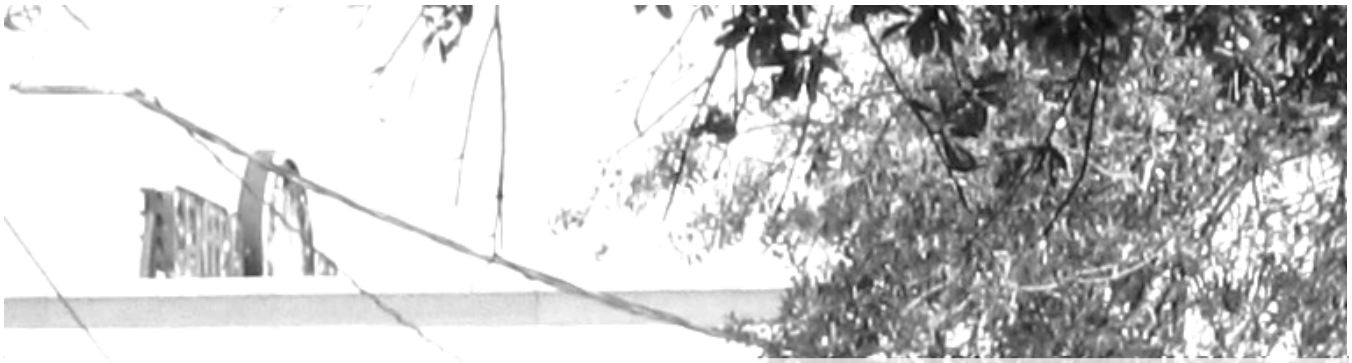


Tampa Historic Streetcar Extension Study

Prepared for

Hillsborough Area Regional Transit Authority

Prepared by

HDR with assistance from LTK Engineering Services

December 2014

I. INTRODUCTION

The Tampa Historic Streetcar Extension Study is being undertaken by the Hillsborough Area Regional Transit Authority (HART) to explore the general feasibility of constructing a streetcar extension through the heart of downtown Tampa to the Marion Transit Center and to identify improvements required to upgrade the existing system to accommodate modern streetcar or light rail transit vehicles. This study report was prepared on HART's behalf by HDR with assistance from LTK Engineering Services.

For the extension to Marion Transit Center, the study focuses on the physical feasibility and conceptual costs of extending streetcar service from the existing terminus at Franklin and Whiting Streets north along one or a combination of north-south streets—Ashley Drive, Tampa Street-Florida Avenue, Franklin Street, and the Marion Transitway. Extension scenarios were prepared, discussed with key stakeholders, and evaluated to identify benefits, costs, and physical constraints of each. Although potential further extensions of the system to serve destinations to the west, north, or east were discussed during stakeholder meetings, this study is limited to extension alternatives to the vicinity of the Marion Transit Center. An assessment of additional extensions was not undertaken as part of this study.

This study also identifies improvements required to upgrade the existing system to accommodate modern streetcar or light rail vehicles. This portion of the study resulted in the identification of a series of improvements required to support higher capacity transit vehicles, including the reconstruction of several horizontal curves, reconfiguration of stations, upgrade of power sources and overhead power systems, and reconstruction or replacement of the existing maintenance and storage facility.

The study offers a conceptual level assessment of extension and improvement scenarios to support policy-making and provide the basis for more detailed analysis. The study does not include estimates of potential ridership, estimates of operating and maintenance costs, benefit-costs analyses, or other detailed assessments of scenarios. In addition, this study does not result in the selection of a preferred alignment alternative or provide specific recommendations for enhancing streetcar technology. Further evaluation is required to determine the most effective and economical solutions to advance local mobility, livability, and economic development goals.

II. PREVIOUS STUDIES

Several previous studies have evaluated options for fixed rail transit serving Downtown Tampa, including options to make the streetcar system a more vital part of the local and regional transportation network.

Studies completed since revenue service was started on the initial segment of the streetcar line have explored alternatives for the following:

- Extending streetcar into the heart of Downtown and north to the Marion Transit Center;
- Converting the existing system to run higher capacity vehicles and extending the system to destinations in Westshore, the USF Area, and to Ybor City via alignments along Palm Avenue and Nuccio Parkway.
- Introducing regional Commuter Rail or light rail service connecting downtown to regional destinations in Westshore, the USF Area, and Brandon.

