

Memorandum

I-440 Widening and Improvement Project – Project U-2719

To:	John Williams, PE – NCDOT Project Development Project U-2719 File		
From:	Jill Gurak, PE, AICP	Email:	Jill.gurak@atkinsglobal.com
Phone:	919-431-5298	Date:	April 13, 2017
Ref:	STIP U-2719 – I-440 Improvements Project	cc:	
Subject:	Methodology and calculations for impacts from the U-2719 Preliminary Designs to jurisdictional streams, ponds, wetlands, and riparian buffers		

The purpose of this memo is to:

- Document the methodology used to estimate the impacts to jurisdictional resources (streams, ponds, wetlands, and riparian buffers) from the Detailed Study Alternatives (DSA) for the subject project.
- Show the impacts at each crossing on graphics
- Provide tables listing the impacts to each individual jurisdictional resource based on each detailed study alternative and a summary of impacts from end-to-end combinations of alternatives.

Data Sources

Impacts to jurisdictional resources and biotic communities from the Detailed Study Alternatives were determined/calculated using the preliminary engineering designs and field-delineated streams/ponds/wetlands, as documented in the following data sources:

- U-2719 Preliminary Engineering Designs – submittal dated 1/23/17 (Atkins)

The preliminary designs for the Detailed Study Alternatives for the project include slope stakes, permanent drainage easements, construction easements, proposed culverts, and the field-delineated streams, wetlands, and open waters.

- *Final Natural Resources Technical Report: I-440 Improvements Project (Atkins, January 17, 2014).*

This natural resources technical report (NRTR) describes the thirty-eight streams, eighteen wetlands, and two areas of open water identified within the original project study area.

As the development of the alternative concepts and preliminary designs progressed, additional areas beyond the original project study area were field-investigated for natural resources, including jurisdictional resources. The additional areas were documented in the following reports:

- *Memo - U-2719 – I-440 Widening Project: Lake Boone Trail Stream/Wetland Survey (Atkins, October 3, 2014).*

In this memo, the expanded portion of the study area is the Lake Boone Trail interchange with I-440. One jurisdictional stream was identified in this area, and additional lengths of House Creek were delineated.

- *Natural Resources Technical Report: Area for Potential Relocation of the Reedy Creek Greenway Along Meredith College Campus (Atkins, August 3, 2015).*

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The surveyed area in this NRTR included a 100-foot wide corridor along Faircloth Road between Wade Avenue and Hillsborough Street, along the east side of the main campus of Meredith College. This area may be a potential location to relocate the Reedy Creek Greenway currently on the west side of campus adjacent to I-440. Two jurisdictional streams and three wetlands were identified in this study corridor.

- Memo U-2719 – I-440 Widening Project: Jones Franklin Road stream/wetland and Michaux's sumac survey (Atkins, May 17, 2016).

This memo documents natural resources along Jones Franklin Road from 250 feet south of the Capital Center Drive intersection south to the Centerview Drive intersection. The study corridor extends 100 feet from the edge of pavement on both sides of Jones Franklin Road. No jurisdictional features were identified in this corridor.

Detailed Study Alternatives

The proposed project would widen I-440/ US 1-64 (referred to as only I-440 through the remainder of this report) in Wake County from south of Walnut Street (SR 1313) in the Town of Cary to east of Wade Avenue (SR 1728) in the City of Raleigh to a six-lane freeway with auxiliary lanes in areas. The length of the proposed project is approximately six miles.

The project includes the modification and/or rehabilitation of interchanges and structures on I-440 within the project limits. Interchanges are located at SR 1313 (Walnut Street), Crossroads Boulevard / SR 1315 (Buck Jones Road), I-40, SR 5039 (Jones Franklin Road), SR 1445 (Melbourne Road), SR 1012 (Western Boulevard), NC 54 (Hillsborough Street), SR 1728 (Wade Avenue), and Lake Boone Trail.

The Detailed Study Alternative(s) at each specific interchange or grade separation can be mixed and matched with the alternatives at the other locations. These are listed below from west to east. In all instances, the mainline is widened to three through-lanes in each direction.

- South of Walnut St interchange through the I-40 interchange
 - Widen I-440 only (no interchange improvements)
- Jones Franklin Road interchange
 - Upgrade Existing Partial Clover
- Athens Drive grade separation
 - Replace Bridge in Place
 - Replace Bridge to North
- Melbourne Road interchange
 - Replace Bridge in Place
 - Replace Bridge to North
- Western Boulevard interchange
 - Double Crossover Diamond (also called a Diverging Diamond)
- Ligon Street grade separation
 - Replace Bridge to North
 - Replace Bridge to South
 - Extend Existing Traffic Culvert
- Hillsborough Street/Wade Avenue interchanges
 - One Flyover
 - Two Flyovers
 - Slight Detour

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Impact Calculation Methodology

Impacts were calculated in accordance with the guidelines for preliminary designs included in the *Wetland, Stream, and Riparian Buffer Impact Calculations* memorandum (NCDOT, September 2006).

Streams/Ponds/Wetlands. Impacts were calculated using the preliminary design estimated construction limits (slope stakes), construction easements, and permanent drainage easements. A buffer of 25-feet was added to the slope stakes and easements in accordance with NCDOT procedures for calculating impacts to jurisdictional resources at the preliminary planning-level design stage.

Impacts are designated permanent impacts or temporary impacts. Permanent impacts are assumed from the construction slope stakes and at locations where stream relocations are proposed to redirect streams into new culverts. Temporary impacts are assumed for drainage and construction easements.

Graphics are attached to this memo that show the slope stakes and easements and their 25-foot buffers, along with the delineated jurisdictional resources and the impacts at each crossing. The tables below summarize the impacts at each stream, wetland, and pond, organized by Detailed Study Alternative. Impacts are rounded to the nearest foot or square foot.

Riparian Buffers. All streams in the project area impacted by the Detailed Study Alternatives are subject to the Neuse River Buffer Rules. These rules regulate a 50-foot buffer around designated streams and ponds. The buffer is divided into two zones. Zone 1 is the first 30 feet from the bank of a stream or edge of a pond. Zone 2 extends 20 feet beyond Zone 1.

Impacts were calculated using the preliminary design estimated construction limits (slope stakes), construction easements, and permanent drainage easements. A buffer of 25-feet was added to the slope stakes and easements in accordance with NCDOT procedures for calculating impacts to jurisdictional resources at the preliminary planning-level design stage. These areas were overlain with the Zone 1 and Zone 2 buffers for each stream and pond in the study area and the overlapping areas were identified as potential riparian buffer impact areas. Actual impacts are likely to be less.

Graphics are attached to this memo that show the slope stakes and easements and their 25-foot buffers, along with the Zone 1 and Zone 2 riparian buffers around streams and ponds and the impacts at each riparian buffer.

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Impacts to Streams, Wetlands, and Ponds

The tables below show the anticipated impacts to streams (**Table 1**), wetlands (**Table 2**), and open waters (**Table 3**) within the project study area from the preliminary planning-level engineering designs for the Detailed Study Alternatives of the I-440 widening project (U-2719).

Only areas where impacts occur are listed in the three tables. Two areas along the project are not listed in any of the three tables below because these areas did not have any jurisdictional resource impacts. These two areas are the Detailed Study Alternative for the I-40 interchange and west of the interchange (Widen I-440 Only) and the Detailed Study Alternatives for the Athens Drive grade separation (Replace Bridge In Place and Replace Bridge to North).

Table 1. Stream Impacts

Interchange or Grade Separation Area	Detailed Study Alternative	Map ID (Stream Name)	Classification	Stream Location	Permanent Impact (lf)	Temporary Impact from Construction Easement (lf)	Temporary Impact from Permanent Drainage Easement (lf)
Jones Franklin Rd Interchange	Upgrade Existing Partial Clover	SW	Perennial	At Denise Drive extension	183	0	66
		SW	Perennial	Near eastbound off-ramp **existing stream to be relocated into new culvert. Permanent impacts include this relocation length.	184	0	0
		SX (Walnut Creek)	Perennial	Where culvert goes under Jones Franklin Rd and outfalls to eastern side of Jones Franklin Rd at Lake Johnson Park	0	0	165
Melbourne Rd Interchange	Replace Bridge in Place	ST (Simmons Branch)	Perennial	In between Athens Dr and Melbourne Rd; crosses underneath I-440	113	0	137
		SU	Intermittent	In between Athens Dr and Melbourne Rd; westbound side of I-440	54	0	0
		SV	Intermittent	In between Athens Dr and Melbourne Rd; eastbound side of I-440	251	0	0

