

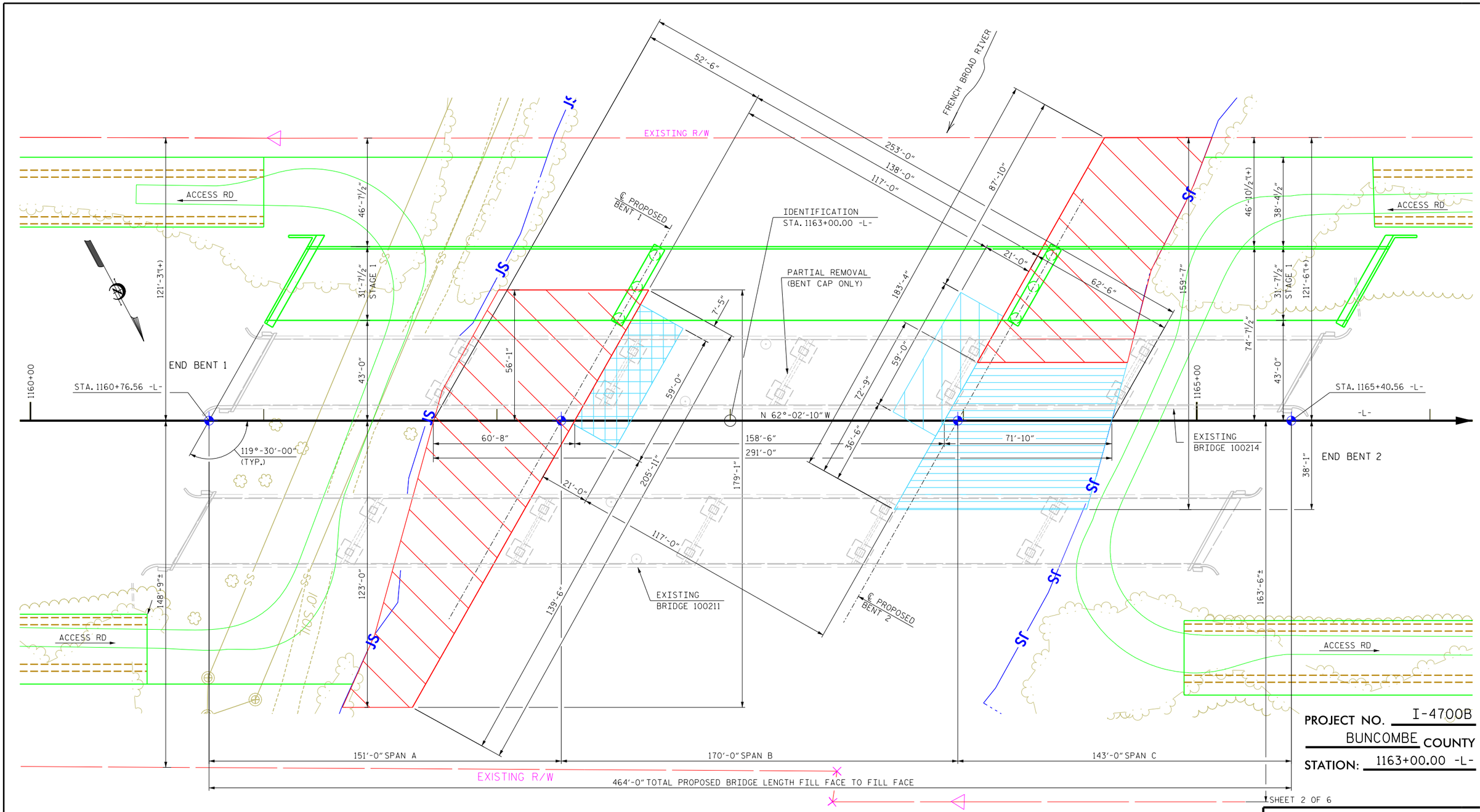
STATE OF NORTH CAROLINA
DEPARTMENT OF TRANSPORTATION
RALEIGH

CAUSEWAY SKETCH FOR I-26 OVER FRENCH BROAD RIVER

PROJECT NO. I-4700B
BUNCOMBE COUNTY
STATION: 1163+00.00 -L-

REVISIONS						SHEET NO.
NO.	BY	DATE	NO.	BY	DATE	
1			3			TOTAL SHEETS
2			4			

SHEET 1 OF 6



LEGEND

- STAGE 1A (35 MONTHS)
- STAGE 2A (9 MONTHS)
- STAGE 2B (3 WEEKS)
- STAGE 2C (3 WEEKS)
- PROPOSED ACCESS ROAD CONSTRUCTION
- PROPOSED BRIDGE CONSTRUCTION
- EXISTING BRIDGE

PLAN - STAGE 2A, 2B, & 2C

NOTES: STAGING BASED ON 10' AVERAGE DEPTH OF CAUSEWAY.

ROCK SLOPES ASSUMED TO BE 1:1.

STAGE 2B AND 2C ARE FOR SHORT DURATION CAUSEWAY PORTION PLACED TO REMOVE EXISTING BRIDGE BENTS.

TIME RANGES SHOWN IN LEGEND ARE APPROXIMATE.

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DWG. NO. 2

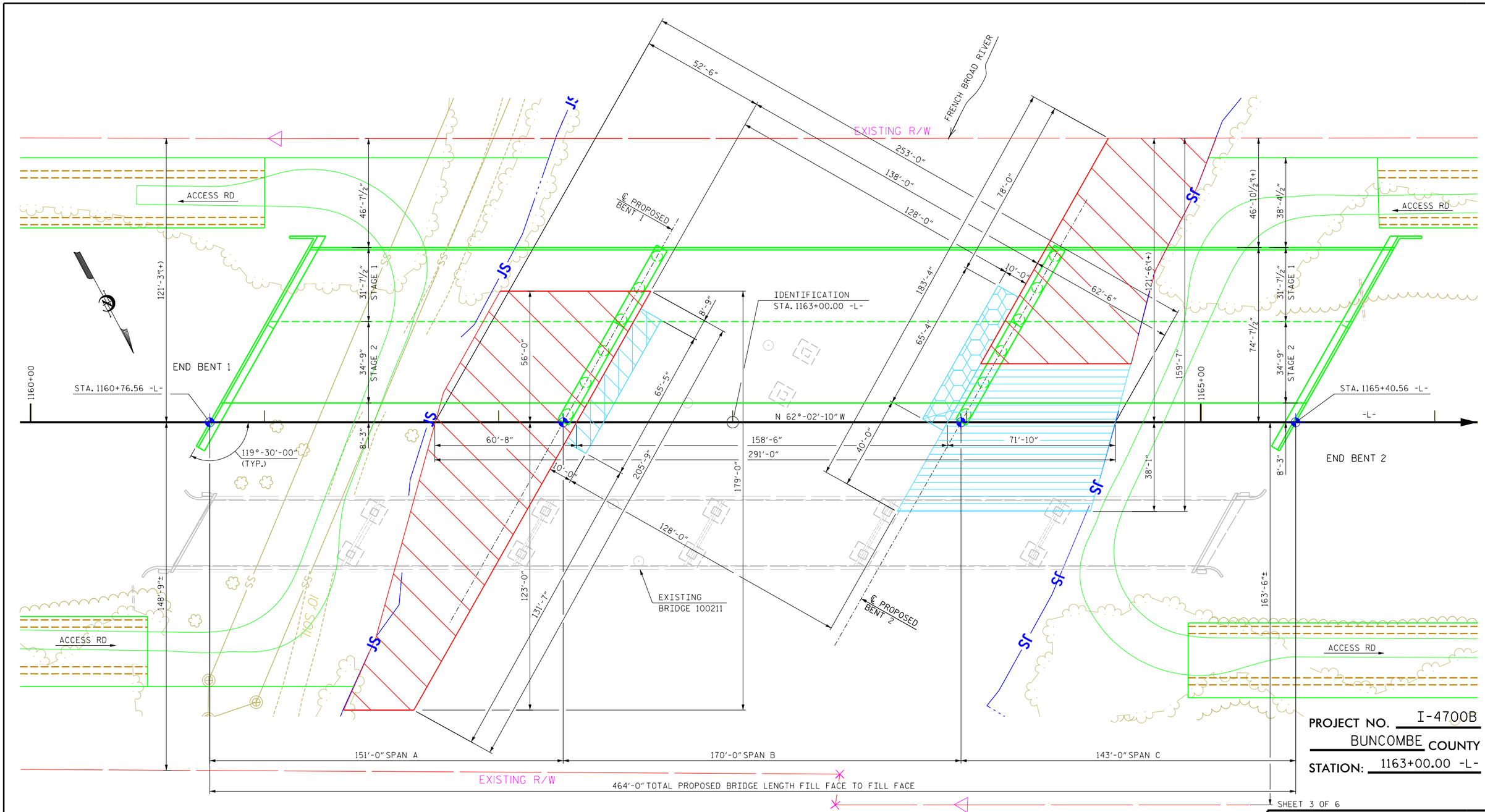
PROJECT NO. I-4700B
BUNCOMBE COUNTY
STATION: 1163+00.00 -L-

SHEET 2 OF 6

STATE OF NORTH CAROLINA
DEPARTMENT OF TRANSPORTATION
RALEIGH

CAUSEWAY SKETCH FOR I-26 OVER FRENCH BROAD RIVER

REVISIONS						SHEET NO.
NO.	BY	DATE	NO.	BY	DATE	
1			3			TOTAL SHEETS
2			4			



PLAN - STAGE 2D & 2E

LEGEND

- STAGE 1A (35 MONTHS)
- STAGE 2A (9 MONTHS)
- STAGE 2D (5 WEEKS)
- STAGE 2E (5 WEEKS)
- PROPOSED ACCESS ROAD CONSTRUCTION
- PROPOSED BRIDGE CONSTRUCTION
- EXISTING BRIDGE

NOTES: STAGING BASED ON 10' AVERAGE DEPTH OF CAUSEWAY.

ROCK SLOPES ASSUMED TO BE 1:1.

STAGE 2D & 2E ARE SHORT DURATION CAUSEWAY PORTIONS PLACED TO CONSTRUCT DRILLED SHAFTS.

TIME RANGES SHOWN IN LEGEND ARE APPROXIMATE.

