

# RS&H Memorandum

TO: North Florida TPO

FROM: RS&H Team

DATE: January 2, 2019

RE: Task 2: **Transportation Infrastructure Flooding Evaluation**  
NFTPO - Resiliency & Vulnerability Assessment (5.22)

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This memorandum describes the methodology for mapping North Florida transportation infrastructure impacted by several types of flooding events. The methodology section describes the surface network links considered and seven scenarios for the year 2045 (Table 1). The Maps section shows roadway segments that may experience inundation or storm surge impacts in the North Florida region using several available inundation model datasets.

Each event is accompanied by assumptions, identified impact locations and the number of segments impacted by roadway types. As other hazards and regional risks assessment are continually updated, this information can be used to further refine the current state of transportation resiliency planning for the North Florida region.

**Table 1: Considered Events and Scenarios Mapped**

Event	Scenario
Sea Level Rise (SLR)	Medium SLR
	High SLR
Inland Flooding	100-year flood
	500-year flood
Storm Surge	Category 1 Storm
	Category 3 Storm
	Category 5 Storm

## Methodology

### Surface Network

The surface network is composed of North Florida roads on the FDOT RCI dataset (Roadway Characteristics Inventory) and the network model features for the future First Coast Expressway. The RCI classification includes all segments with a functional classification of arterial or collector, as well as a few local roads that meet the RCI criteria. SIS rail network links, as defined by FDOT, are depicted on maps. All functionally classified arterials and collectors may be found on the State Highway

System (SHS), county road system and city street network. However, most off-system alignments functionally classified as local are excluded. Local roads are only required to be in RCI if one of the following instances occurs:

- Construction/reconstruction records in the Department’s Financial Management (FM) System
- Roadways with bridges or railroad crossings
- On or proposed for the NHS
- On or proposed for the Florida Freight System or
- On or proposed for the Strategic Intermodal System (SIS) or SIS connector

In this study, facilities were grouped in four types: *interstate* (Arterial-Interstate); *arterial* (all non-interstate arterials); *collector*; and *local* (as defined by RCI). The total network for the North Florida TPO region included 2,068 centerline miles of roads.

Each impacted segment received a classification of *low*, *medium* or *high* impact. This classification is based on largest reported annual average daily traffic (AADT) in the segment. Using this method, the impact level is based on the volume of people and goods traversing the segment: low, medium and high (see Table 2). The rail network, while projected on maps, was not evaluated under these conditions.

**Table 2: Traffic Impact Measures**

Traffic Impact	AADT
Low	<10,000
Medium	10,000 – 50,000
High	50,000+

### Sea Level Rise

Sea level rise impacts are presented by total length of centerline miles measured within the Sea Level Rise zone, as quantified by the UF GeoPlan Sea Level Scenario Sketch Planning Tool transportation infrastructure layers. The applicable scenarios are the *USACE Intermediate Rate for 2013 curve* (C2MHHW40FT) and the *USACE High Rate for 2013 curve* (C4MHHW40FT) on the dataset. These values, converted to miles, are presented on Table 3, under “Impacted.” This table also shows the percentage (by length) of impacted facilities. Total Network values are also presented.

Due to the nature of the roadway dataset, segments larger than the measured impact are shown maps. For example, a 1-mile segment can have a 50 ft impact reflected along the entire length of the segment. Due to this limitation, an ‘Impacts as shown on Map’ column estimates the length of the segments as indicated on the Sea Level Rise data maps. These segments, often longer than the measured area of impact, show potential impacts leading to intersecting roads.

**Table 3: Sea Level Rise Impacts on Roadway**

Sea Level Rise	Total Length (miles)	USACE Medium Estimate			USACE High Estimate		
		Impacted (miles)	Segments Impacted (%)	Impacted as shown on Map	Impacted (miles)	Segments Impacted (%)	Impacted as shown on Map
Interstate	167.9	<0.1	<0.1%	10	<0.1	<0.1%	10
Arterial	796.7	1.3	0.2%	110	1.5	0.2%	110
Collector	933.3	0.1	<0.1%	40	0.6	0.1%	60
Local	170.0	<0.1	<0.1%	10	0.2	0.1%	30
Total Network	2,067.9	1.4	0.1%	160	2.4	0.1%	210

Source: GeoPlan Sea Level Scenario Sketch Planning Tool (Impacted)

### Inland Flooding

Inland flooding impacts are presented by total length of centerline miles measured within the flood risk insurance zones, as quantified by the Sea Level Scenario Sketch Planning Tool. The applicable scenarios are the *100-year floodplain (DFIM100FT)* and *500-year floodplain (DFIRM500FT)* from *Federal Emergency Management Agency (FEMA) Digital Flood Rate Insurance Maps*. Please refer to FEMA for an in-depth explanation on insurance risk zones and input data. Centerline miles of impact are presented on Table 4, under "Impacted." This table also shows the percentage (by length) of impacted facilities. Total Network values are also presented.

Like Sea Level Rise maps, an 'Impacts as shown on Map' column quantifies the length of the segments as presented graphically on the Inland Flooding data maps.