The most recent study addressing improvements and extensions to the existing streetcar system is the *Transit Assets and Opportunities Study* completed by the Hillsborough Metropolitan Planning Organization (MPO) in cooperation with the Tampa Downtown Partnership. Completed in September 2014, the study explored opportunities to leverage existing transit assets and focus on the feasibility of using lower cost forms of fixed-guideway transit to serve key activity centers in the region.

The study looked at the potential use of existing freight rail lines, as well as Interstate highway right-of-way specifically reserved for transit, and recommended repurposing the existing streetcar system to make it faster and more effective for day-to-day travel. The study resulted in recommendations to make an improved and expanded streetcar system part of a larger regional system designed to link the three largest job centers in Hillsborough County—Downtown, Westshore, and the USF Area—and ultimately connect Tampa's urban core with the rest of the Tampa Bay region.

The *Transit Assets and Opportunities Study* recommended upgrading the existing streetcar system to accommodate modern streetcar or light rail vehicles, and constructing extensions to the north end of Downtown and eventually to the west to connect to the proposed Westshore Intermodal Center and north along Florida Avenue, Busch Boulevard and 30th Street to serve the USF area.

The *Transit Assets and Opportunities Study* recognized many potential benefits associated with upgrading and extending the existing system, including:

- Improvements to the existing system can better serve existing and planned residential, office, educational, and entertainment destinations along the existing line in Ybor City, the Channel District, South Downtown, and the core of Downtown Tampa.
- An improved and expanded system can serve as the backbone of an expanded urban circulator system connecting existing concentrations of transit-supportive development in greater Downtown Tampa with regional activity centers in Westshore and the USF Area.

- Enhanced transit service can be an attractive and feasible alternative to single-occupancy vehicle travel between downtown, Westshore, and the USF Area and help address projected increases in levels of congestion along key regional corridors
- The potential for incremental improvement and extension to the existing allows for service upgrades and extensions as demand warrants.

III. EXTENSION SCENARIOS

A. Scenario Development

During the course of the study, four scenarios for the northward extension of streetcar service to Marion Transit Center were defined and evaluated. The scenarios, generally following alignments shown in previous studies, explore the potential to extend streetcar from the existing terminus on Franklin Street along Ashley Drive, the Tampa Street and Florida Avenue Pair, Franklin Street, and the Marion Transitway.

Each of the scenarios was developed to meet the general design standards and assumptions presented below:

- ***Use of Existing Vehicles.*** The scenarios assume the existing heritage streetcar vehicles are used on the extension but the extension is designed to allow the introduction of larger vehicle types in the future. Under the scenarios, service on the extension could be introduced without requiring the purchase of new vehicles; upgrades to existing track, stations, or overhead power on all or part of the existing system; or the expansion or replacement of the existing vehicle maintenance and storage facility on 7th Avenue in Ybor City.
- ***Double-Track System.*** To allow for the potential to offer frequent, high capacity service, the scenarios are designed to provide the maximum extent of double-track service feasible given right-of-way constraints and horizontal curvature limits. Double-tracking allows for vehicles to pass along all sections of an alignment, thus avoiding dwell times at stations and passing tracks required in single-track systems, and allows for more frequent service.
- ***Turning Radii for Larger Vehicles.*** The horizontal curve radii of transit tracks shown in each scenario is greater than 66’ (20m) to accommodate the vast majority of modern streetcar vehicle types. Horizontal curve radii of 82’ (25m) were also tested to determine if light rail vehicles could be accommodated. Notes regarding locations where existing right-of-way constraints may impact the use of 82’ (25m) radius horizontal curves are provided in the descriptions of each scenario.
- ***Use of Existing Rights-of-Way.*** The scenarios are designed to maximize the use of existing public rights-of-way and minimize impacts on bike lanes, crosswalks, and sidewalks. Except where noted

below in the scenario descriptions, the scenarios assume new service is located within existing public rights-of-way with limited impact on space dedicated for bicycle and pedestrian use.