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DESIGN ENGINEER OF RECORD P. BARBER DATE 11/18

DWG. NO. 3

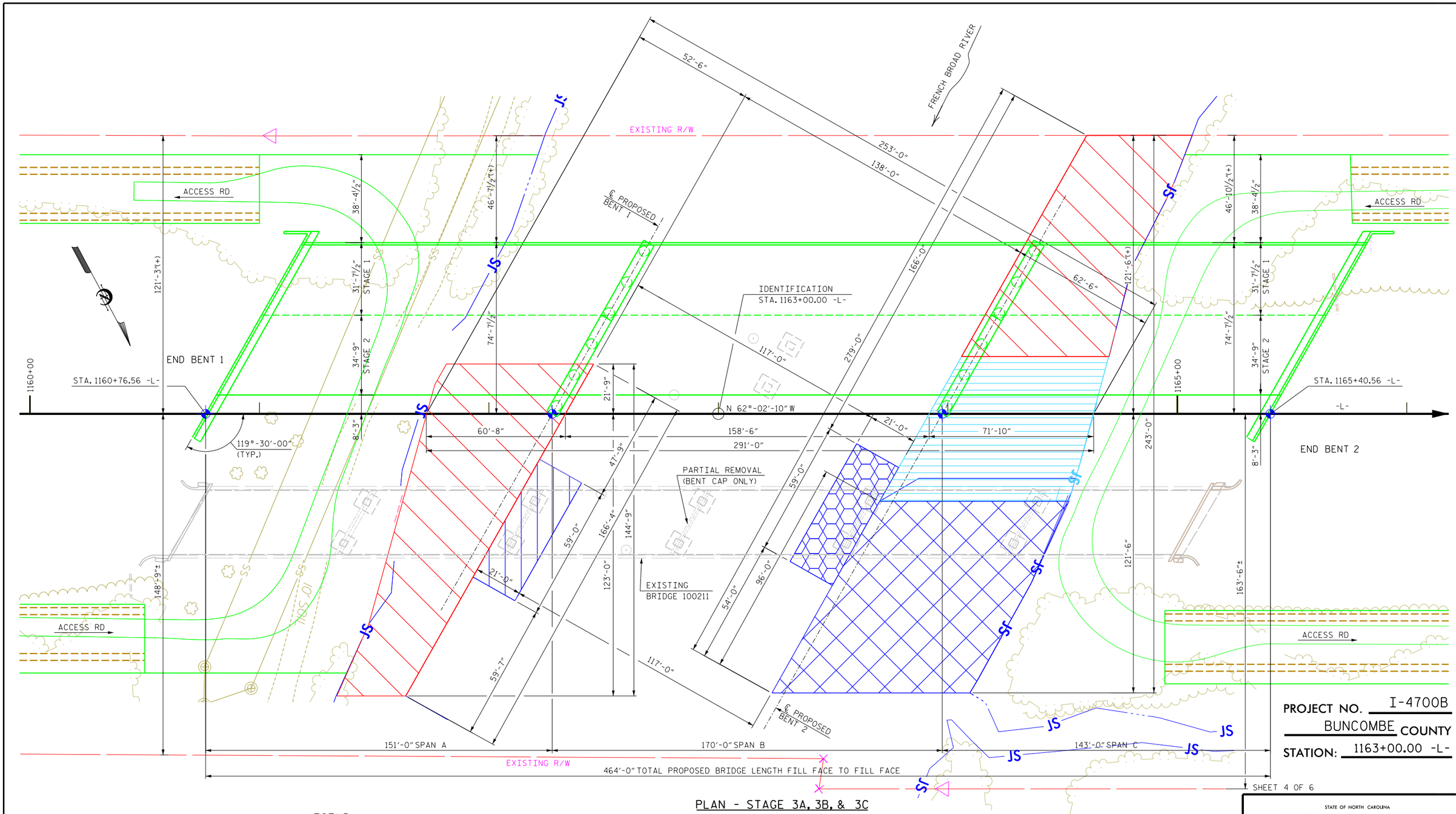
PROJECT NO. I-4700B
BUNCOMBE COUNTY
STATION: 1163+00.00 -L-

SHEET 3 OF 6

STATE OF NORTH CAROLINA
DEPARTMENT OF TRANSPORTATION
RALEIGH

CAUSEWAY SKETCH FOR I-26 OVER FRENCH BROAD RIVER

REVISIONS						SHEET NO.
NO.	BY	DATE	NO.	BY	DATE	
1			3			TOTAL SHEETS
2			4			



PLAN - STAGE 3A, 3B, & 3C

LEGEND

- STAGE 1A (35 MONTHS)
- STAGE 2A (9 MONTHS)
- STAGE 3A (17 MONTHS)
- STAGE 3B (3 WEEKS)
- STAGE 3C (3 WEEKS)
- PROPOSED ACCESS ROAD CONSTRUCTION
- PROPOSED BRIDGE CONSTRUCTION
- EXISTING BRIDGE

NOTES: STAGING BASED ON 10' AVERAGE DEPTH OF CAUSEWAY.

ROCK SLOPES ASSUMED TO BE 1:1.

STAGE 3B AND 3C ARE SHORT DURATION CAUSEWAY PORTIONS PLACED TO REMOVE EXISTING BRIDGE BENTS.

TIME RANGES SHOWN IN LEGEND ARE APPROXIMATE.

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DESIGN ENGINEER OF RECORD P. BARBER DATE 11/18

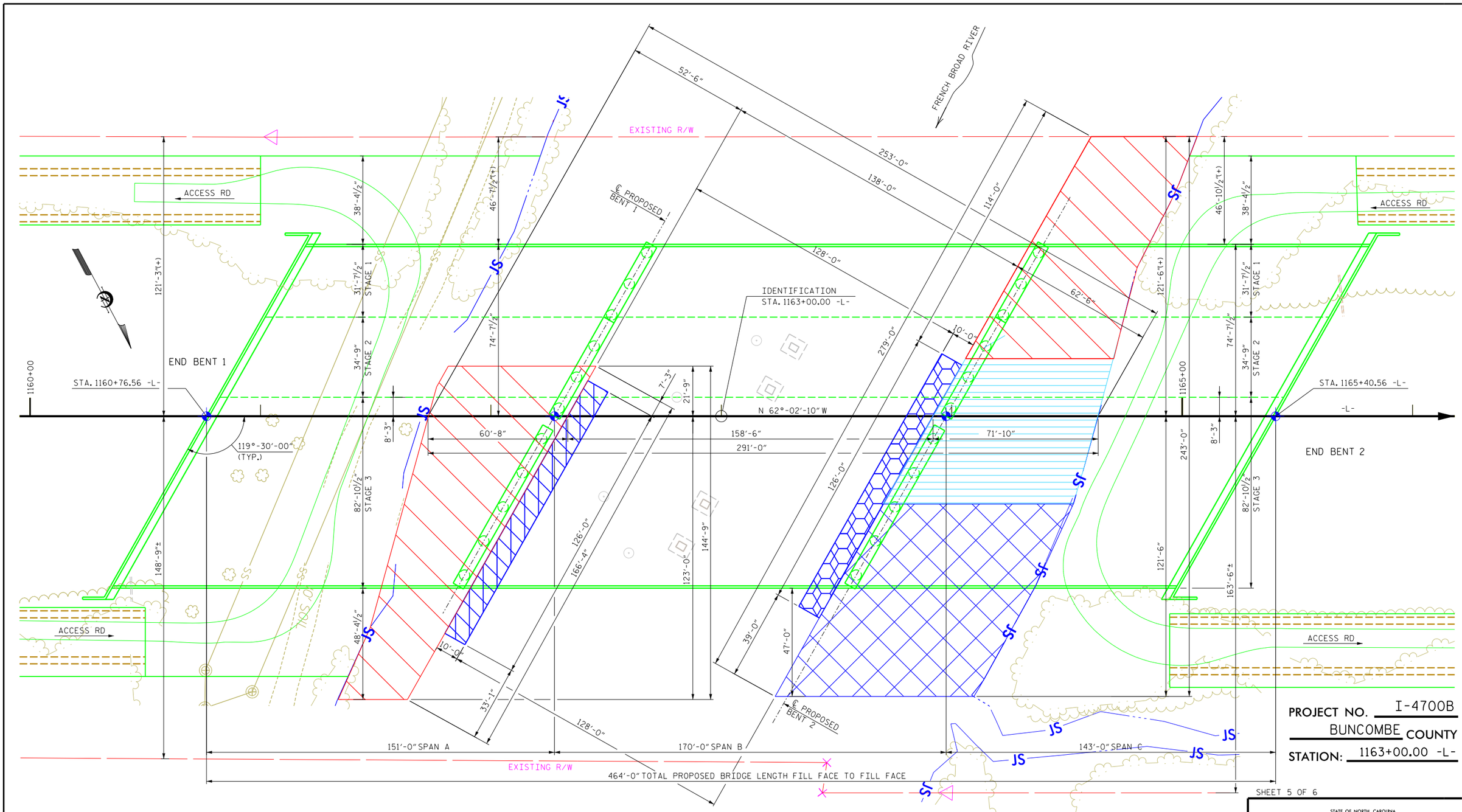
DWG. NO. 4

PROJECT NO. I-4700B
BUNCOMBE COUNTY
STATION: 1163+00.00 -L-

STATE OF NORTH CAROLINA
DEPARTMENT OF TRANSPORTATION
RALEIGH

CAUSEWAY SKETCH FOR I-26 OVER FRENCH BROAD RIVER

REVISIONS						SHEET NO.
NO.	BY	DATE	NO.	BY	DATE	
1			3			TOTAL SHEETS
2			4			



LEGEND

- STAGE 1A (35 MONTHS)
- STAGE 2A (9 MONTHS)
- STAGE 3A (17 MONTHS)
- STAGE 3D (9 WEEKS)
- STAGE 3E (9 WEEKS)
- PROPOSED ACCESS ROAD CONSTRUCTION
- PROPOSED BRIDGE CONSTRUCTION
- EXISTING BRIDGE

PLAN - STAGE 3D & 3E

NOTES: STAGING BASED ON 10′ AVERAGE DEPTH OF CAUSEWAY.

ROCK SLOPES ASSUMED TO BE 1:1.

STAGE 3D & 3E ARE SHORT DURATION CAUSEWAY PORTIONS PLACED TO CONSTRUCT DRILLED SHAFTS.

TIME RANGES SHOWN IN LEGEND ARE APPROXIMATE.