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Table 1. Stream Impacts

Interchange or Grade Separation Area	Detailed Study Alternative	Map ID (Stream Name)	Classification	Stream Location	Permanent Impact (lf)	Temporary Impact from Construction Easement (lf)	Temporary Impact from Permanent Drainage Easement (lf)
	Replace Bridge to North	ST (Simmons Branch)	Perennial	In between Athens Dr and Melbourne Rd; crosses underneath I-440	113	0	137
		SU	Intermittent	In between Athens Dr and Melbourne Rd; westbound side of I-440	54	0	0
		SV	Intermittent	In between Athens Dr and Melbourne Rd; eastbound side of I-440	251	0	0
Western Blvd Interchange	Double Crossover Diamond	SS	Perennial	At on-ramp from Western Blvd to westbound I-440	67	0	59
		SR (Bushy Creek)	Perennial	Crosses diagonally from northwest quadrant (at K-mart) to southeast quadrant under the Western Blvd interchange	92	0	66
		SO	Perennial	In between Western Blvd and Ligon St on eastbound side of I-440	217	0	0
Ligon St Grade Separation	Extend Existing Traffic Culvert	SO	Perennial	Parallel to eastbound I-440 north of Ligon St	51	0	0
		SO	Intermittent	Parallel to eastbound I-440 north of Ligon St	52	0	0
		SN	Intermittent	Flows into Stream SO north of Ligon St	22	0	0
	Bridge to South	SO	Perennial	Parallel to eastbound I-440 north and south of Ligon St	236	64	0
		SO	Intermittent	Parallel to eastbound I-440 north of Ligon St	52	0	0
		SN	Intermittent	Flows into Stream SO north of Ligon St	22	0	0

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Table 1. Stream Impacts

Interchange or Grade Separation Area	Detailed Study Alternative	Map ID (Stream Name)	Classification	Stream Location	Permanent Impact (lf)	Temporary Impact from Construction Easement (lf)	Temporary Impact from Permanent Drainage Easement (lf)
	Bridge to North	SO	Perennial	Parallel to eastbound I-440 north of Ligon St	51	0	0
		SO	Intermittent	Parallel to eastbound I-440 north of Ligon St	52	0	0
		SN	Intermittent	Flows into Stream SO north of Ligon St	71	0	0
Hillsborough St and Wade Ave Interchanges	One Flyover	SI	Intermittent	SW quadrant of I-440/Wade Ave interchange - NCSU	28	0	0
		SJ	Perennial	SW quadrant of I-440/Wade Ave interchange - NCSU	195	0	61
		SK	Intermittent	SW quadrant of I-440/Wade Ave interchange - NCSU	0	0	24
		SC (House Creek)	Perennial	SW quadrant of I-440/Wade Ave interchange - NCSU	176	0	110
		SC (House Creek)	Perennial	East of I-440/Wade Ave interchange, crosses under I-440 by Mesa Ct	94	0	133
		SE	Intermittent	East of I-440/Wade Ave interchange, eastbound side of I-440 near House Creek Trail	47	0	0
	Two Flyovers	SI	Intermittent	SW quadrant of I-440/Wade Ave interchange - NCSU	28	0	0
		SJ	Perennial	SW quadrant of I-440/Wade Ave interchange - NCSU	194	0	61
		SK	Intermittent	SW quadrant of I-440/Wade Ave interchange - NCSU	0	0	25

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Table 1. Stream Impacts

Interchange or Grade Separation Area	Detailed Study Alternative	Map ID (Stream Name)	Classification	Stream Location	Permanent Impact (lf)	Temporary Impact from Construction Easement (lf)	Temporary Impact from Permanent Drainage Easement (lf)
		SC (House Creek)	Perennial	SW quadrant of I-440/Wade Ave interchange - NCSU	177	0	110
		SC (House Creek)	Perennial	NW quadrant of I-440/Wade Ave interchange – Museum Park	85	0	87
		SC (House Creek)	Perennial	East of I-440/Wade Ave interchange, crosses under I-440 by Mesa Ct	94	0	133
		SE	Intermittent	East of I-440/Wade Ave interchange, eastbound side of I-440 near House Creek Trail	47	0	0
	Slight Detour	SI	Intermittent	SW quadrant of I-440/Wade Ave interchange - NCSU	28	0	0
		SJ	Perennial	SW quadrant of I-440/Wade Ave interchange - NCSU	194	0	61
		SK	Intermittent	SW quadrant of I-440/Wade Ave interchange - NCSU	0	0	25
		SC (House Creek)	Perennial	SW quadrant of I-440/Wade Ave interchange - NCSU	178	0	110
		SC (House Creek)	Perennial	East of I-440/Wade Ave interchange, crosses under I-440 by Mesa Ct	94	0	133
		SE	Intermittent	East of I-440/Wade Ave interchange, eastbound side of I-440 near House Creek Trail	47	0	0

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Table 1. Stream Impacts

Interchange or Grade Separation Area	Detailed Study Alternative	Map ID (Stream Name)	Classification	Stream Location	Permanent Impact (lf)	Temporary Impact from Construction Easement (lf)	Temporary Impact from Permanent Drainage Easement (lf)
Reedy Creek Greenway	Reconstruct Greenway adjacent to I-440 on Meredith College main campus	none	N/A	No streams in this area	0	0	0
	Relocate Greenway along Faircloth St on east side of Meredith College main campus	SZA	Perennial	Crossing Faircloth St south of Wade Ave and north of Meredith College East Campus Dr entrance	41	29	0
		SZB (Southwest Prong Beaverdam Creek)	Perennial	Crossing Faircloth St south of Beaverdam Rd and north of Furches St	29	25	0

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Table 2. Wetland Impacts

Interchange or Grade Separation Area	Detailed Study Alternative	Wetland Name/ Map ID	Classification	Wetland Location	Permanent Impact (ft ²)	Temporary Impact from construction easement (ft ²)	Temporary Impact from permanent drainage easement (ft ²)
Jones Franklin Rd interchange	Upgrade Existing Partial Clover	WL	Riparian	Adjacent to eastbound on-ramp to I-440	958	0	0
Melbourne Rd interchange	Replace Bridge in Place	WH	Riparian	In between Melbourne Rd and Athens Dr on eastbound side of I-440	0	0	261
		WI	Riparian	In between Melbourne Rd and Athens Dr on westbound side of I-440	131	0	0
		WJ	Riparian	In between Melbourne Rd and Athens Dr on westbound side of I-440	44	0	0
		WF	Riparian	In between Melbourne Rd and Athens Dr on westbound side of I-440	2,744 (0.06 ac)	0	0
	Replace Bridge to North	WH	Riparian	In between Melbourne Rd and Athens Dr on eastbound side of I-440	0	0	261
		WI	Riparian	In between Melbourne Rd and Athens Dr on westbound side of I-440	131	0	0
		WJ	Riparian	In between Melbourne Rd and Athens Dr on westbound side of I-440	44	0	0
		WF	Riparian	In between Melbourne Rd and Athens Dr on westbound side of I-440	2,744 (0.06 ac)	0	0

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Table 2. Wetland Impacts

Interchange or Grade Separation Area	Detailed Study Alternative	Wetland Name/ Map ID	Classification	Wetland Location	Permanent Impact (ft ²)	Temporary Impact from construction easement (ft ²)	Temporary Impact from permanent drainage easement (ft ²)
Reedy Creek Greenway	Reconstruct Greenway on west side of Meredith College main campus	None	N/A	No wetland impacts.	0	0	0
	Relocate Greenway along Faircloth St on east side of Meredith College main campus	WZA	Riparian	West side of Faircloth St, south of Wade Ave and north of Meredith College East Campus Dr entrance along Stream SZA	44	1,525 (0.04 ac)	0
		WZB	Riparian	West side of Faircloth St, south of Beaverdam Rd and north of Furches St, on north side of Stream SZB (Southwest Prong Beaverdam Creek)	174	2,047 (0.05 ac)	0
		WZC	Riparian	West side of Faircloth St, south of Beaverdam Rd and north of Furches St, on south side of Stream SZB (Southwest Prong Beaverdam Creek)	1,873 (0.04 ac)	3,964 (0.09 ac)	0

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Table 3. Open Water Impacts

Interchange or Grade Separation Area	Detailed Study Alternative	Open Water Name/ Map ID	Classification	Open Water Location	Permanent Impact (ft ²)	Temporary Impact from construction easement (ft ²)	Temporary Impact from permanent drainage easement (ft ²)
Jones Franklin Rd Interchange	Upgrade Existing Partial Clover	OWD	Unnamed Pond	Adjacent to westbound off-ramp to I-440. Entire pond assumed to be impacted.	28,532 (0.66 ac)	9,801 (0.23 ac)	0
Melbourne Rd Interchange	Replace Bridge in Place	OWC	White Oak Lake	In between Melbourne Rd and Athens Dr on westbound side of I-440	3,311 (0.08 ac)	0	0
	Replace Bridge to North	OWC	White Oak Lake	In between Melbourne Rd and Athens Dr on westbound side of I-440	3,311 (0.08 ac)	0	0

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Impact Summaries for Ponds, Wetlands, and Streams

Ponds. Impacts to ponds would be the same for any end-to-end alternatives, since these impacts occur where there is only one option currently under consideration. Total pond impacts would be approximately 31,842 square feet (0.73 acre) of permanent impact and 9,801 square feet (0.23 acre) of temporary impact. It should be noted that the City of Raleigh has a project to relocate the White Oak Lake dam outside the U-2719 proposed right of way.