**Table 4: Inland Flooding Impacts on Roadway**

FIRM Base Flood	Total Length (miles)	100-Year Flood			500-Year Flood		
		Impacted (miles)	Segments Impacted (%)	Impacted as shown on Map	Impacted (miles)	Segments Impacted (%)	Impacted as shown on Map
Interstate	167.9	7.9	4.7%	140	9.8	5.8%	170
Arterial	796.7	93.5	11.7%	720	140.7	17.7%	740
Collector	933.3	98.8	10.6%	700	135.7	14.5%	760
Local	170.0	20.1	11.8%	150	25.1	14.7%	160
Total Network	2,067.9	220.3	10.7%	1,710	311.2	15.1%	1,830

Source: GeoPlan Sea Level Scenario Sketch Planning Tool (Impacted)

### Storm Surge

Roadway storm surge impacts are similarly quantified by total length of centerline miles for the respective *Category 1, 3 and 5* scenarios. The applicable scenarios are the 2017 Florida Department of Emergency Management (FDEM) *Category 1* storm surge zones from Statewide Regional Evacuation Studies (C1MHHW50FT), the FDEM *Category 3* storm surge zones (C3MHHW50FT), and the FDEM *Category 5* storm surge zones (C5MHHW50FT). Values for each scenario are presented on Table 5 to 7 below, under “Impacted.” Each table also shows the percentage (by length) of impacted facilities. Total Network values by facility and scenario are also presented.

As expected, the network reflects an increase in impacted roadways as the severity of the storm increases. Nonetheless, this relationship is not linear. All facility types across the North Florida region would be expected to have some segments impacted, with non-interstate arterials and collectors being the largest types in a *Category 1* storm. All facilities would have significant areas of impacts for the *Category 3 and Category 5* scenarios.

For comparison, while a *Category 1* storm could have 30.2 miles of impacted network, a *Category 3* could have roughly 309.1 miles of impact and a *Category 5* with 660.3 miles of impact—comparable to +20 *Category 1* storms across the region.

**Table 5: Storm Surge Impacts on Roadway – Category 1 Storm**

<b>Storm Surge</b>	<b>Category 1</b>			
Facility Type	Total Length (miles)	Impacted (miles)	Segments Impacted (%)	Impacted as shown on Map
Interstate	167.9	2.7	1.6%	10
Arterial	796.7	18.9	2.4%	30
Collector	933.3	6.7	0.7%	10
Local	170.0	1.8	1.0%	10
Total Network	2,067.9	30.2	1.5%	60

Source: GeoPlan Sea Level Scenario Sketch Planning Tool (Impacted)

**Table 6: Storm Surge Impacts on Roadway – Category 3 Storm**

<b>Storm Surge</b>	<b>Category 3</b>			
Facility Type	Total Length (miles)	Impacted (miles)	Segments Impacted (%)	Impacted as shown on Map
Interstate	167.9	12.7	7.5%	20
Arterial	796.7	152.4	19.1%	160
Collector	933.3	119.9	12.8%	130
Local	170.0	24.1	14.2%	30
Total Network	2,067.9	309.1	14.9%	340

Source: GeoPlan Sea Level Scenario Sketch Planning Tool (Impacted)

**Table 7: Storm Surge Impacts on Roadway – Category 5 Storm**

<b>Storm Surge</b>	<b>Category 5</b>			
Facility Type	Total Length (miles)	Impacted (miles)	Segments Impacted (%)	Impacted as shown on Map
Interstate	167.9	29.6	17.6%	40
Arterial	796.7	286.4	35.9%	290
Collector	933.3	287.2	30.8%	290
Local	170.0	57.1	33.6%	60
Total Network	2,067.9	660.3	31.9%	680

Source: GeoPlan Sea Level Scenario Sketch Planning Tool (Impacted)

## Maps

### Sea Level Rise

As shown in Figure 1 and Figure 2, models indicate some impact across all type of facilities due to sea level rise. Using the USACE model, the impact can range from 1.4 miles to 2.4 miles of infrastructure. Duval, St. Johns and Nassau counties may appear to be affected by the USACE medium and high estimate curves. As expected, areas near the coast and the St Johns River are more likely to receive some impacts. Areas of concern include SR-105 and I-95 on Duval County, SR-13 and A1A in St. Johns County, and SR-200 in Nassau County. Altogether, less than 1 percent of the network studied overlap both sea level rise models.

### Inland Flooding

Figure 3 and Figure 4 show the 100-Year and 500-Year flood risk insurance area over the surface network. Using DFIRM locations, the impacted area ranges from 220.3 to 311.2 centerline miles. All counties appear to be similarly affected by both inland flooding risk models. Roadways near the coast, as well as those crossing over creeks and other water bodies (bridges & bulkheads), appear to be more susceptible to impacts. Areas with higher insurance flood risk include segments of all major interstates (I-95, I-295, and I-10). Due to non-continuous nature of impacted locations along the network, a substantial number of segments are fully highlighted on maps. Overall, 10.7 percent of the network areas are designated at risk of a 100-year flood and 15.1 percent of a 500-year flood.