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DWG. NO. 5

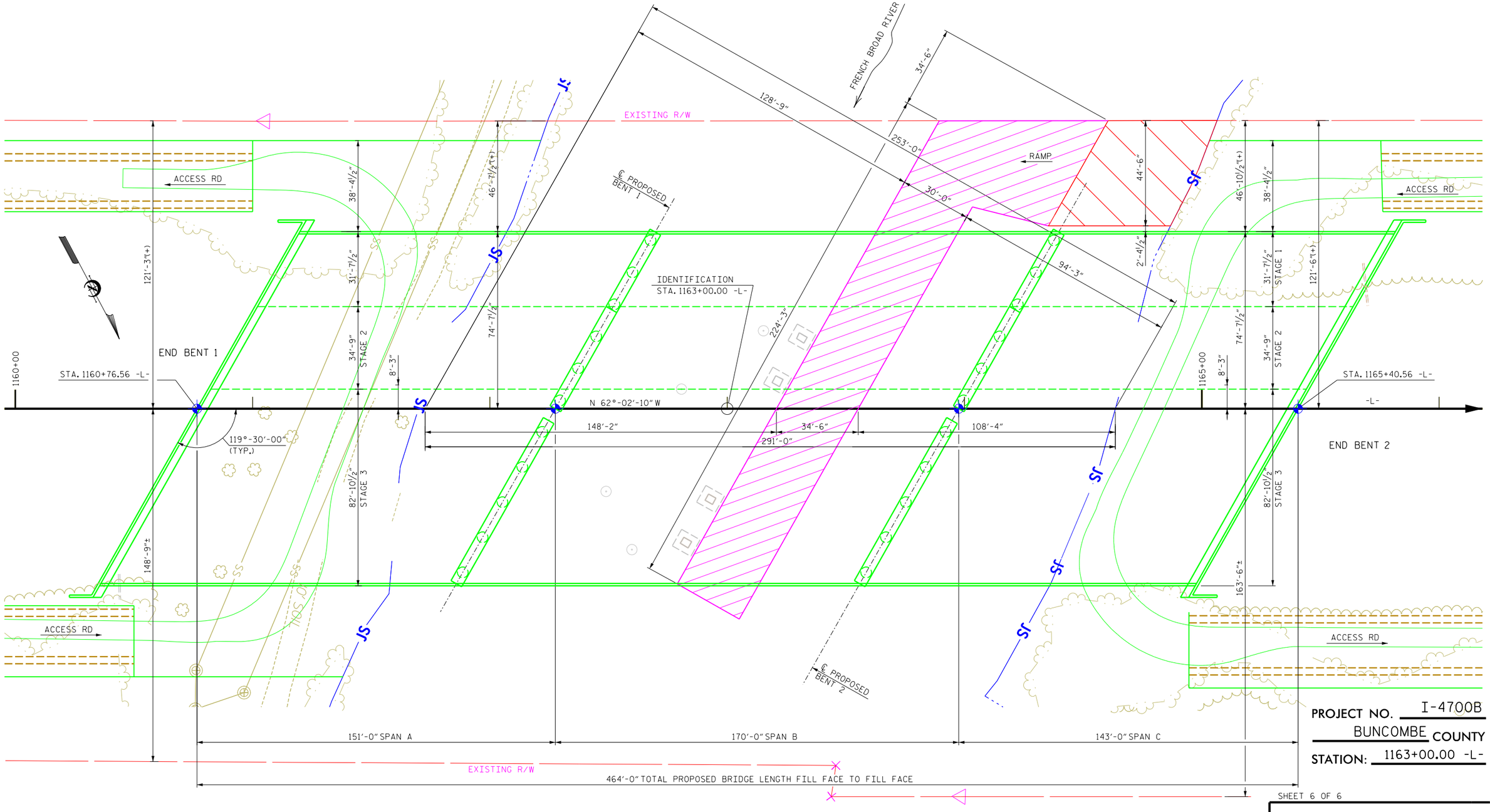
PROJECT NO. I-4700B
BUNCOMBE COUNTY
STATION: 1163+00.00 -L-

SHEET 5 OF 6

STATE OF NORTH CAROLINA
DEPARTMENT OF TRANSPORTATION
RALEIGH

CAUSEWAY SKETCH FOR I-26 OVER FRENCH BROAD RIVER

REVISIONS						SHEET NO.
NO.	BY	DATE	NO.	BY	DATE	
1			3			TOTAL SHEETS
2			4			



PROJECT NO. I-4700B

BUNCOMBE COUNTY

STATION: 1163+00.00 -L-

SHEET 6 OF 6

LEGEND

- STAGE 1A (35 MONTHS)
- STAGE 4 (1 MONTH)
- PROPOSED ACCESS ROAD CONSTRUCTION
- PROPOSED BRIDGE CONSTRUCTION
- EXISTING BRIDGE

PLAN - STAGE 4

NOTES: STAGE 4 BASED ON 2' AVERAGE DEPTH OF CAUSEWAY.

ROCK SLOPES ASSUMED TO BE 1:1.

STAGE 4 IS A SHORT DURATION CAUSEWAY PORTION PLACED TO REMOVE EXISTING BRIDGE BENTS.

TIME RANGES SHOWN IN LEGEND ARE APPROXIMATE.

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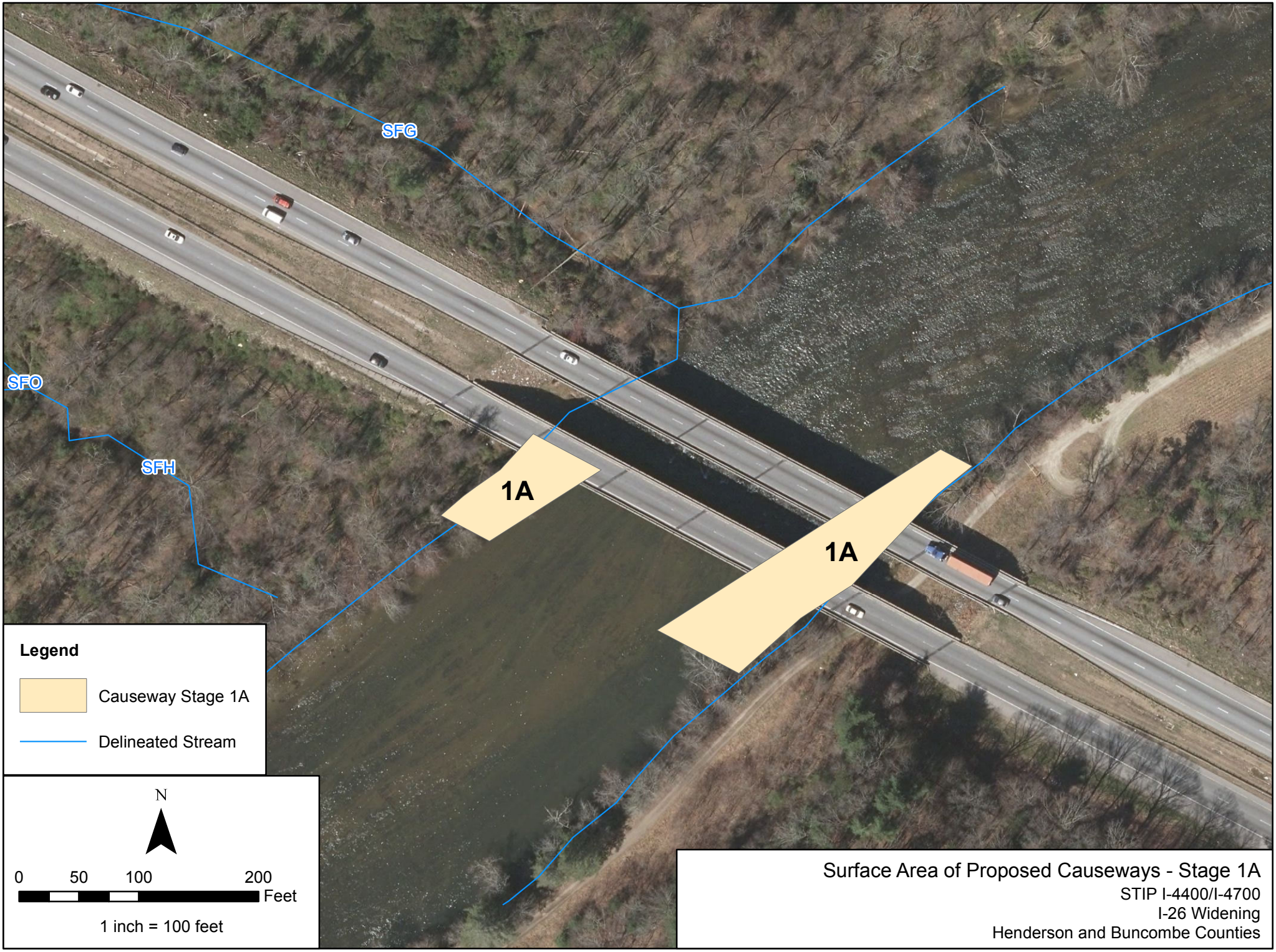
DESIGN ENGINEER OF RECORD P. BARBER DATE 11/18