- ***Operation in Shared Lanes.*** Each scenario follows an assumption that tracks would be constructed mostly in existing vehicle travel lanes rather than exclusive guideways. Although further study is required to determine the optimal operating context (i.e. running in exclusive guideway vs. mixed traffic), the mixed traffic scenarios allow fixed guideway transit to be introduced without removing, significantly reducing, or encroaching on existing travel lanes, bicycle lanes, on-street parking, driveways, landscaping, and sidewalks. (As shown in Table 1 below, modern streetcar and light rail vehicles widths allow for operation in 11- to 12-foot wide travel lanes.) Further study is required to determine impacts on traffic operations, bike and pedestrian circulation, on-street parking, and driveway access.
- ***Station Improvements.*** For station sites, the scenarios assume stations are located at curb extensions where on-street parking exists or along existing sidewalks where the tracks run along existing curb lines. The level and types of passenger amenities at stations-including shelters, real time passenger information displays, seating, and lighting—is assumed to be similar to what exists at the recently constructed MetroRapid stations along Nebraska Avenue and Fletcher Avenue.
- ***Traction Power System.*** It is also assumed the traction power system for the extension would be designed to support continued use of the existing heritage streetcar vehicles but with the potential to easily convert to an Overhead Contact System (OCS) to run modern streetcar or light rail vehicles with pantographs.
- ***Crossing of CSX Tracks.*** Each scenario assumes it would be feasible to provide at-grade crossings of the CSX tracks along Polk Street. Coordination with CSX regarding the feasibility of these crossings was not completed as part of the study but would be necessary as further study is undertaken. The scenarios also assumed construction of grade-separated crossings is not feasible due to impacts associated with the closing of local streets to accommodate approach ramps and elevated track structures over the CSX tracks in Downtown Tampa.

Table 1. Characteristics of Heritage Streetcar, Modern Streetcar, and Light Rail Vehicles

Vehicle Characteristics	*Heritage Streetcar*	*Modern Streetcar*	*Light Rail*
Passenger Capacity	88 per vehicle	120 per vehicle	125 per car - 4 cars max.
Speed	20mph typ. / 30mph max.	25-35mph typ. / 45mph max.	30-40mph typ. / 55mph max.
Length	46.1’(14.05m)	66-80’ (20-24m)	80-95’ (24.4-per car)
Width	10’ (3.05m)	8.1-8.7’ (2.46-2.65m)	8.7’ (2.65m)
Fit in Travel Lane	12’	11-12’	11-12’
Min. Turning Radius	50’ (15m)	66-82’ (20-25m)	82’(25m)

Notes:

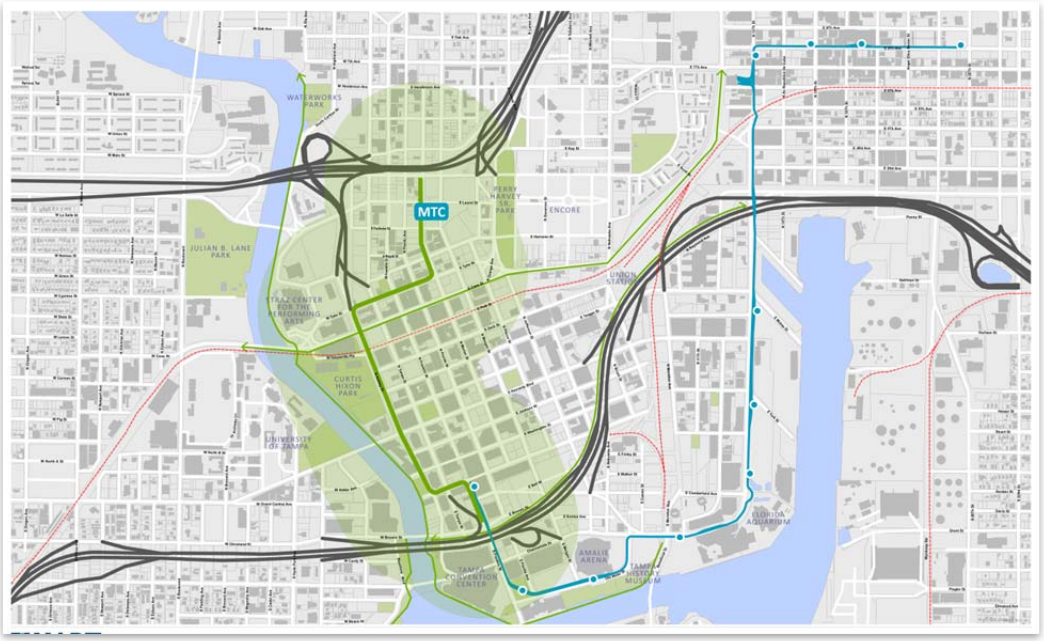
Speed is affected by station spacing and operating environment.