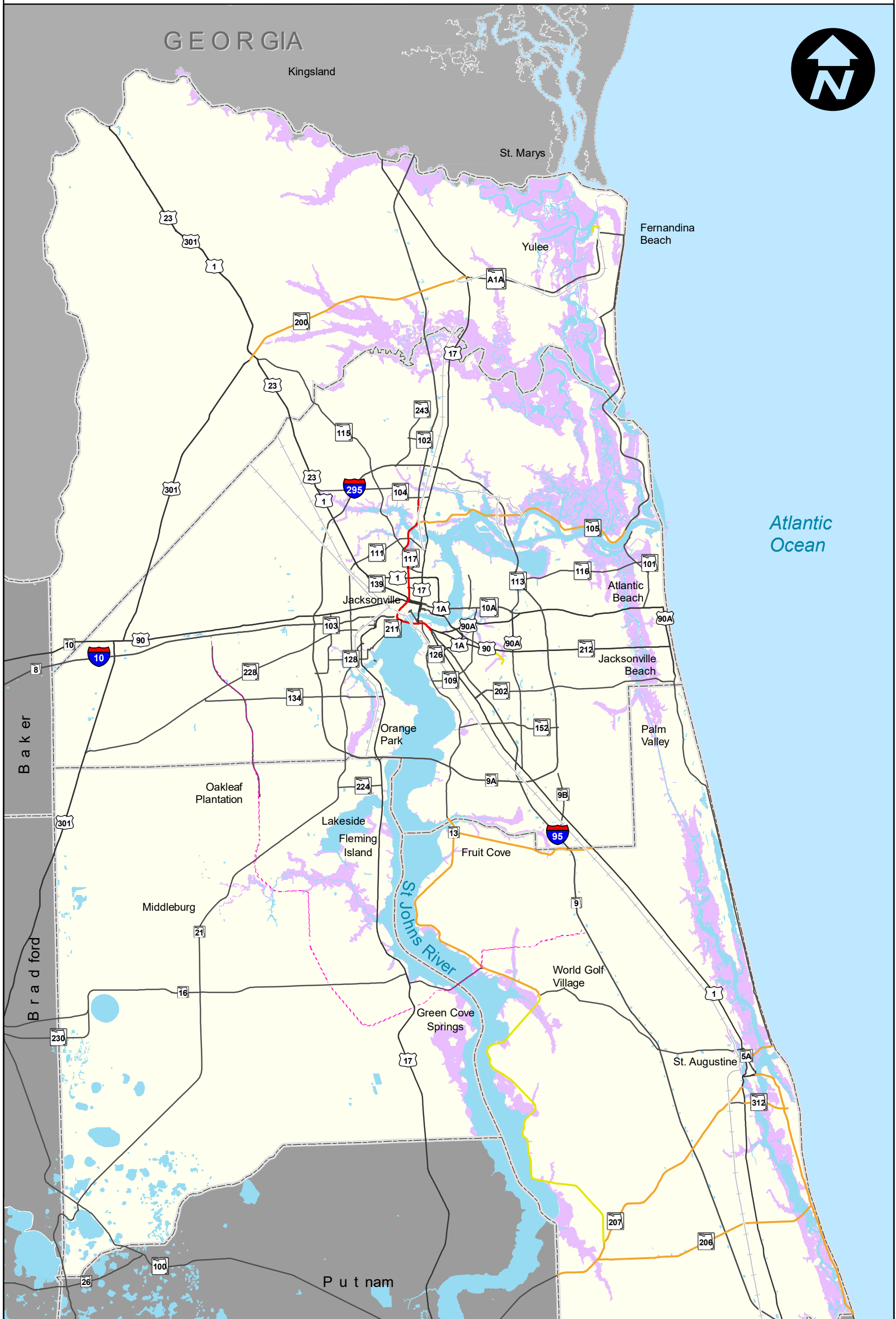
### Storm Surge

Figures 5, 6, and 7 show the *Category 1, 3, and 5* storm surge scenarios over the surface network. All counties appear to be affected by in each scenario, in particularly Duval County near the Jacksonville Beaches, St. Johns County near St. Augustine, and Nassau County near Fernandina Beach. The effects of the First Coast Expressway (FCE) within Clay County are not available or quantified due to its existing construction phase. However, in subsequent evaluation phases, the FCE can be evaluated but will require design level elevation information, for both Clay and St. Johns counties. Across the region, roadways near the coast, the Intracoastal Waterway, and the St. Johns River, appear to be more susceptible to impacts, as expected. Due to non-continuous nature of impacted locations along the network, a substantial number of segments appear to be fully highlighted on maps, but are in fact shorter spans, in most cases of less than half a mile of impacts.

### Next Steps

In Phase II of the *Resiliency & Vulnerability Assessment* evaluation, to be undertaken during the 2045 LRTP update, additional details and criteria can be evaluated. It is recognized that the level of evaluation varies by area and conditions. However, this evaluation intends to examine tools for consideration in developing the LRTP with project information that considers the overall potential impacts of flooding and storm impacts. In Phase II, a series of roadway system elements will be included (Cost Feasible/Needs), along with other potential transportation system elements such as railroads, airports, ports and major private sector facilities (distribution centers, intermodal yards, spaceport, etc.).