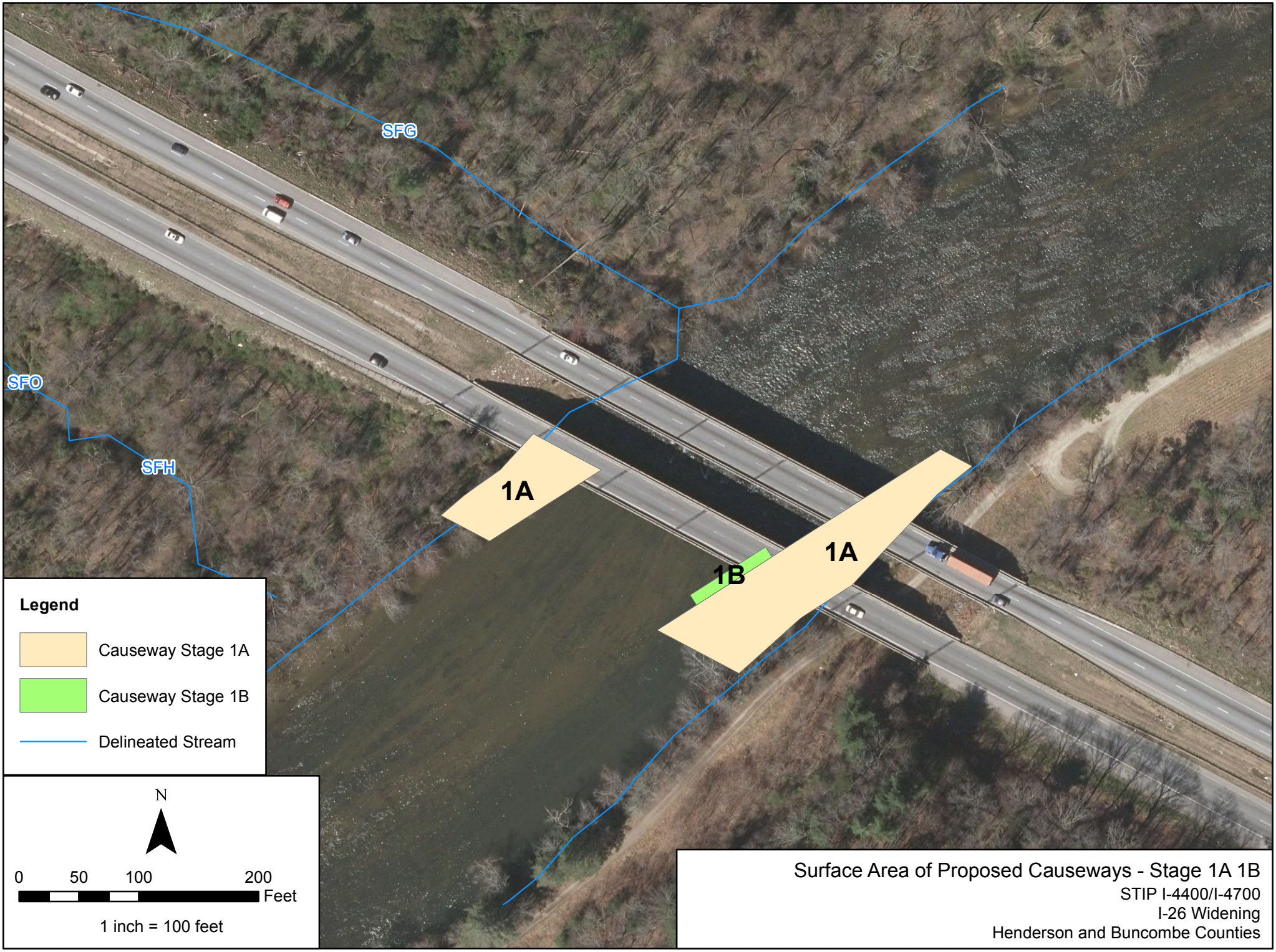
DWG. NO. 6

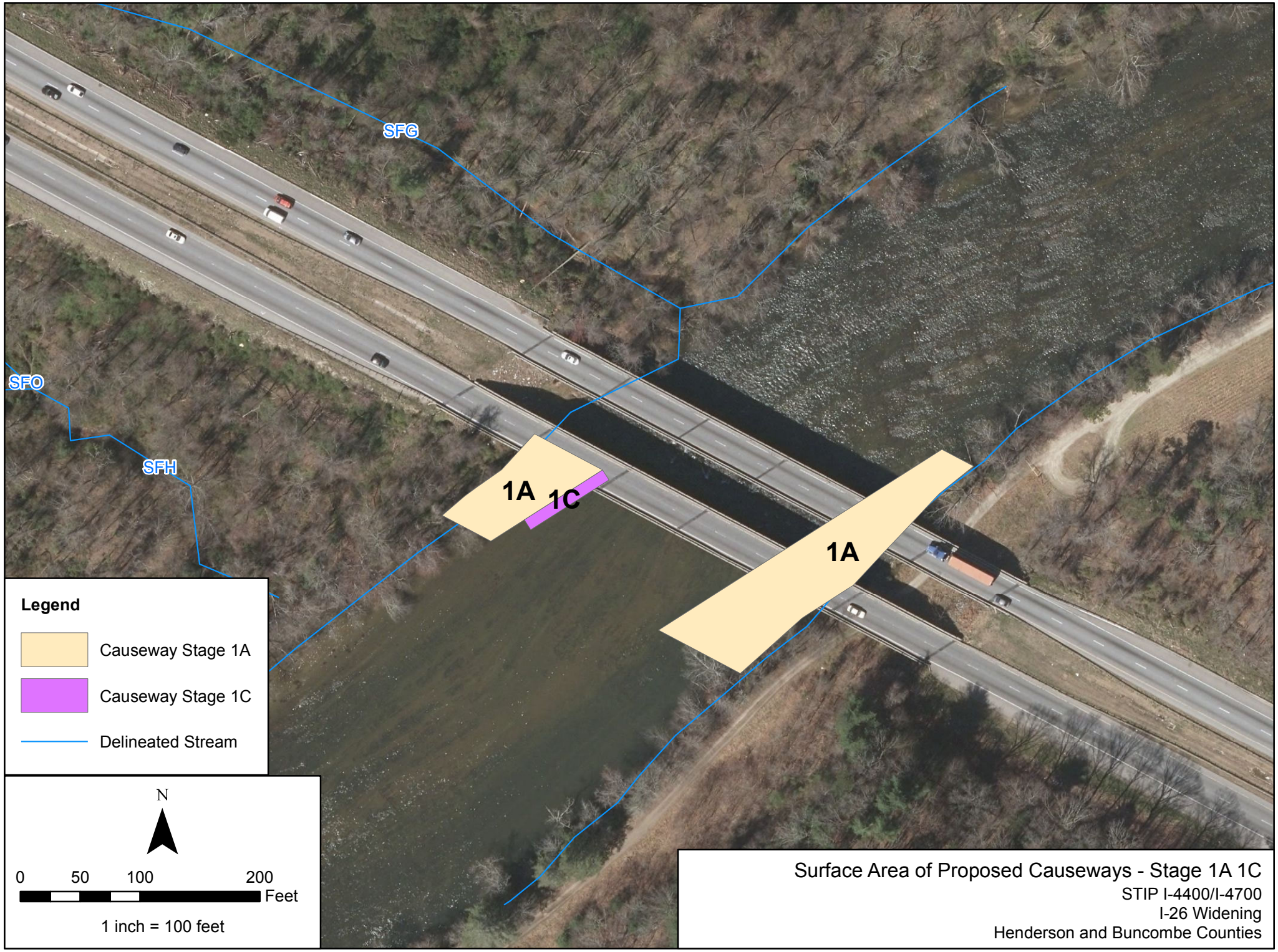
STATE OF NORTH CAROLINA
DEPARTMENT OF TRANSPORTATION
RALEIGH

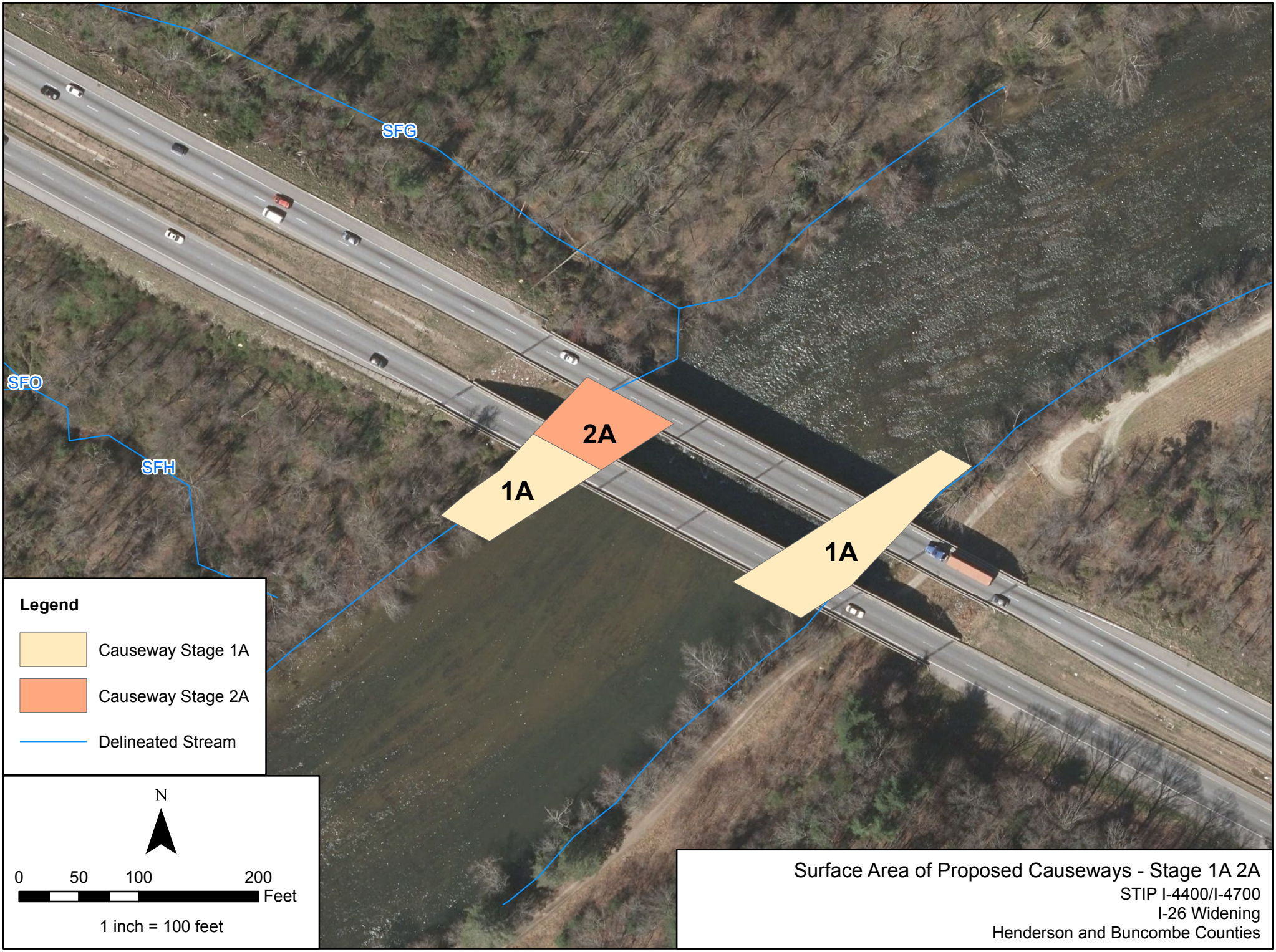
CAUSEWAY SKETCH FOR I-26 OVER FRENCH BROAD RIVER

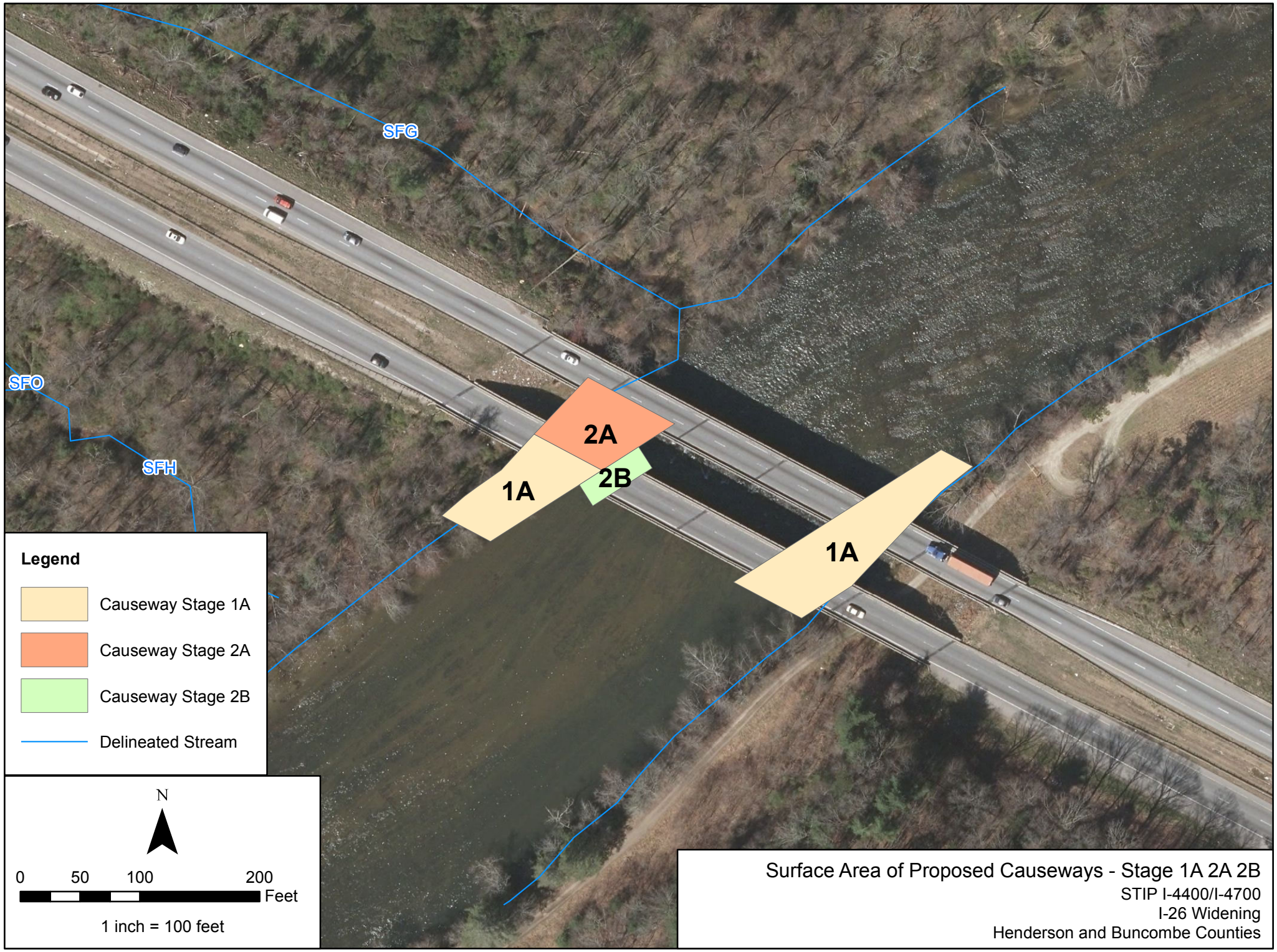
REVISIONS						SHEET NO.
NO.	BY	DATE	NO.	BY	DATE	
1			3			TOTAL SHEETS
2			4			

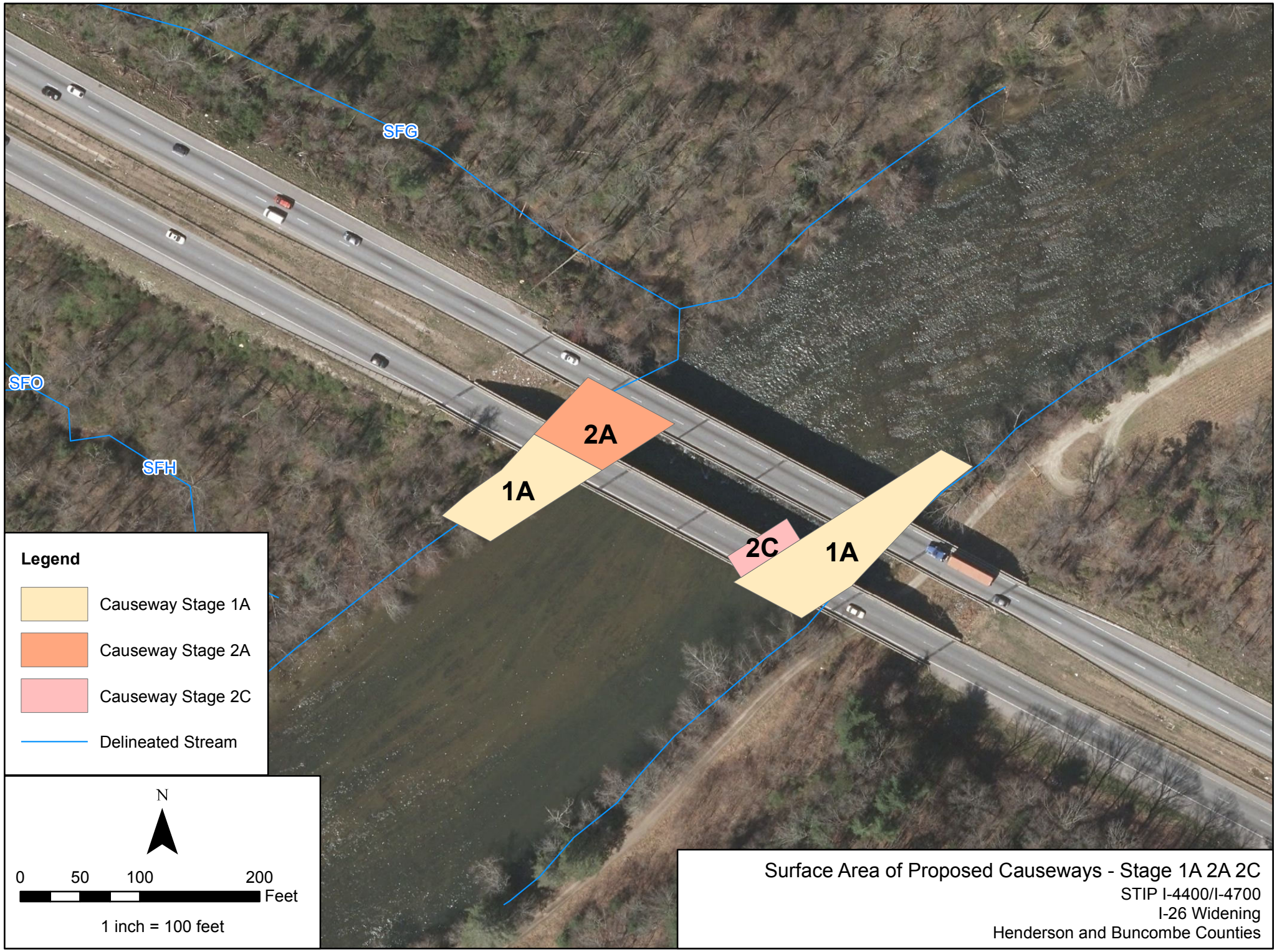

SFG
SFO
SFH
1A
1A
Legend
Causeway Stage 1A