Wetlands. Total wetland impacts for any end-to-end alternative would vary only with the choice of greenway relocation option. Total wetland impacts for end-to-end alternatives that reconstruct the Reedy Creek Greenway adjacent to I-440 on west side of Meredith College would be approximately 3,877 square feet (0.09 acre) of permanent impact and 261 square feet (0.01 acre) of temporary impact.

Total wetland impacts for end-to-end alternatives that relocate Reedy Creek Greenway to Faircloth Street would be approximately 5,968 square feet (0.14 acre) of permanent impact and 7,797 square feet (0.18 acre) of temporary impact.

Streams. Table 4 below is a summary of stream impacts for end-to-end Detailed Study Alternatives. The three primary end-to-end Detailed Study Alternatives are organized around the three options at the Hillsborough Street/Wade Avenue interchange area: One Flyover, Two Flyovers and Slight Detour. Options at Ligon Street (3 options), Melbourne Road (2 options) and Athens Drive (2 options) in various combinations comprise the different variations of the Detailed Study Alternatives. There are single options at I-40, Jones Franklin Road, and Western Boulevard that are common to all end-to-end combinations.

A review of the summary table shows that there are three locations where there are differences in stream impacts in alternative options: I-440/Wade Avenue interchange, Ligon Street grade separation, and the Reedy Creek Greenway relocation. These areas are described below.

At the Wade Avenue interchange, there are differences at the culvert crossing under Wade Avenue just west of I-440. On the NC Museum of Art property on the north side of Wade Avenue, a culvert extension is needed under the Two Flyovers alternative that is not needed under the One Flyover or Slight Detour alternatives. Under the Two Flyovers alternative, the ramp from westbound I-440 to westbound Wade Avenue needs to be shifted outward so that the flyover ramp from eastbound I-440 to westbound Wade Avenue can join with this ramp before joining Wade Avenue, creating a need to extend the House Creek culvert on the north side. This culvert extension would have approximately 85 linear feet of permanent impact and 87 linear feet of temporary impact.

At the Ligon Street grade separation, the Build Bridge to South alternative would have approximately 85 more linear feet of permanent stream impacts and 64 linear feet more of temporary impacts compared to the Build Bridge to North and Extend Existing Traffic Culvert alternatives.

There are two options for relocating the Reedy Creek Greenway that currently traverses the east side of the Meredith College main campus adjacent to existing I-440. This greenway can be shifted slightly to remain adjacent to the new right of way of I-440. Another option would be to relocate this greenway segment to the opposite side of campus, along Faircloth Road. The Faircloth Road option would result in approximately 70 linear feet more of permanent impacts and approximately 54 linear feet more of temporary impact.

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Table 4. Summary of Permanent and Temporary Stream Impacts by Detailed Study Alternative

Interchange or Grade Separation Location Area (east to west)	Detailed Study Alternative								
	XX / XX = Permanent Impacts / Temporary Impacts (linear feet)								
Hillsborough St / Wade Ave interchanges	One Flyover			Two Flyovers			Slight Detour		
	540 / 328			625 / 416			541 / 329		
Ligon St grade separation	Bridge North	Bridge South	Extend Culvert	Bridge North	Bridge South	Extend Culvert	Bridge North	Bridge South	Extend Culvert
	174 / 0	310 / 64	125 / 0	174 / 0	310 / 64	125 / 0	174 / 0	310 / 64	125 / 0
Western Blvd interchange	Double Crossover Diamond			Double Crossover Diamond			Double Crossover Diamond		
	376 / 125			376 / 125			376 / 125		
Melbourne Rd interchange	Bridge in Place	Bridge to North		Bridge in Place	Bridge to North		Bridge in Place	Bridge to North	
	418 / 137	418 / 137		418 / 137	418 / 137		418 / 137	418 / 137	
Athens Dr grade separation	Bridge in Place	Bridge to North		Bridge in Place	Bridge to North		Bridge in Place	Bridge to North	
	0 / 0	0 / 0		0 / 0	0 / 0		0 / 0	0 / 0	
Jones Franklin Rd interchange	Upgrade Existing Partial Clover			Upgrade Existing Partial Clover			Upgrade Existing Partial Clover		
	367 / 231			367 / 231			367 / 231		
I-40 interchange and west	Widen I-440 Only			Widen I-440 Only			Widen I-440 Only		
	0 / 0			0 / 0			0 / 0		
Reedy Creek Greenway Relocation at Meredith College	Adjacent to I-440	Along Faircloth Rd		Adjacent to I-440	Along Faircloth Rd		Adjacent to I-440	Along Faircloth Rd	
	0 / 0	70 / 54		0 / 0	70 / 54		0 / 0	70 / 54	
RANGE OF PERMANENT IMPACTS	1,826-2,130			1,911-2,215			1,827-2,131		
RANGE OF TEMPORARY IMPACTS	821-939			909-1,027			822-940		

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Impacts to Riparian Buffers

The tables below show the anticipated impacts to riparian buffers (**Table 5**) within the project study area from the preliminary planning-level engineering designs for the Detailed Study Alternatives of the I-440 widening project (U-2719).

Only areas where impacts occur are listed in the table. It is not known at this time how much of the buffer impacts would be permanent, and how much would be temporary and able to be revegetated, although it is expected most will be temporary. These impact details would be determined during final design.

Table 5. Riparian Buffer Impacts

Interchange or Grade Separation Area	Detailed Study Alternative	Map ID (Stream or Pond Name)	Classification	Stream/Pond Location	Zone 1 Impacts (ft ²)	Zone 2 Impacts (ft ²)	Total Buffer Impacts (ft ²)
Jones Franklin Rd Interchange	Upgrade Existing Partial Clover	SW	Perennial	At Denise Drive extension	16,617	8,232	24,849
		SW	Perennial	Near eastbound off-ramp **existing stream to be relocated into new culvert. Permanent impacts include this relocation length.	5,793	3,939	9,732
		SX (Walnut Creek)	Perennial	WB side of I-440 and also culvert outfall at Lake Johnson Park	14,352	10,657	25,009
		SAA	Perennial	Westbound side of I-440 west of Jones Franklin Road intersection.	185	1,591	1,776
		SAK	Intermittent	Westbound side of I-440 west of Jones Franklin Road intersection.	33	1,398	1,431
		OWD	Unnamed Pond	Near westbound I-440 off-ramp onto Jones Franklin Road.	64,783	17,862	82,645
Melbourne Rd Interchange	Replace Bridge in Place	ST (Simmons Branch)	Perennial	In between Athens Dr and Melbourne Rd on the eastbound side of I-440 and runs parallel to it. Combined the buffers for these two streams to avoid overlapping impacts.	27,305	12,380	39,685
		SV	Intermittent				

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Table 5. Riparian Buffer Impacts

Interchange or Grade Separation Area	Detailed Study Alternative	Map ID (Stream or Pond Name)	Classification	Stream/Pond Location	Zone 1 Impacts (ft ²)	Zone 2 Impacts (ft ²)	Total Buffer Impacts (ft ²)
		ST	Perennial	In between Athens Dr and Melbourne Rd; westbound side of I-440	9,999	6,844	16,843
		SU	Intermittent	In between Athens Dr and Melbourne Rd; westbound side of I-440; Riparian Buffer Rules do not apply since stream not on USGS topo map or USDA Soils Survey	-	-	-
		OWC	Unnamed Pond	On westbound side of I-440 in between Athens Drive and Melbourne Road.	10,618	6,550	17,168
	Replace Bridge to North	ST (Simmons Branch)	Perennial	In between Athens Dr and Melbourne Rd; ST crosses underneath I-440, while SV is located on the eastbound side of I-440 and runs parallel to it. Combined buffers to avoid overlapping impacts.	27,305	12,380	39,685
		SV	Intermittent				
		ST	Perennial	In between Athens Dr and Melbourne Rd; westbound side of I-440	9,999	6,844	16,843

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Interchange or Grade Separation Area	Detailed Study Alternative	Map ID (Stream or Pond Name)	Classification	Stream/Pond Location	Zone 1 Impacts (ft ²)	Zone 2 Impacts (ft ²)	Total Buffer Impacts (ft ²)
		SU	Intermittent	In between Athens Dr and Melbourne Rd; westbound side of I-440; Riparian Buffer Rules do not apply since stream not on USGS topo map or USDA Soils Survey	-	-	-
		OWC	Unnamed Pond	On westbound side of I-440 in between Athens Drive and Melbourne Road.	10,618	6,550	17,168
Western Blvd Interchange	Double Crossover Diamond	SS	Perennial	At on-ramp from Western Blvd to westbound I-440	9,756	6,026	15,782
		SR (Bushy Creek)	Perennial	Crosses diagonally from northwest quadrant (at K-mart) to southeast quadrant under the Western Blvd interchange	17,980	11,700	29,680
		SO	Perennial	In between Western Blvd and Ligon St on eastbound side of I-440	19,320	10,648	29,968
		SQ	Intermittent	In between Western Blvd and Ligon St on eastbound side of I-440. This stream buffer is completely covered by the Stream SO buffer, therefore it is not included in the impact calculations to avoid overlap.	-	-	-
Ligon St Grade Separation	Extend Existing Traffic Culvert	SO	Perennial/Intermittent	Parallel to eastbound I-440 north and south of Ligon St	9,698	9,395	19,093