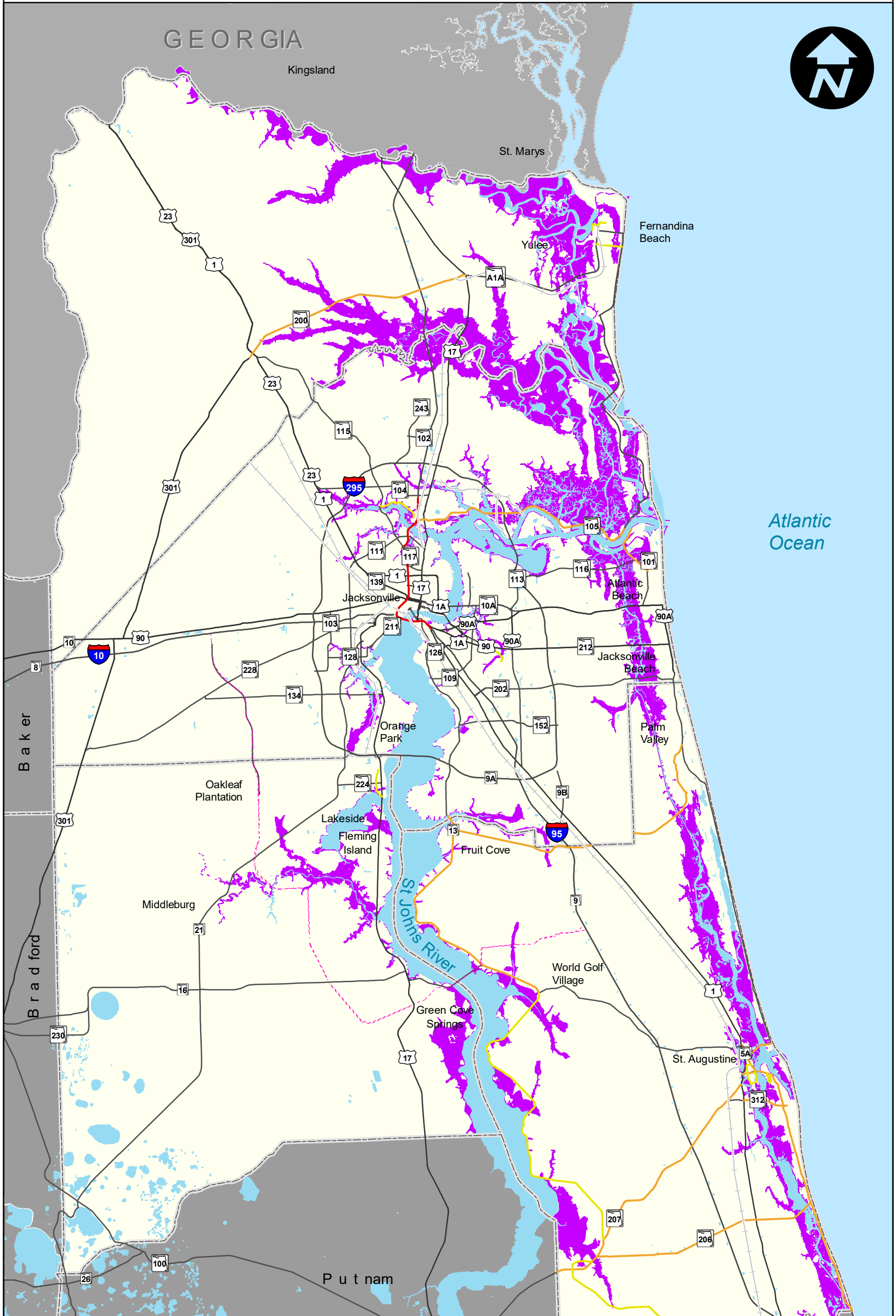
Figure 1: Sea Level Rise - USACE Intermediate Projection Map



<b>Legend</b>		<b>Traffic Impact (AADT)</b>	<b>Climate Impact</b>
North Florida MPO	RCI Road Network	Low	USACE Sea Level Rise Intermediate Projection (0.23 ft Mayport, FL)
County Boundary	First Coast Expressway	Medium	
Water Bodies	SIS Rail Network	High	

Notes: Impacts not evaluated for Rail or planned FCX. See narrative for measured impacts and climate data. Highlighted segments may extend beyond area of impact. Sources: UF GeoPlan Center, North Florida TPO, FDOT TDA.