Delineated Stream
N
0
50
100
200
Feet
1 inch = 100 feet
Surface Area of Proposed Causeways - Stage 1A
STIP I-4400/I-4700
I-26 Widening
Henderson and Buncombe Counties

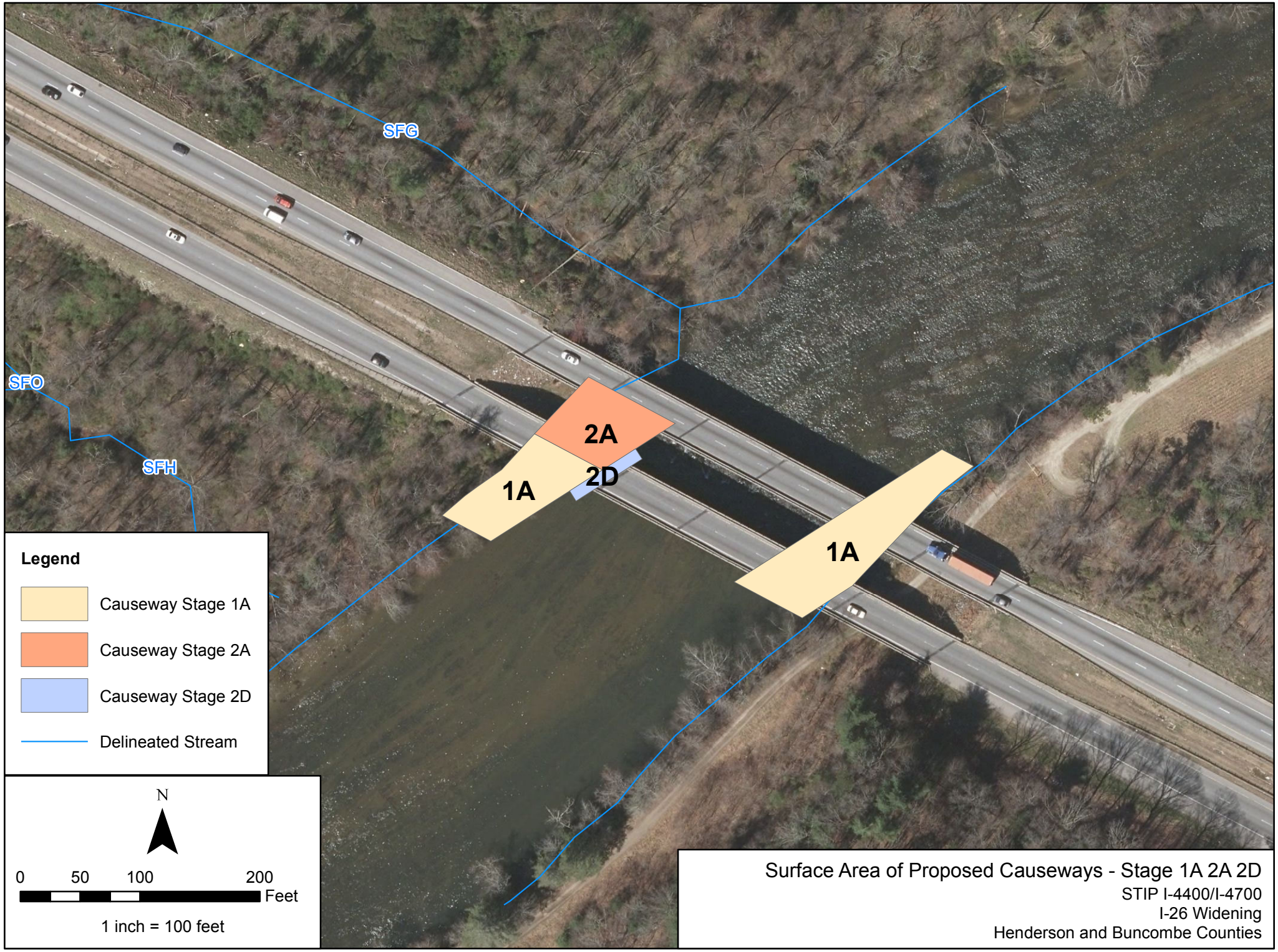

SFG
SFO
SFH
1A
1B
1A
Legend
Causeway Stage 1A
Causeway Stage 1B
Delineated Stream
N
0
50
100
200
Feet
1 inch = 100 feet
Surface Area of Proposed Causeways - Stage 1A 1B
STIP I-4400/I-4700
I-26 Widening
Henderson and Buncombe Counties