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Table 5. Riparian Buffer Impacts

Interchange or Grade Separation Area	Detailed Study Alternative	Map ID (Stream or Pond Name)	Classification	Stream/Pond Location	Zone 1 Impacts (ft ²)	Zone 2 Impacts (ft ²)	Total Buffer Impacts (ft ²)
		SN	Intermittent	Flows into Stream SO north of Ligon St. This stream buffer is completely covered by the Stream SO buffer, therefore it is not included in the impact calculations to avoid overlap.	-	-	-
	Bridge to South	SO	Intermittent	Parallel to eastbound I-440 north of Ligon St	9,724	3,522	13,246
		SO SP	Perennial Perennial	SO parallel to eastbound I-440 south of Ligon St, and SP perpendicular to eastbound I-440 south of Ligon St. Combined buffers to avoid overlapping impacts.	16,522	15,729	32,251
		SN	Intermittent	Flows into Stream SO north of Ligon St. This stream buffer is completely covered by the Stream SO buffer, therefore it is not included in the impact calculations to avoid overlap.	-	-	-
	Bridge to North	SO SN	Perennial Intermittent	SO parallel to eastbound I-440 south of Ligon St, and SN flows into SO north of Ligon St. Combined buffers to avoid overlapping impacts.	13,211	8,581	21,792
		SO	Intermittent	Parallel to eastbound I-440 south of Ligon St	1,279	7,901	9,180

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Interchange or Grade Separation Area	Detailed Study Alternative	Map ID (Stream or Pond Name)	Classification	Stream/Pond Location	Zone 1 Impacts (ft ²)	Zone 2 Impacts (ft ²)	Total Buffer Impacts (ft ²)
Hillsborough St and Wade Ave Interchanges	One Flyover	SI	Intermittent	SW quadrant of I-440/Wade Ave interchange – NCSU, Riparian Buffer Rules do not apply since stream not on USGS topo map or USDA Soils Survey	-	-	-
		SC SJ SK	Perennial Perennial Intermittent	SW quadrant of I-440/Wade Ave interchange – NCSU. Combined buffers to avoid overlapping impacts	23,842	18,093	41,935
		SC (House Creek)	Perennial	East of I-440/Wade Ave interchange, crosses under I-440 by Mesa Ct	19,304	12,840	32,144
		SE	Intermittent	East of I-440/Wade Ave interchange, eastbound side of I-440 near House Creek Trail	5,482	5,815	11,297
	Two Flyovers	SI	Intermittent	SW quadrant of I-440/Wade Ave interchange – NCSU, Riparian Buffer Rules do not apply since stream not on USGS topo map or USDA Soils Survey	-	-	-
		SC SJ SK	Perennial Perennial Intermittent	SW quadrant of I-440/Wade Ave interchange – NCSU. Combined buffers to avoid overlapping impacts	23,842	18,093	41,935
		SC (House Creek)	Perennial	East of I-440/Wade Ave interchange, crosses under I-440 by Mesa Ct	19,304	12,840	32,144
		SC (House Creek)	Perennial	NW quadrant of I-440/Wade Ave interchange – Museum Park	13,474	9,446	22,920

Memorandum

Table 5. Riparian Buffer Impacts

Interchange or Grade Separation Area	Detailed Study Alternative	Map ID (Stream or Pond Name)	Classification	Stream/Pond Location	Zone 1 Impacts (ft ²)	Zone 2 Impacts (ft ²)	Total Buffer Impacts (ft ²)
	Slight Detour	SE	Intermittent	East of I-440/Wade Ave interchange, eastbound side of I-440 near House Creek Trail	5,478	5,815	11,293
		SI	Intermittent	SW quadrant of I-440/Wade Ave interchange – NCSU, Riparian Buffer Rules do not apply since stream not on USGS topo map or USDA Soils Survey	-	-	-
		SC SJ SK	Perennial Perennial Intermittent	SW quadrant of I-440/Wade Ave interchange – NCSU. Combined buffers to avoid overlapping impacts	24,061	18,354	42,415
		SC (House Creek)	Perennial	East of I-440/Wade Ave interchange, crosses under I-440 by Mesa Ct	19,296	12,835	32,131
		SE	Intermittent	East of I-440/Wade Ave interchange, eastbound side of I-440 near House Creek Trail	5,482	5,823	11,305
Reedy Creek Greenway	ONE FLYOVER Reconstruct Greenway adjacent to I-440 on Meredith College main campus	OWA	Unnamed Pond	Adjacent to eastbound I-440 on-ramp from Hillsborough Street.	1,030	2,953	3,983

Memorandum

Table 5. Riparian Buffer Impacts

Interchange or Grade Separation Area	Detailed Study Alternative	Map ID (Stream or Pond Name)	Classification	Stream/Pond Location	Zone 1 Impacts (ft ²)	Zone 2 Impacts (ft ²)	Total Buffer Impacts (ft ²)
	TWO FLYOVERS Reconstruct Greenway adjacent to I-440 on Meredith College main campus	OWA	Unnamed Pond	Adjacent to eastbound I-440 on-ramp from Hillsborough Street.	779	4,738	5,517
	SLIGHT DETOUR Reconstruct Greenway adjacent to I-440 on Meredith College main campus	OWA	Unnamed Pond	Adjacent to eastbound I-440 on-ramp from Hillsborough Street.	2,851	3,801	6,652
	Relocate Greenway along Faircloth St on east side of Meredith College main campus	SZA	Perennial	Crossing Faircloth St south of Wade Ave and north of Meredith College East Campus Dr entrance	9,177	7,593	16,770
		SZB (Southwest Prong Beaverdam Creek)	Perennial	Crossing Faircloth St south of Beaverdam Rd and north of Furches St	14,851	11,282	25,863