All dimensions, drawn from information on transit vehicles operating on systems in the United States, area provided for planning purposes only.

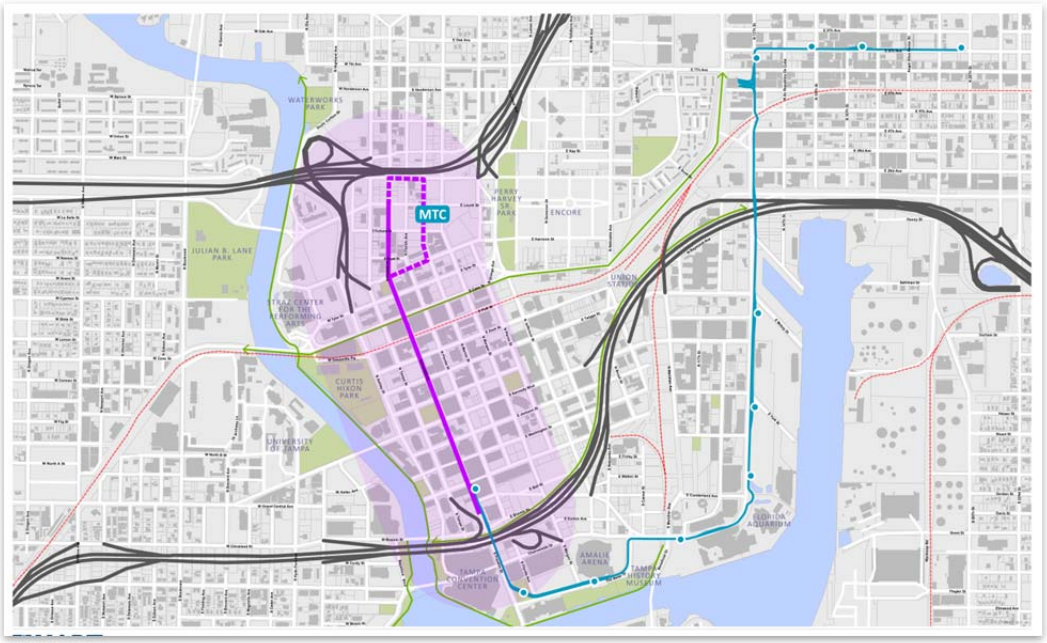
B. Scenario Descriptions

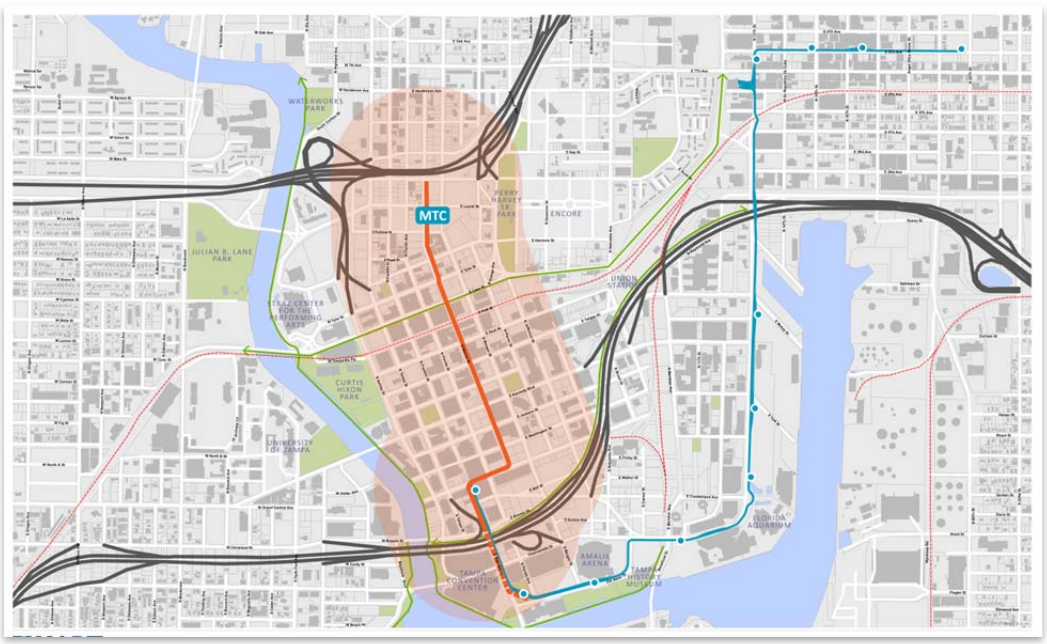
The following section of the report includes text and graphics describing each extension scenario. The section provides a review of each of the four extension scenarios along with information regarding, benefits and challenges, conceptual construction costs, and topics requiring further study. Figures 1 through 4 below illustrate the general alignment and a ¼ mile buffer for each scenario. More detailed plans are provided in the Appendix

Figures 1 and 2: Scenario Maps – Ashley and Tampa-Florida



Figures 3 and 4: Scenario Maps – Franklin and Marion Street Transitway





Ashley Scenario

Alignment Description. From south to north, the Ashley Drive alignment extends from the existing single track at the Whiting Street Station to a median running single track along Whiting Street to Ashley Drive. The single track design in this location is required due to right-of-way constraints at the Franklin Street-Whiting Street and Ashley Drive-Whiting Street intersections. From Whiting Street, a double-track system runs along the outside travel lanes of Ashley Drive to the intersection of Ashley Drive and Tyler Street. From the Ashley Street-Tyler Street intersection, the alignment runs in the center lanes of Tyler Street, turns north onto Marion Street, and runs along Marion Street to a station at the Marion Transit Center.

Under this scenario, it is assumed the existing station at Franklin Street is removed, a replacement station is constructed on the CAMLS block, two pairs of new stations are constructed along Ashley Drive, and one pair of new stations is located along Marion Street at the Marion Transit Center. Further study is required to determine appropriate number, location, and design for stations.