SFG
SFO
SFH
1A
1C
1A
Legend
Causeway Stage 1A
Causeway Stage 1C
Delineated Stream
N
0
50
100
200
Feet
1 inch = 100 feet
Surface Area of Proposed Causeways - Stage 1A 1C
STIP I-4400/I-4700
I-26 Widening
Henderson and Buncombe Counties


SFG
SFO
SFH
2A
1A
1A
Legend
Causeway Stage 1A
Causeway Stage 2A
Delineated Stream
N
0
50
100
200
Feet
1 inch = 100 feet
Surface Area of Proposed Causeways - Stage 1A 2A
STIP I-4400/I-4700
I-26 Widening
Henderson and Buncombe Counties


SFG
SFO
SFH
2A
2B
1A
1A
Legend
Causeway Stage 1A
Causeway Stage 2A
Causeway Stage 2B
Delineated Stream
N
0
50
100
200
Feet
1 inch = 100 feet
Surface Area of Proposed Causeways - Stage 1A 2A 2B
STIP I-4400/I-4700
I-26 Widening
Henderson and Buncombe Counties


SFG
SFO
SFH
2A
1A
2C
1A
Legend
Causeway Stage 1A
Causeway Stage 2A
Causeway Stage 2C
Delineated Stream
N
0
50
100
200
Feet
1 inch = 100 feet
Surface Area of Proposed Causeways - Stage 1A 2A 2C
STIP I-4400/I-4700
I-26 Widening
Henderson and Buncombe Counties


SFG
SFO
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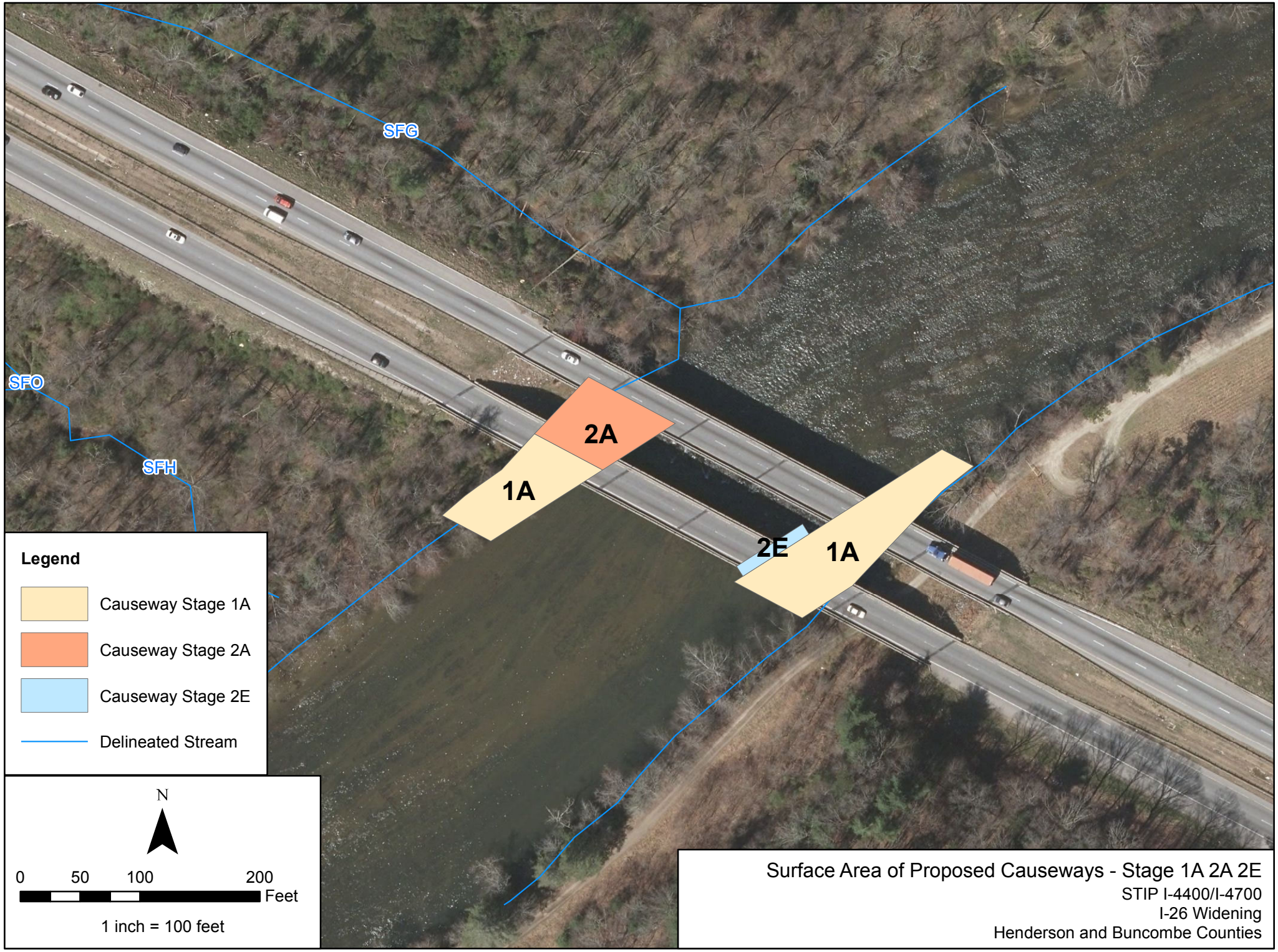
2A
2D
1A
1A
Legend
Causeway Stage 1A
Causeway Stage 2A
Causeway Stage 2D
Delineated Stream
N
0
50
100
200
Feet
1 inch = 100 feet
Surface Area of Proposed Causeways - Stage 1A 2A 2D
STIP I-4400/I-4700
I-26 Widening
Henderson and Buncombe Counties