Figure 2: Sea Level Rise - USACE High Projection Map

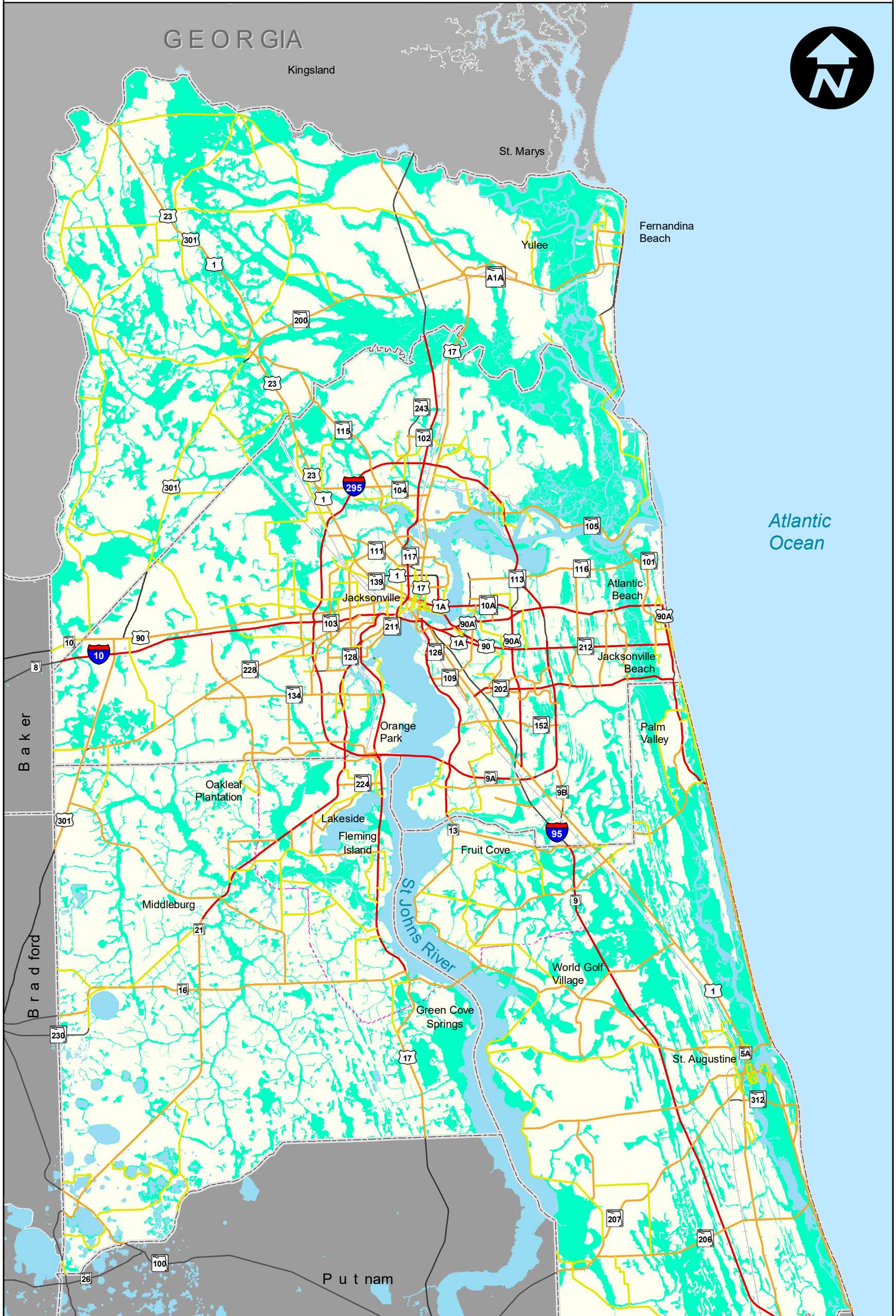


<b>Legend</b>		<b>Traffic Impact (AADT)</b>	<b>Climate Impact</b>
North Florida MPO	RCI Road Network	Low	USACE Sea Level Rise High Projection (1.17 ft Mayport, FL)
County Boundary	First Coast Expressway	Medium	
Water Bodies	SIS Rail Network	High	

Notes: Impacts not evaluated for Rail or planned FCX. See narrative for measured impacts and climate data. Highlighted segments may extend beyond area of impact. Sources: UF GeoPlan Center, North Florida TPO, FDOT TDA.



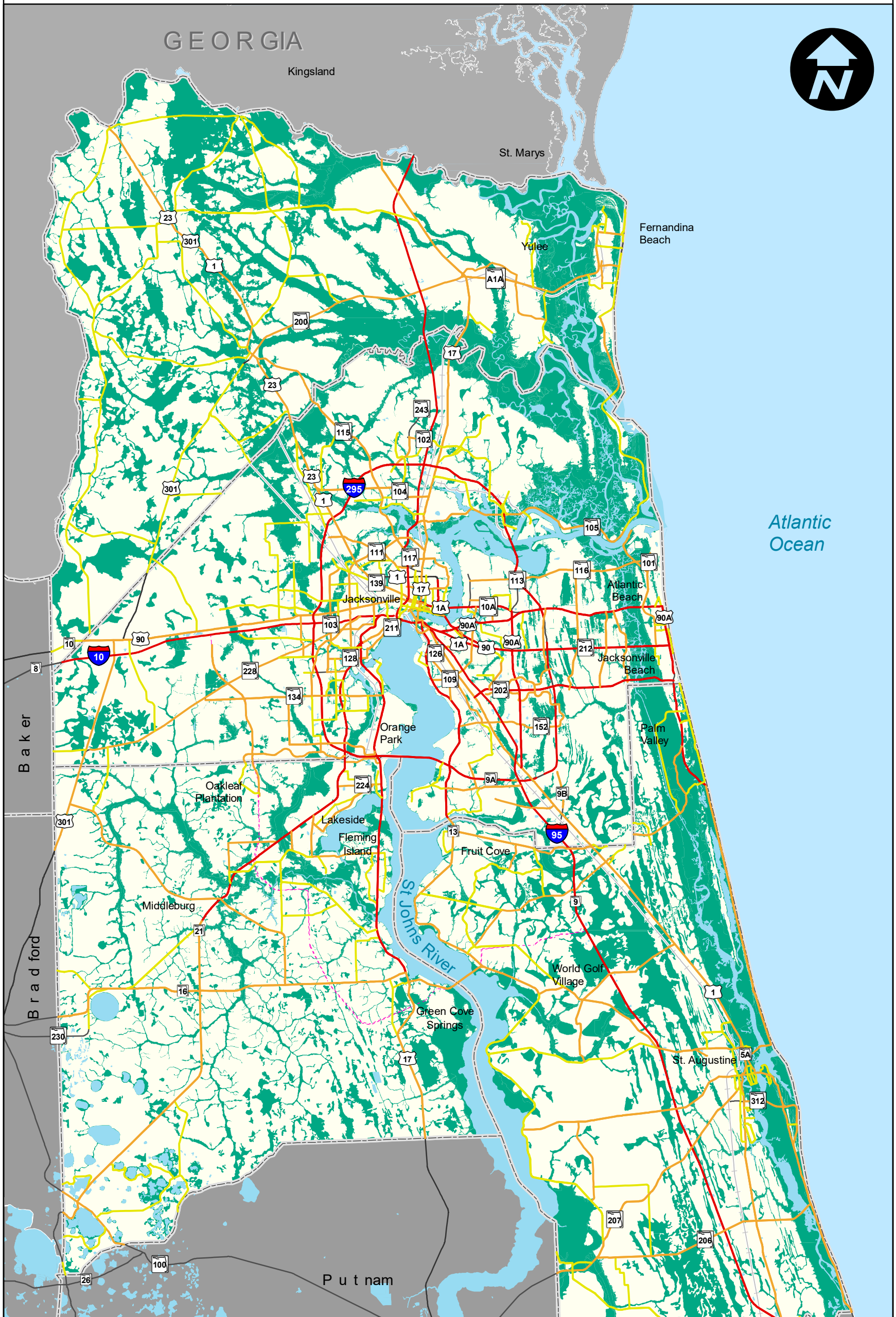
Figure 3: Inland Flooding - FEMA 100-Year Floodplain Map