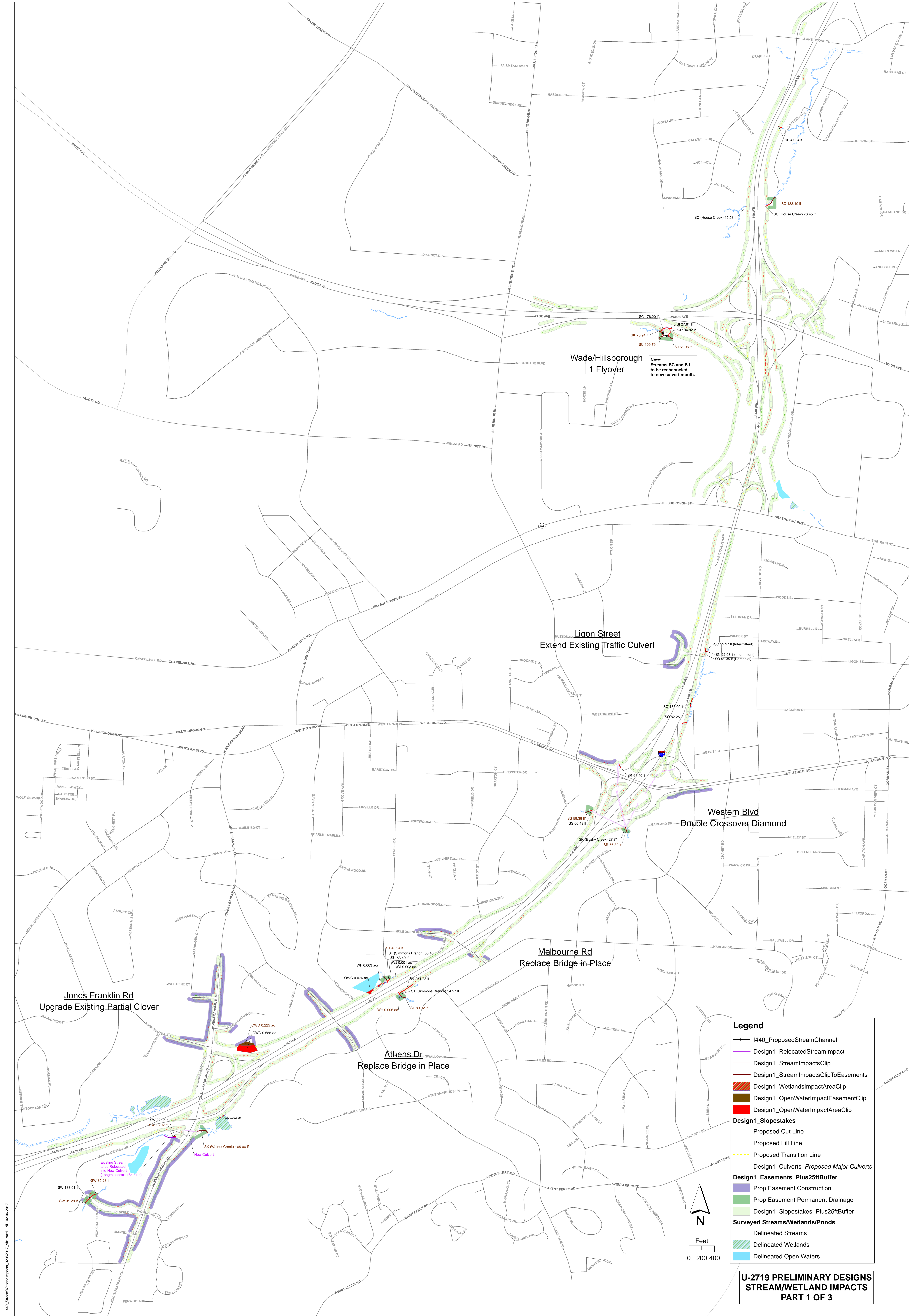
Memorandum

Table 4. Summary of Riparian Buffer Impacts by Detailed Study Alternative

Interchange or Grade Separation Location Area (east to west)	Detailed Study Alternative								
	XX / XX = Zone 1 Impacts / Zone 2 Impacts (square feet)								
Hillsborough St / Wade Ave interchanges	One Flyover			Two Flyovers			Slight Detour		
	48,628 / 36,748			62,098 / 46,194			48,839 / 37,012		
Ligon St grade separation	Bridge North	Bridge South	Extend Culvert	Bridge North	Bridge South	Extend Culvert	Bridge North	Bridge South	Extend Culvert
	14,490 / 16,482	26,246 / 19,251	9,698 / 9,395	14,490 / 16,482	26,246 / 19,251	9,698 / 9,395	14,490 / 16,482	26,246 / 19,251	9,698 / 9,395
Western Blvd interchange	Double Crossover Diamond			Double Crossover Diamond			Double Crossover Diamond		
	47,056 / 28,374			47,056 / 28,374			47,056 / 28,374		
Melbourne Rd interchange	Bridge in Place	Bridge North		Bridge in Place	Bridge North		Bridge in Place	Bridge North	
	47,922 / 25,774	47,922 / 25,774		47,922 / 25,774	47,922 / 25,774		47,922 / 25,774	47,922 / 25,774	
Athens Dr grade separation	Bridge in Place	Bridge North		Bridge in Place	Bridge North		Bridge in Place	Bridge North	
	0 / 0	0 / 0		0 / 0	0 / 0		0 / 0	0 / 0	
Jones Franklin Rd interchange	Upgrade Existing Partial Clover			Upgrade Existing Partial Clover			Upgrade Existing Partial Clover		
	101,763 / 55,850			101,763 / 55,850			101,763 / 55,850		
I-40 interchange and west	Widen I-440 Only			Widen I-440 Only			Widen I-440 Only		
	0 / 0			0 / 0			0 / 0		
Reedy Creek Greenway Relocation at Meredith College	Adjacent to I-440	Along Faircloth Rd		Adjacent to I-440	Along Faircloth Rd		Adjacent to I-440	Along Faircloth Rd	
	1,030 / 2,953	24,029 / 18,874		779 / 4,738	24,029 / 18,874		2,851 / 3,801	24,029 / 18,874	
RANGE OF ZONE 1 IMPACTS	256,098 – 295,644 (5.9 – 6.8 acres)			269,316 – 309,114 (6.2 - 7.1 acres)			258,129 – 295,855 (5.9 – 6.8 acres)		
RANGE OF ZONE 2 IMPACTS	159,095 – 184,872 (3.7 – 4.2 acres)			170,325 – 194,317 (3.9 – 4.5 acres)			160,206 – 185,135 (3.7 – 4.3 acres)		
RANGE OF TOTAL RIPARIAN BUFFER IMPACTS	415,193 – 480,516 (9.5 – 11.0 acres)			439,641 – 503,431 (10.1 - 11.6 acres)			418,335 – 480,990 (9.6 – 11.0 acres)		

Memorandum

STREAM, POND, AND WETLAND IMPACT MAPS



Note:
Streams SC and SJ
to be rechanneled
to new culvert mouth.

Wade/Hillsborough
1 Flyover

Ligon Street
Extend Existing Traffic Culvert

Western Blvd
Double Crossover Diamond

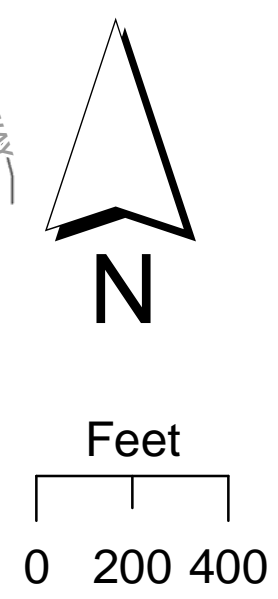
Melbourne Rd
Replace Bridge in Place

Athens Dr
Replace Bridge in Place

Jones Franklin Rd
Upgrade Existing Partial Clover

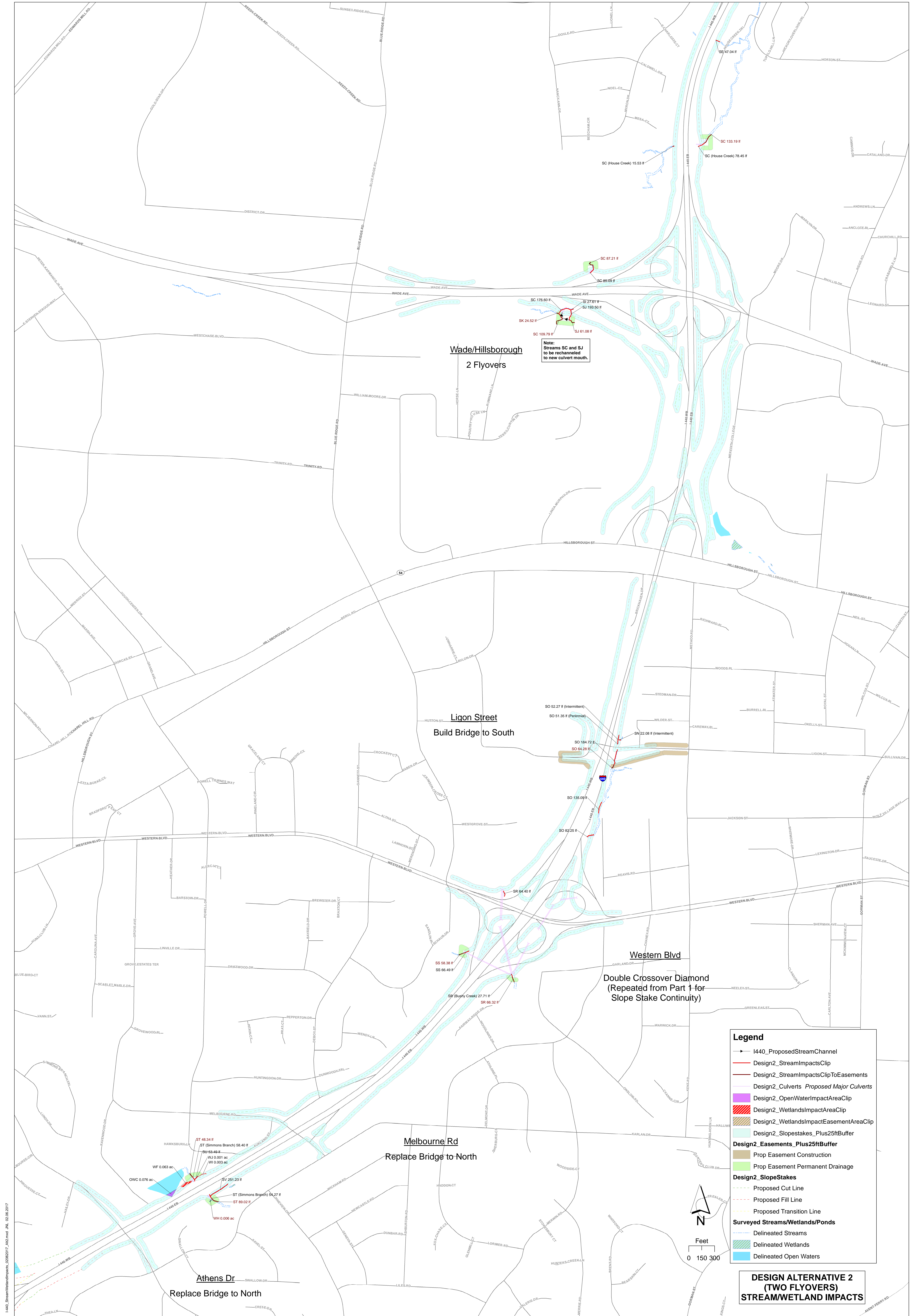
Legend

- I440_ProposedStreamChannel
- Design1_RelocatedStreamImpact
- Design1_StreamImpactsClip
- Design1_StreamImpactsClipToEasements
- Design1_WetlandsImpactAreaClip
- Design1_OpenWaterImpactEasementClip
- Design1_OpenWaterImpactAreaClip
- Design1_Slopestakes**
 - Proposed Cut Line
 - Proposed Fill Line
 - Proposed Transition Line
 - Design1_Culverts Proposed Major Culverts
- Design1_Easements_Plus25ftBuffer**
 - Prop Easement Construction
 - Prop Easement Permanent Drainage
 - Design1_Slopestakes_Plus25ftBuffer
- Surveyed Streams/Wetlands/Ponds**
 - Delineated Streams
 - Delineated Wetlands
 - Delineated Open Waters



**U-2719 PRELIMINARY DESIGNS
STREAM/WETLAND IMPACTS
PART 1 OF 3**

I:\440_StreamWetlandImpacts_02062017_Alt.mxd JNL 02/06/2017



Wade/Hillsborough
2 Flyovers

Note:
Streams SC and SJ
to be rechanneled
to new culvert mouth.