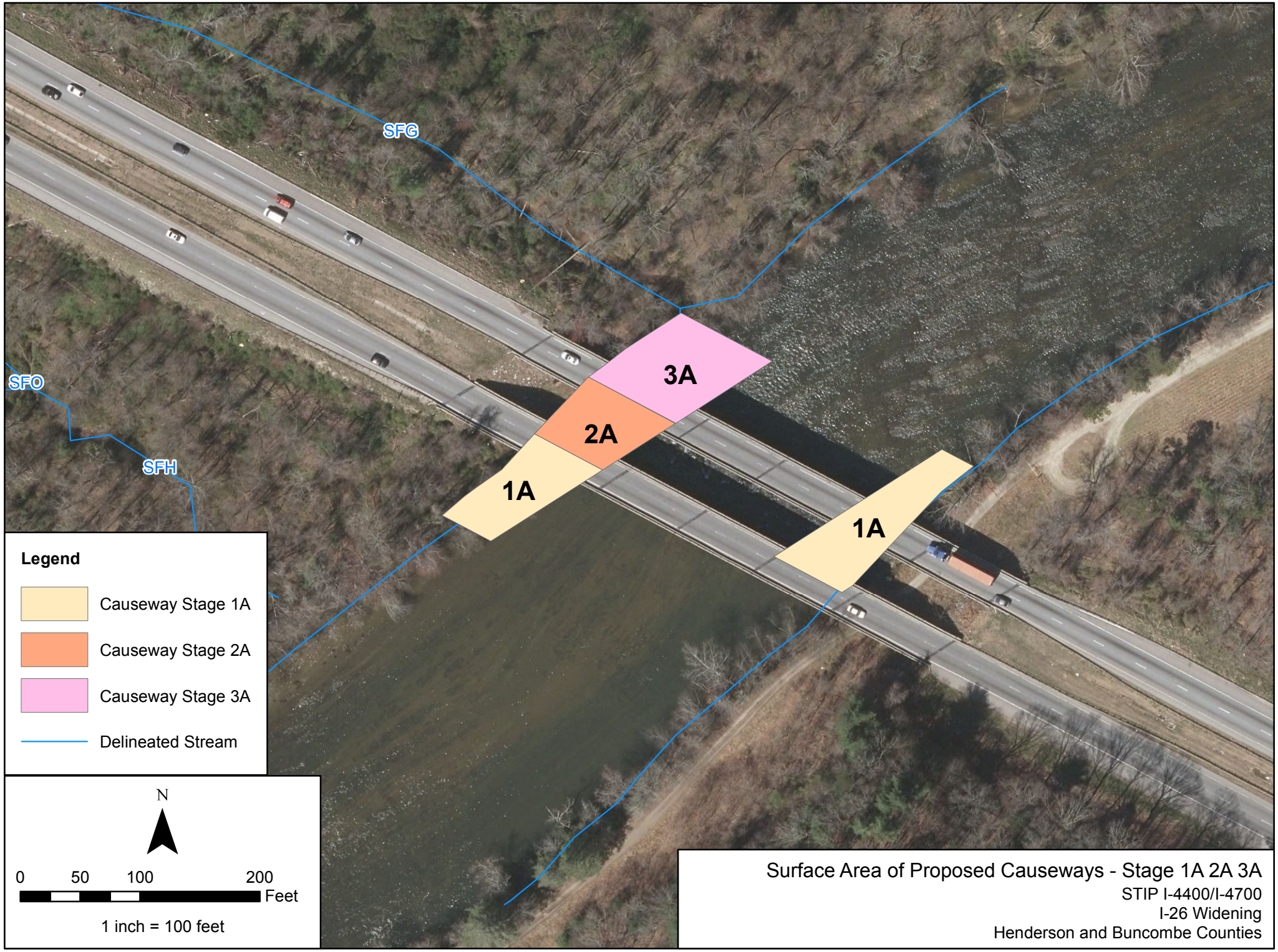


Surface Area of Proposed Causeways - Stage 1A 2A 2E

STIP I-4400/I-4700

I-26 Widening

Henderson and Buncombe Counties

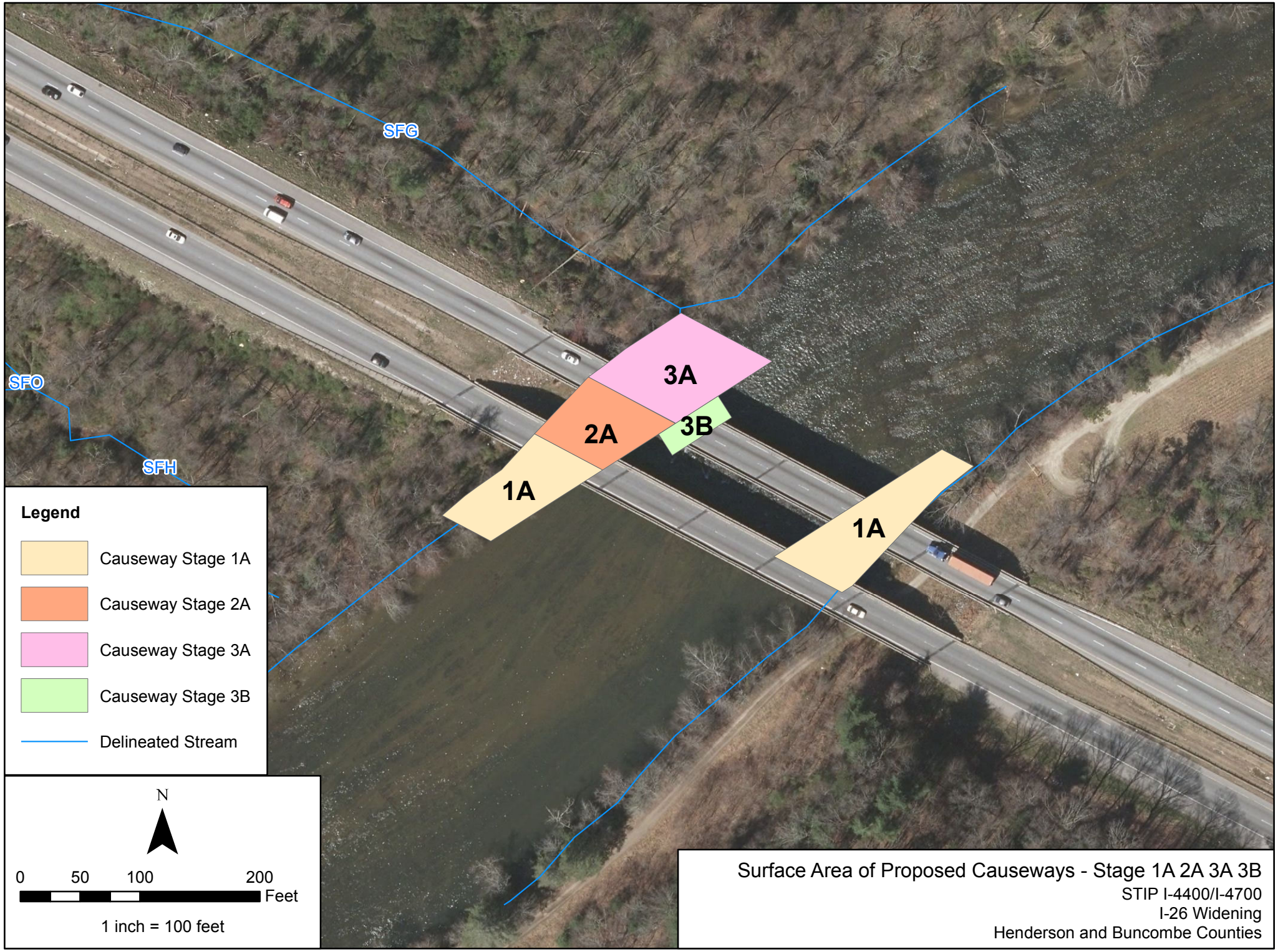


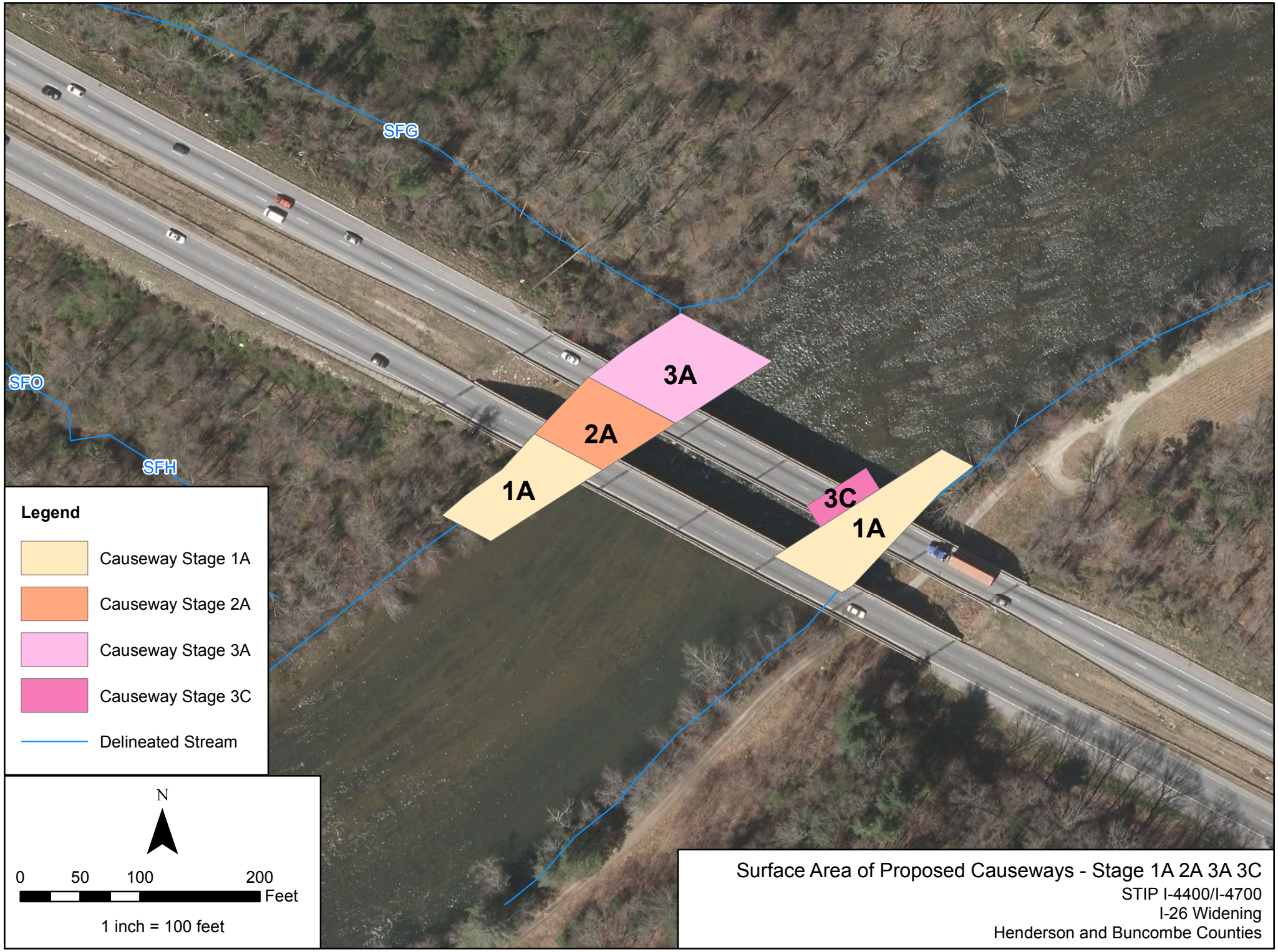
Surface Area of Proposed Causeways - Stage 1A 2A 3A

STIP I-4400/I-4700

I-26 Widening

Henderson and Buncombe Counties


SFG
SFO
SFH
3A
2A
3B
1A
1A
Legend
Causeway Stage 1A
Causeway Stage 2A
Causeway Stage 3A
Causeway Stage 3B
Delineated Stream
N
0
50
100
200
Feet
1 inch = 100 feet
Surface Area of Proposed Causeways - Stage 1A 2A 3A 3B
STIP I-4400/I-4700
I-26 Widening
Henderson and Buncombe Counties


SFG
SFO
SFH
3A
2A
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3C
1A
Legend
Causeway Stage 1A
Causeway Stage 2A
Causeway Stage 3A
Causeway Stage 3C
Delineated Stream
N
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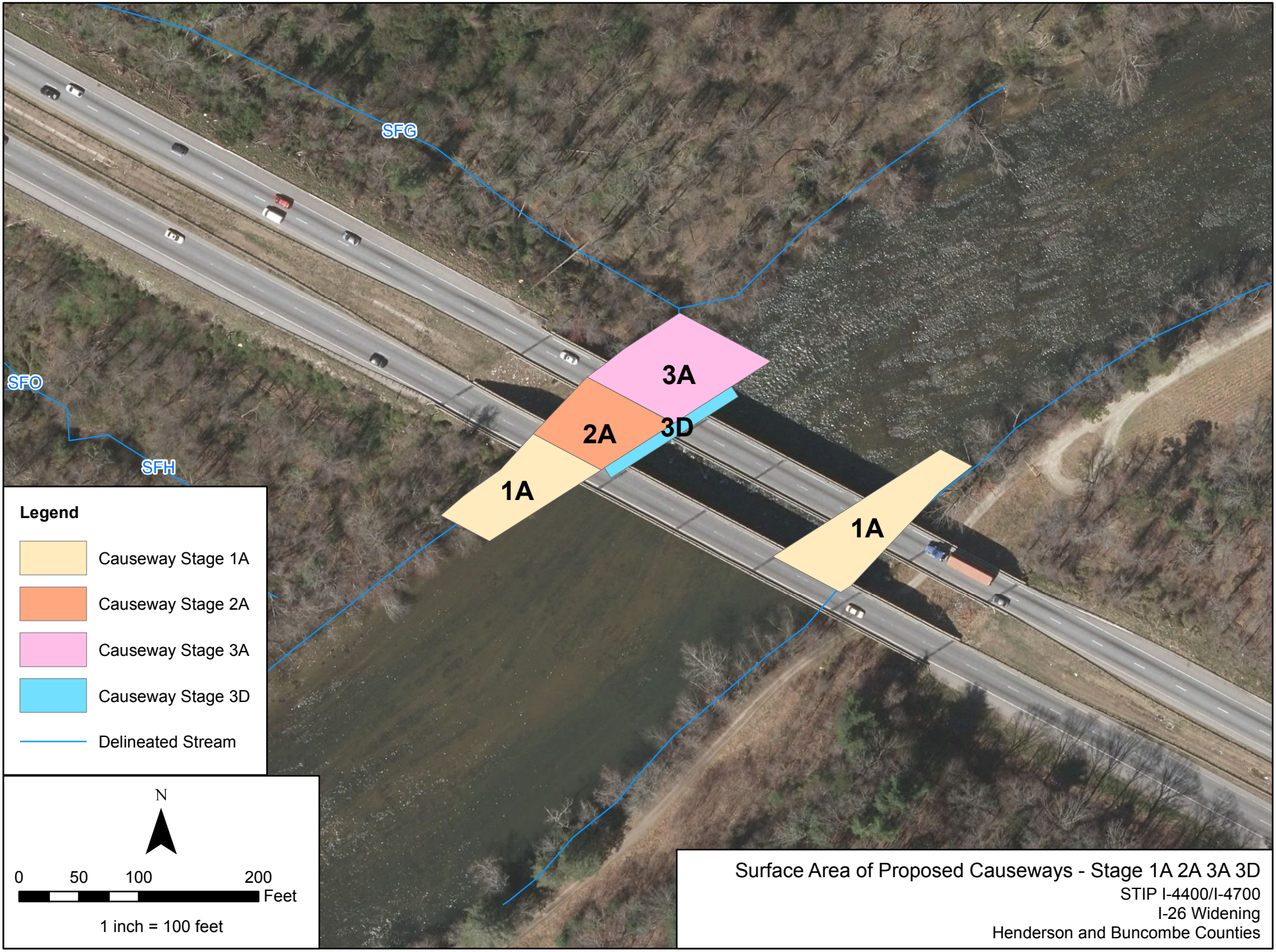
200
Feet
1 inch = 100 feet
Surface Area of Proposed Causeways - Stage 1A 2A 3A 3C
STIP I-4400/I-4700
I-26 Widening
Henderson and Buncombe Counties