<b>Legend</b>		<b>Traffic Impact (AADT)</b>	<b>Climate Impact</b>
North Florida MPO	RCI Road Network	Low	FEMA 100-Year Floodplain
County Boundary	First Coast Expressway	Medium	
Water Bodies	SIS Rail Network	High	

Notes: Impacts not evaluated for Rail or planned FCX. See narrative for measured impacts and climate data. Highlighted segments may extend beyond area of impact. Sources: UF GeoPlan Center, FEMA, North Florida TPO, FDOT TDA.

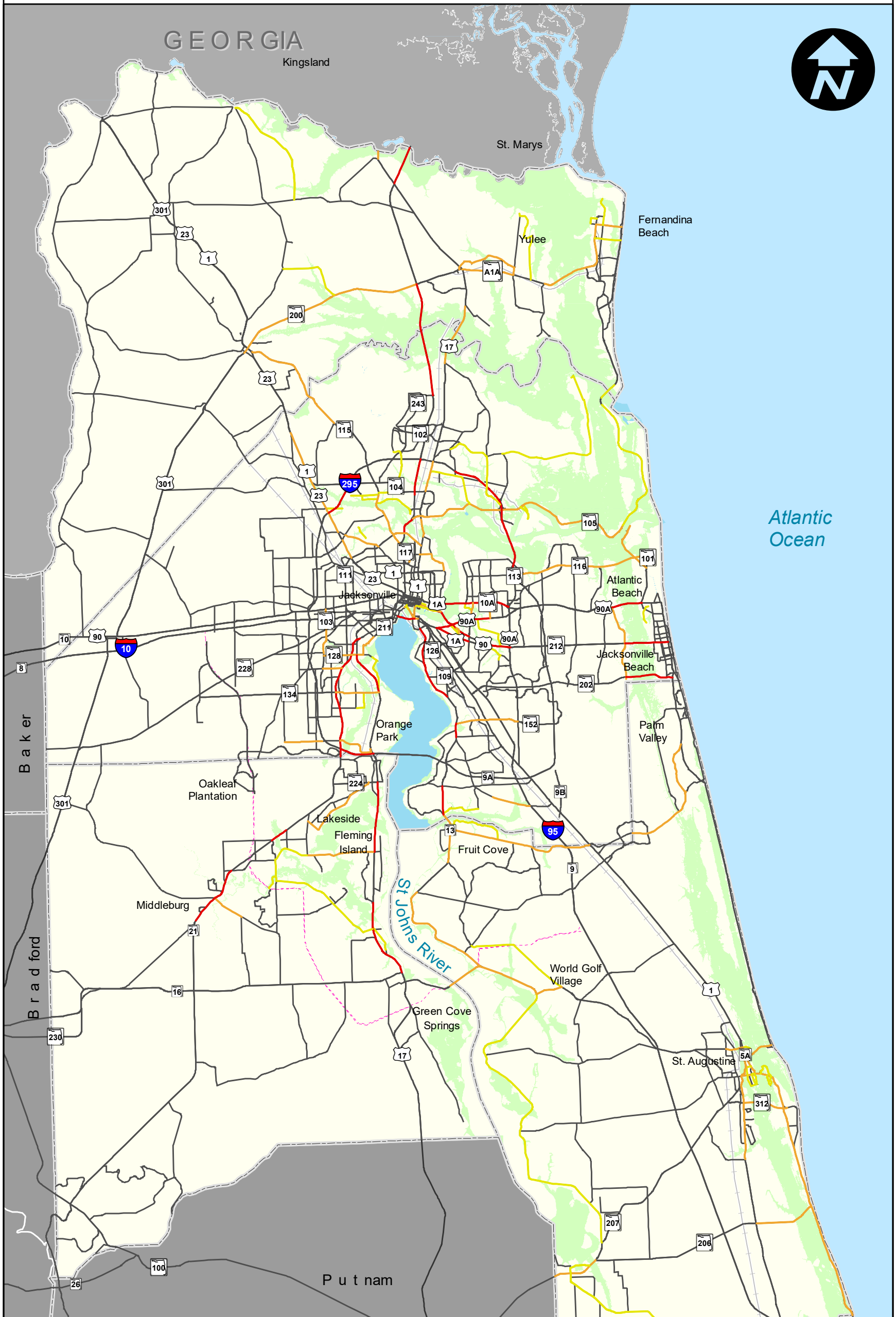
Figure 4: Inland Flooding - FEMA 500-Year Floodplain Map