Ligon Street
Build Bridge to South

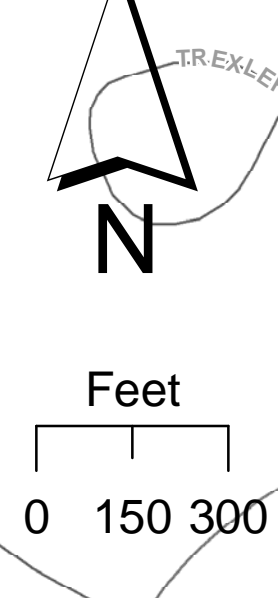
Western Blvd
Double Crossover Diamond
(Repeated from Part 1 for
Slope Stake Continuity)

Melbourne Rd
Replace Bridge to North

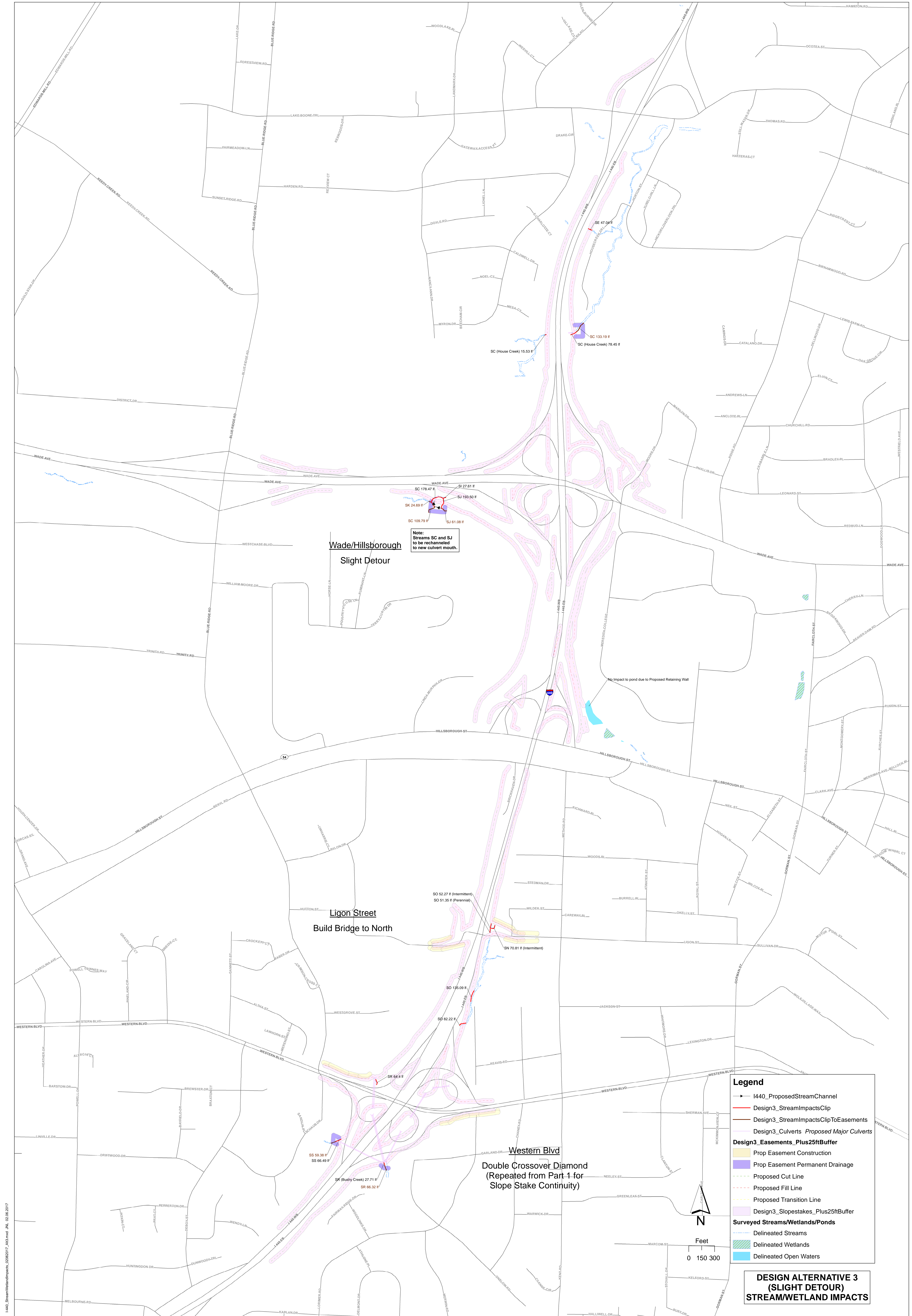
Athens Dr
Replace Bridge to North

Legend

- I440_ProposedStreamChannel
- Design2_StreamImpactsClip
- Design2_StreamImpactsClipToEasements
- Design2_Culverts_Proposed Major Culverts
- Design2_OpenWaterImpactAreaClip
- Design2_WetlandsImpactAreaClip
- Design2_WetlandsImpactEasementAreaClip
- Design2_Slopestakes_Plus25ftBuffer
- Design2_Easements_Plus25ftBuffer
- Prop Easement Construction
- Prop Easement Permanent Drainage
- Design2_SlopeStakes
- Proposed Cut Line
- Proposed Fill Line
- Proposed Transition Line
- Surveyed Streams/Wetlands/Ponds
- Delineated Streams
- Delineated Wetlands
- Delineated Open Waters



**DESIGN ALTERNATIVE 2
(TWO FLYOVERS)
STREAM/WETLAND IMPACTS**



Note:
Streams SC and SJ
to be rechanneled
to new culvert mouth.

Wade/Hillsborough
Slight Detour

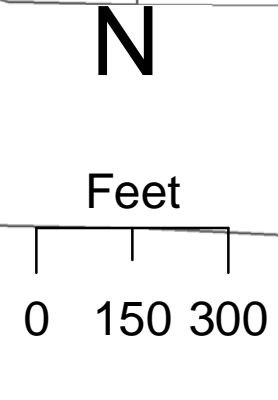
Ligon Street
Build Bridge to North

Western Blvd
Double Crossover Diamond
(Repeated from Part 1 for
Slope Stake Continuity)

No impact to pond due to Proposed Retaining Wall

Legend

- I440_ProposedStreamChannel
- Design3_StreamImpactsClip
- Design3_StreamImpactsClipToEasements
- Design3_Culverts_Proposed Major Culverts
- Design3_Easements_Plus25ftBuffer**
- Prop Easement Construction
- Prop Easement Permanent Drainage
- Proposed Cut Line
- Proposed Fill Line
- Proposed Transition Line
- Design3_Slopestakes_Plus25ftBuffer
- Surveyed Streams/Wetlands/Ponds**
- Delineated Streams
- Delineated Wetlands
- Delineated Open Waters



**DESIGN ALTERNATIVE 3
(SLIGHT DETOUR)
STREAM/WETLAND IMPACTS**



Legend

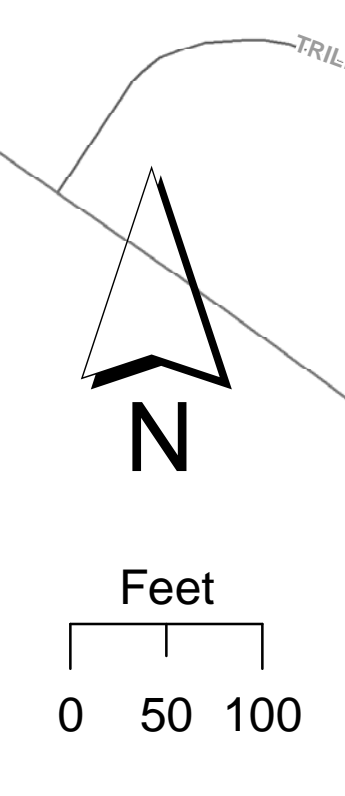
- Greenway_StreamImpactsClip
- Greenway_StreamImpactsClipToEasements
- Greenway_WetlandsImpactAreaClip
- Greenway_WetlandsImpactEasementAreaClip

GreenwayOption_AddtI

- Prop Conc 4in Sidewalk
- Prop Easement Construction
- Prop Horiz. Alignment (Potential Greenway Relocation)
- Surveyed Streams
- Rivers&Streams_CropToU2719_OutsideOfStudyArea
- Existing Greenways
- Greenway_Slopestakes_Plus25ftBuffer
- Greenway_Easement_Plus25ftBuffer