SFG
SFO
SFH
3A
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3D
1A
1A
Legend
Causeway Stage 1A
Causeway Stage 2A
Causeway Stage 3A
Causeway Stage 3D
Delineated Stream
N
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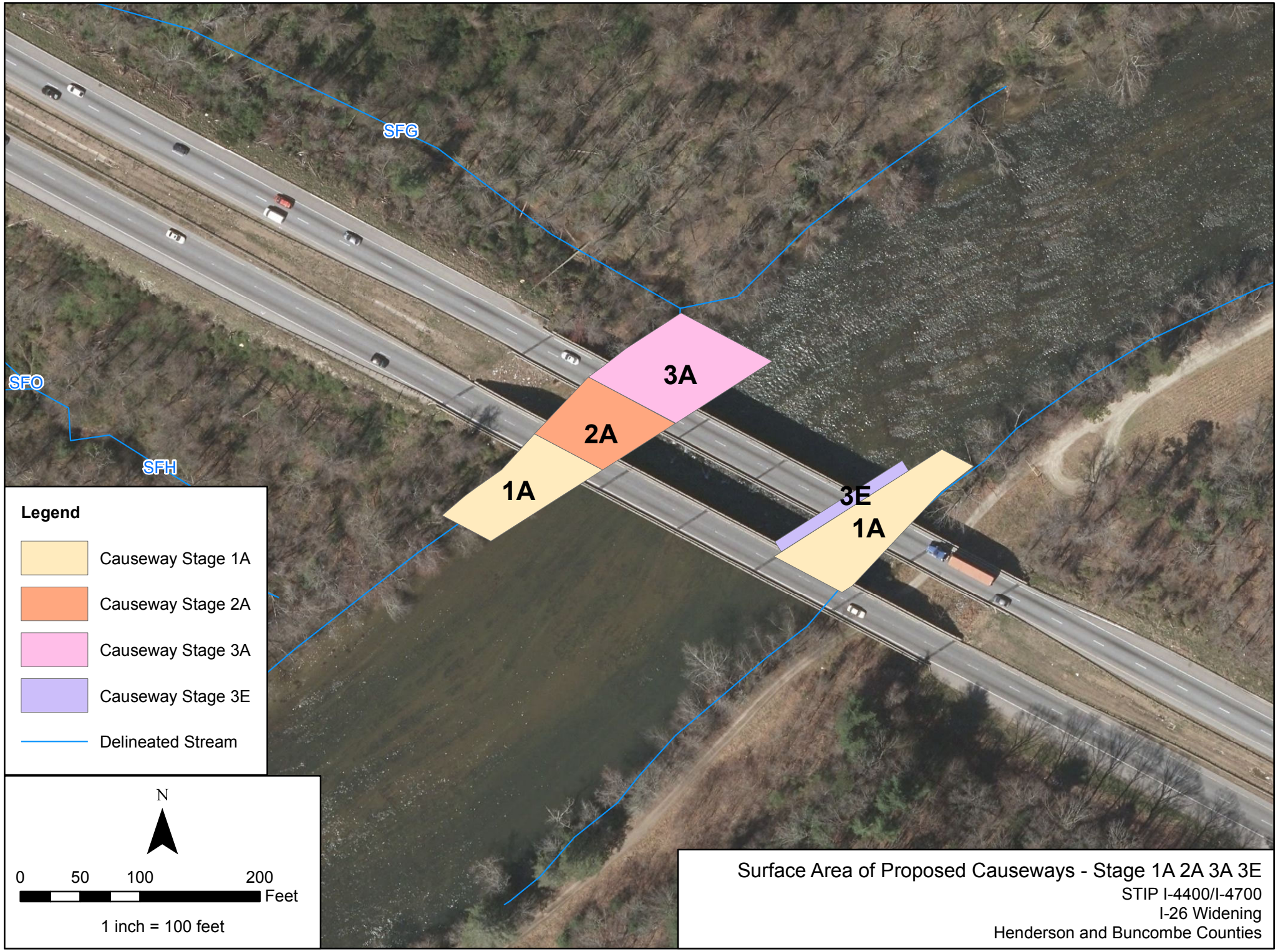
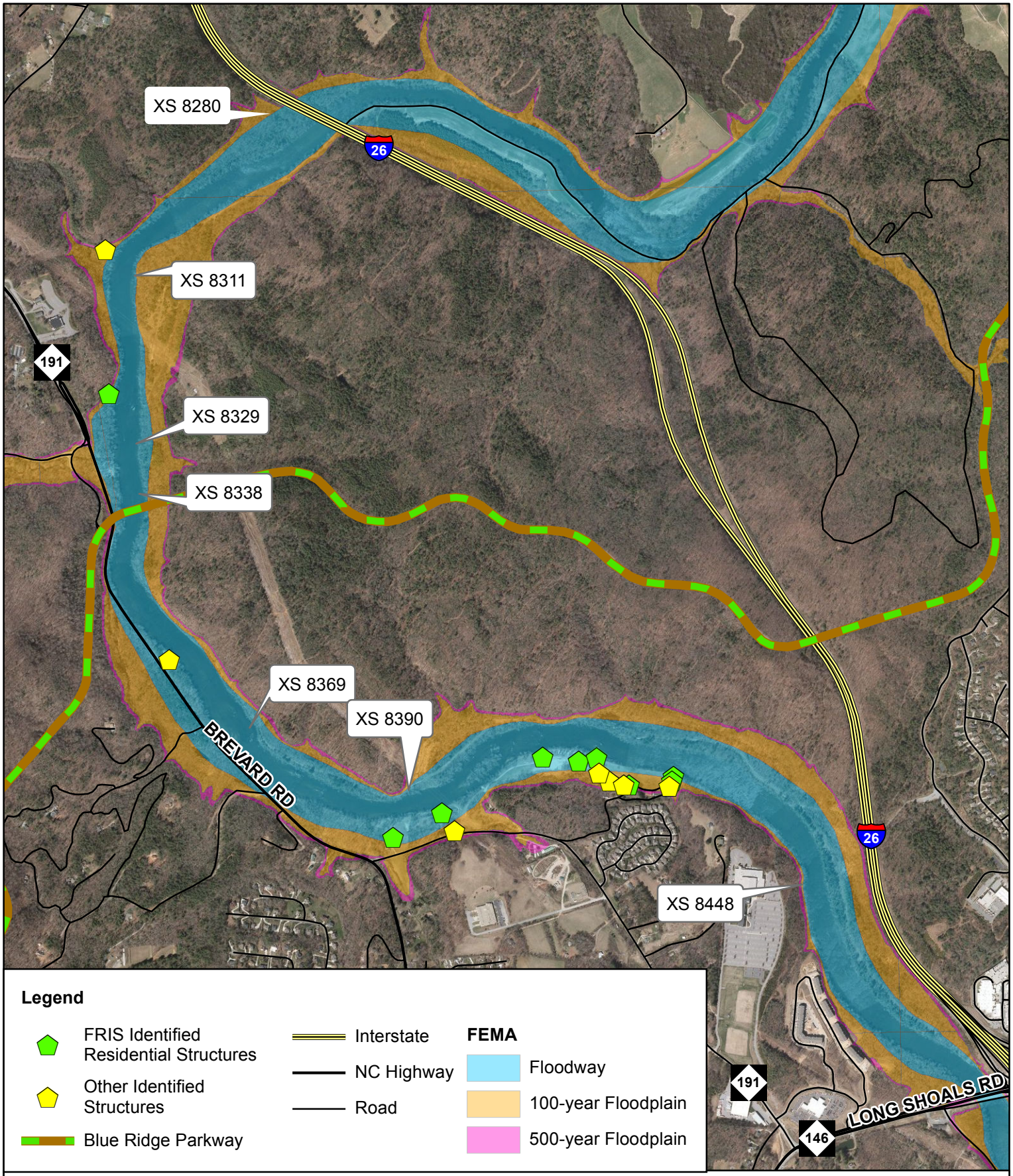
200
Feet
1 inch = 100 feet
Surface Area of Proposed Causeways - Stage 1A 2A 3A 3D
STIP I-4400/I-4700
I-26 Widening
Henderson and Buncombe Counties


SFG
SFO
SFH
3A
2A
1A
3E
1A
Legend
Causeway Stage 1A
Causeway Stage 2A
Causeway Stage 3A
Causeway Stage 3E
Delineated Stream
N
0
50
100
200
Feet
1 inch = 100 feet
Surface Area of Proposed Causeways - Stage 1A 2A 3A 3E
STIP I-4400/I-4700
I-26 Widening
Henderson and Buncombe Counties


SFG
SFO
SFH
1A
4
Legend
Causeway Stage 1A
Causeway Stage 4
Delineated Stream
N
0
50
100
200
Feet
1 inch = 100 feet
Surface Area of Proposed Causeways - Stage 1A 4
STIP I-4400/I-4700
I-26 Widening
Henderson and Buncombe Counties



N

0 750 1,500 3,000 Feet

1 inch = 1,500 feet

River Stations and Potential Structures in Flood Zone of the French Broad River from I-26 Bridge Upstream to Long Shoals Road (NC 146)

STIP I-4400/I-4700
I-26 Widening
Henderson and Buncombe Counties

Sources: FEMA, FRIS, Buncombe Co, HNTB