<b>Legend</b>		<b>Traffic Impact (AADT)</b>	<b>Climate Impact</b>
North Florida MPO	RCI Road Network	Low	FEMA 500-Year Floodplain
County Boundary	First Coast Expressway	Medium	
Water Bodies	SIS Rail Network	High	

Notes: Impacts not evaluated for Rail or planned FCX. See narrative for measured impacts and climate data. Highlighted segments may extend beyond area of impact. Sources: UF GeoPlan Center, FEMA, North Florida TPO, FDOT TDA.

Figure 5: Storm Surge - Category 1 Storm Map

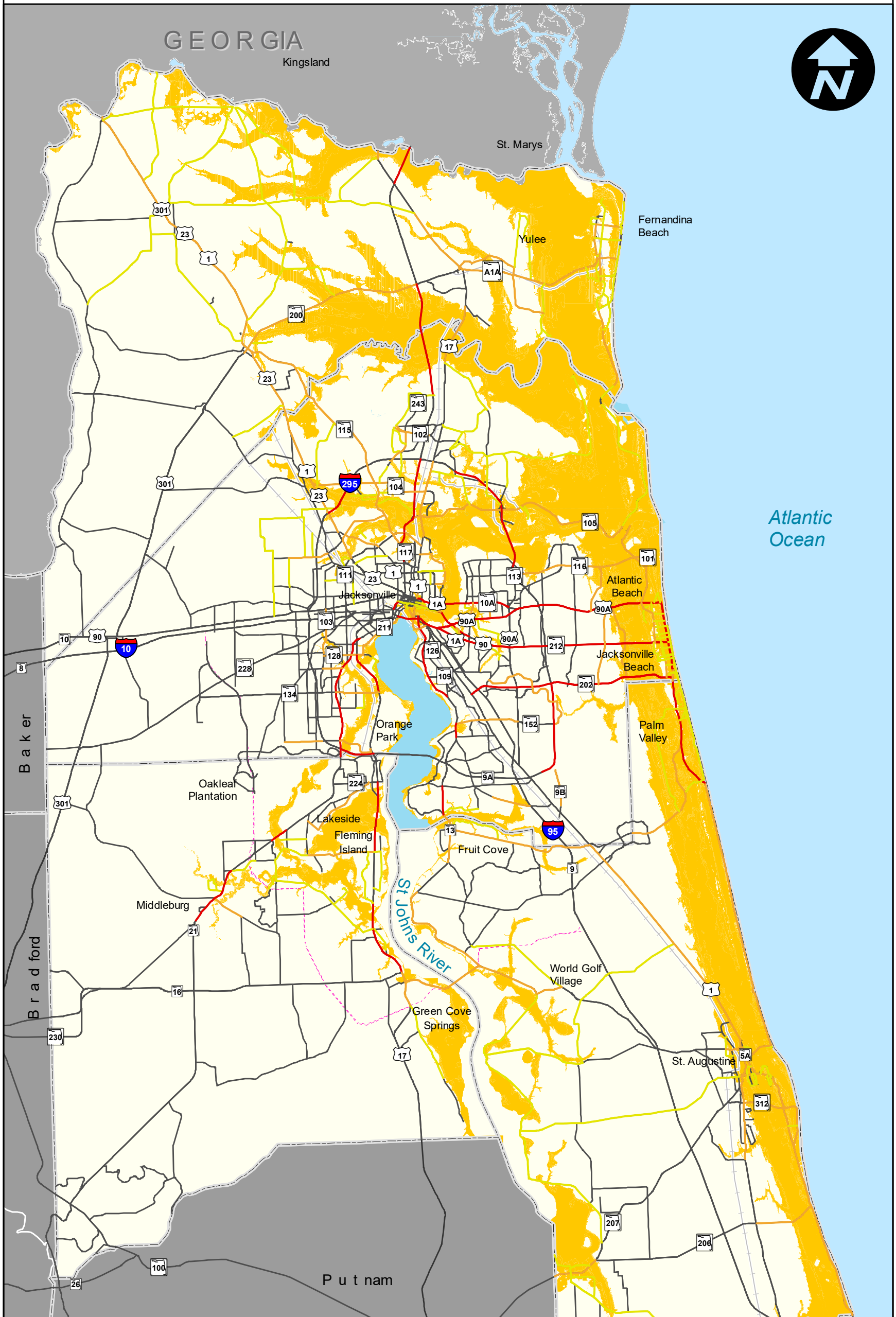


**Legend**

- |                   |                        |        |                              |
|-------------------|------------------------|--------|------------------------------|
| North Florida MPO | RCI Road Network       | Low    | Category 1 Storm Surge Zones |
| County Boundary   | First Coast Expressway | Medium |                              |
| Water Bodies      | SIS Rail Network       | High   |                              |

Notes: Impacts not evaluated for Rail or planned FCX. See narrative for measured impacts and climate data. Highlighted segments may extend beyond area of impact. Sources: UF GeoPlan Center, Florida Division of Emergency Management, North Florida TPO, FDOT TDA.