Surveyed Streams/Wetlands/Ponds

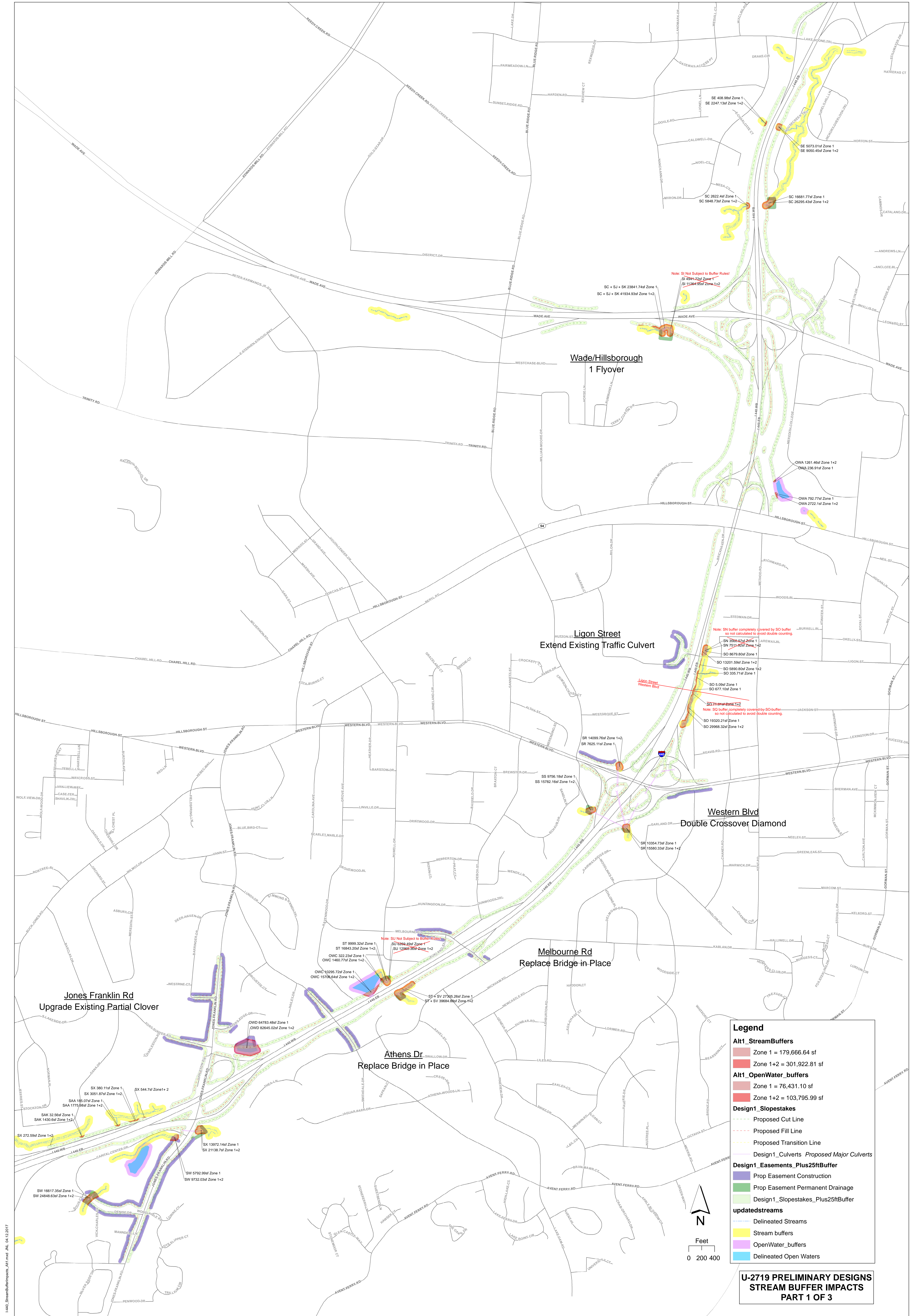
- Delineated Streams
- Delineated Wetlands
- Delineated Open Waters



**U-2719 PRELIMINARY DESIGNS
STREAM/WETLAND IMPACTS
REEDY CREEK GREENWAY
POTENTIAL RELOCATION OPTION**

Memorandum

RIPARIAN BUFFER IMPACT MAPS



**Wade/Hillsborough
1 Flyover**

**Ligon Street
Extend Existing Traffic Culvert**

**Western Blvd
Double Crossover Diamond**

**Melbourne Rd
Replace Bridge in Place**

**Athens Dr
Replace Bridge in Place**

**Jones Franklin Rd
Upgrade Existing Partial Clover**

Legend

Alt1_StreamBuffers

- Zone 1 = 179,666.64 sf
- Zone 1+2 = 301,922.81 sf

Alt1_OpenWater_buffers

- Zone 1 = 76,431.10 sf
- Zone 1+2 = 103,795.99 sf

Design1_Slopestakes

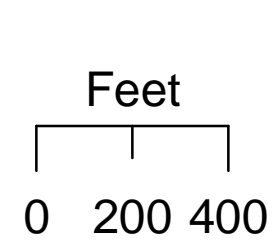
- Proposed Cut Line
- Proposed Fill Line
- Proposed Transition Line
- Design1_Culverts Proposed Major Culverts

Design1_Easements_Plus25ftBuffer

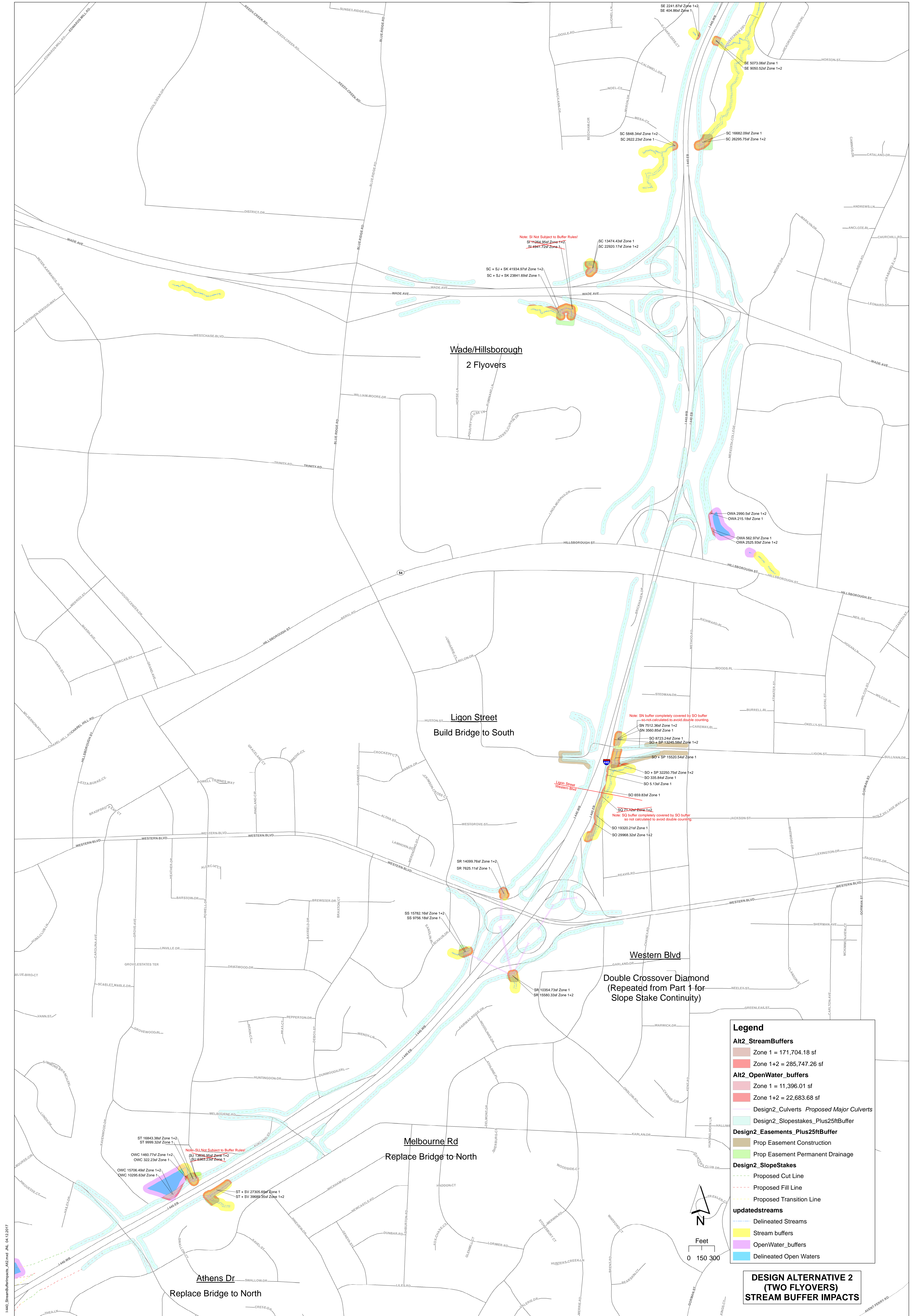
- Prop Easement Construction
- Prop Easement Permanent Drainage
- Design1_Slopestakes_Plus25ftBuffer

updatedstreams

- Delineated Streams
- Stream buffers
- OpenWater_buffers
- Delineated Open Waters