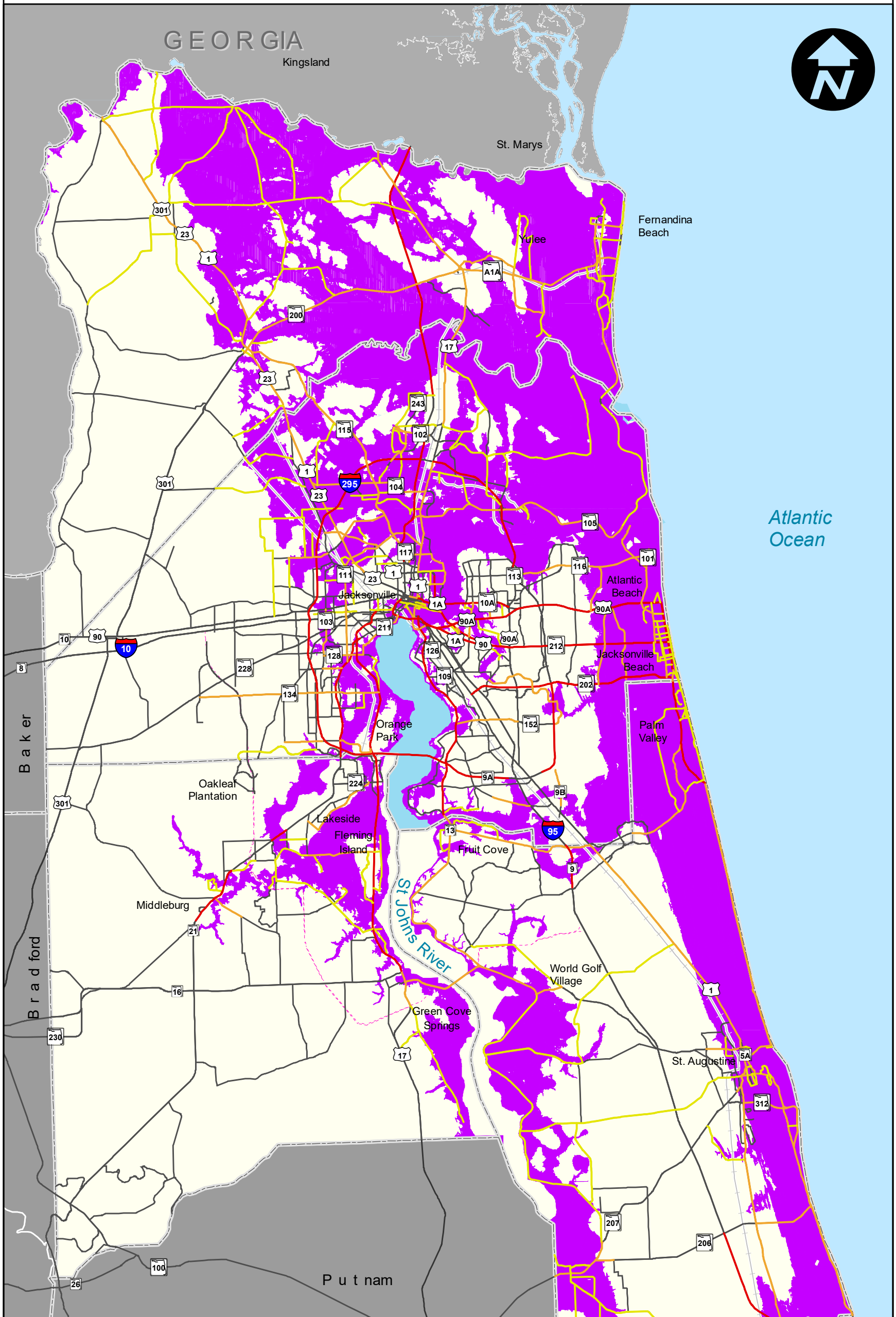
Figure 6: Storm Surge - Category 3 Storm Map



<b>Legend</b>		<b>Traffic Impact (AADT)</b>	<b>Climate Impact</b>
North Florida MPO	RCI Road Network	Low	Category 3 Storm Surge Zones
County Boundary	First Coast Expressway	Medium	
Water Bodies	SIS Rail Network	High	

Notes: Impacts not evaluated for Rail or planned FCX. See narrative for measured impacts and climate data. Highlighted segments may extend beyond area of impact. Sources: UF GeoPlan Center, Florida Division of Emergency Management, North Florida TPO, FDOT TDA.

Figure 7: Storm Surge - Category 5 Storm Map



**Legend**

- |                   |                        |        |                              |
|-------------------|------------------------|--------|------------------------------|
| North Florida MPO | RCI Road Network       | Low    | Category 5 Storm Surge Zones |
| County Boundary   | First Coast Expressway | Medium |                              |
| Water Bodies      | SIS Rail Network       | High   |                              |

Notes: Impacts not evaluated for Rail or planned FCX. See narrative for measured impacts and climate data. Highlighted segments may extend beyond area of impact. Sources: UF GeoPlan Center, Florida Division of Emergency Management, North Florida TPO, FDOT TDA.