**U-2719 PRELIMINARY DESIGNS
STREAM BUFFER IMPACTS
PART 1 OF 3**



Wade/Hillsborough
2 Flyovers

Ligon Street
Build Bridge to South

Western Blvd
Double Crossover Diamond
(Repeated from Part 1 for
Slope Stake Continuity)

Melbourne Rd
Replace Bridge to North

Athens Dr
Replace Bridge to North

Legend

Alt2_StreamBuffers

- Zone 1 = 171,704.18 sf
- Zone 1+2 = 285,747.26 sf

Alt2_OpenWater_buffers

- Zone 1 = 11,396.01 sf
- Zone 1+2 = 22,683.68 sf

Design2_Culverts_Proposed Major Culverts

- Design2_Slopestakes_Plus25ftBuffer

Design2_Easements_Plus25ftBuffer

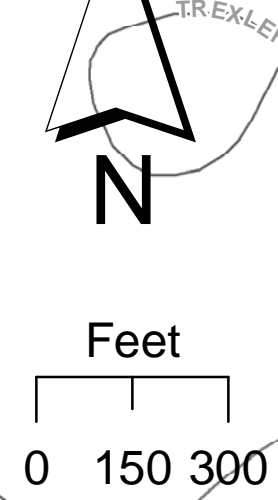
- Prop Easement Construction
- Prop Easement Permanent Drainage

Design2_SlopeStakes

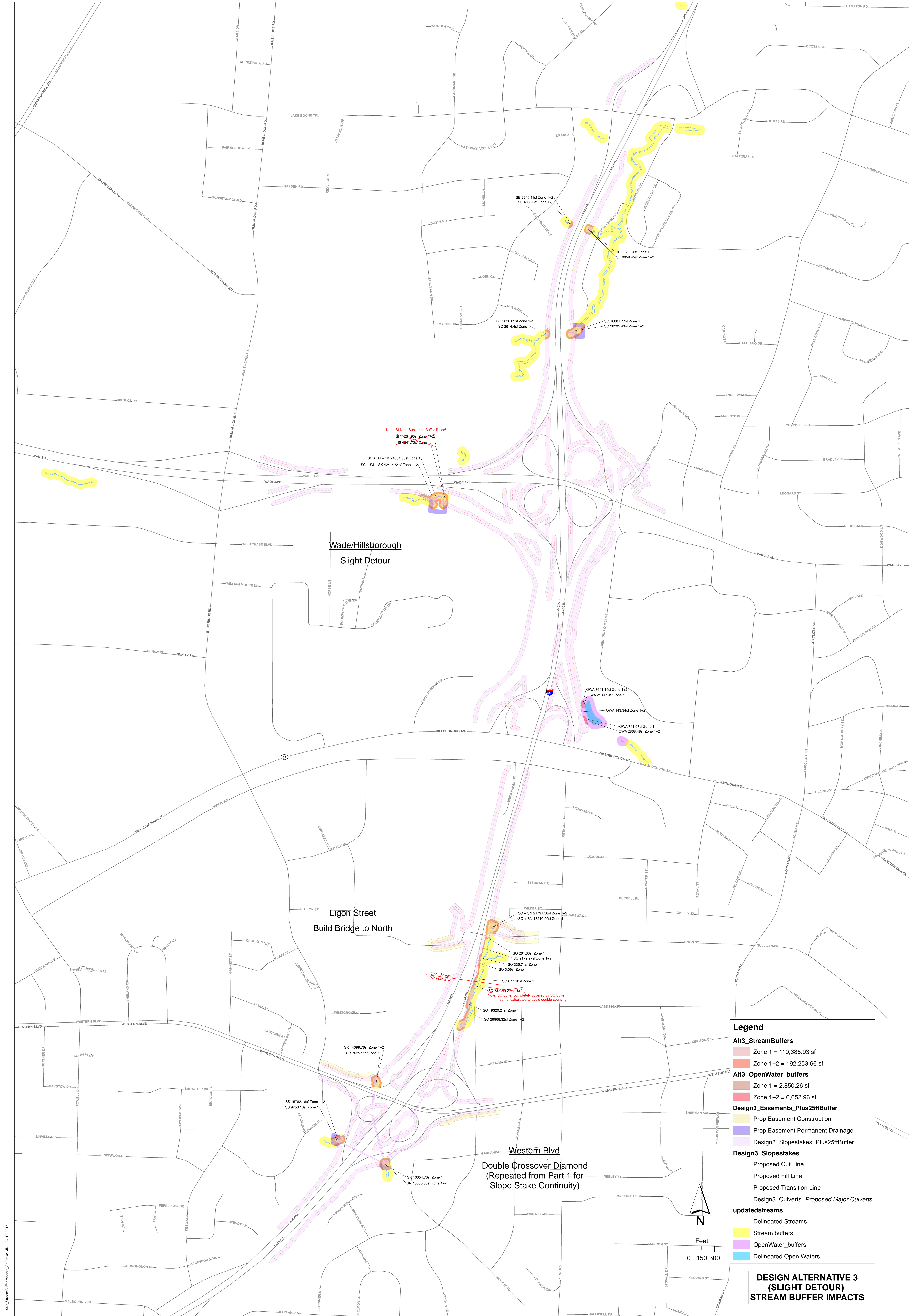
- Proposed Cut Line
- Proposed Fill Line
- Proposed Transition Line

updatedstreams

- Delineated Streams
- Stream buffers
- OpenWater_buffers
- Delineated Open Waters



**DESIGN ALTERNATIVE 2
(TWO FLYOVERS)
STREAM BUFFER IMPACTS**



Note: SI Not Subject to Buffer Rules!
 SI 11264 95sf Zone 1+2
 SI 4941 72sf Zone 1

SC + SJ = SK 34061.30sf Zone 1
 SC + SJ = SK 42414.54sf Zone 1+2

**Wade/Hillsborough
 Slight Detour**

**Ligon Street
 Build Bridge to North**

**Western Blvd
 Double Crossover Diamond
 (Repeated from Part 1 for
 Slope Stake Continuity)**

Legend

Alt3_StreamBuffers

- Zone 1 = 110,385.93 sf
- Zone 1+2 = 192,253.66 sf

Alt3_OpenWater_buffers

- Zone 1 = 2,850.26 sf
- Zone 1+2 = 6,652.96 sf

Design3_Easements_Plus25ftBuffer

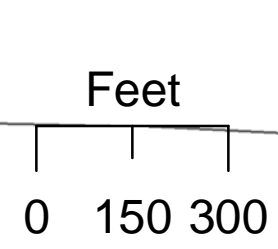
- Prop Easement Construction
- Prop Easement Permanent Drainage
- Design3_Slopestakes_Plus25ftBuffer

Design3_Slopestakes

- Proposed Cut Line
- Proposed Fill Line
- Proposed Transition Line
- Design3_Culverts Proposed Major Culverts

updatedstreams

- Delineated Streams
- Stream buffers
- OpenWater_buffers
- Delineated Open Waters



**DESIGN ALTERNATIVE 3
 (SLIGHT DETOUR)
 STREAM BUFFER IMPACTS**



Legend

Greenway StreamBuffers

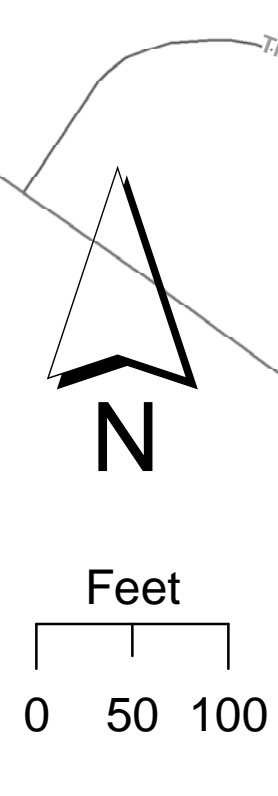
- Zone 1 = 23,758.47 sf
- Zone 1+2 = 42,632.90 sf

GreenwayOption_AddtI

- Prop Conc 4in Sidewalk
- Prop Easement Construction
- Prop Horiz. Alignment (Potential Greenway Relocation)

updatedstreams

- Rivers&Streams_CropToU2719_OutsideOfStudyArea
- Existing Greenways
- Greenway_Slopestakes_Plus25ftBuffer
- Greenway_Easement_Plus25ftBuffer
- Delineated Streams
- JD Streams for Greenway
- Stream Buffers
- Delineated Open Waters



**U-2719 PRELIMINARY DESIGNS
STREAM BUFFER IMPACTS
REEDY CREEK GREENWAY
POTENTIAL RELOCATION OPTION**