The scenario does not require the acquisition of rights-of-way and may accommodate both modern streetcar and light rail vehicles with minor adjustments to curb lines and streetscapes required at the following intersections: Whiting Street-Ashely Drive, Ashely Drive-Tyler Street, and Tyler Street-Marion Street.

Conceptual Costs. Conceptual estimates of construction costs for this scenario resulted in a range of costs between $40.8M and $55.2M. The estimate includes hard and soft costs associated with the construction of improvements.

Benefits and Challenges. Benefits and challenges associated with this scenario include the following:

- The scenario provides the most direct transit connections to entertainment and cultural destinations along Ashley Drive and the Hillsborough River, including Curtis Hixon Park and Kiley Gardens, the Tampa Museum of Art, the Glazer Children's Museum, and the Straz Center for the Performing Arts.
- The single-track section of the alignment along Whiting Street between Ashley Drive and Franklin Street limits the extension's potential capacity, and double-tracking of this segment would require traffic mitigation and potential right-of-way acquisition.
- The alignment's western location is within walking distance of the University of Tampa and but has limited potential to serve existing and potential development east of the Marion Street Transitway.
- The alignment's location within existing rights-of-way likely eliminates the need for property acquisition.

Topics for Future Study. Future studies of the Ashley Scenario should focus on the following:

- Development of operating scenarios that minimize the effect of single-track of the single-track sections on the extension's capacity.
- Assessing ridership potential given the western location of the alignment and distance of stations from key destinations.
- Determining the optimal operating context along Ashley Drive (i.e. fixed guideway versus shared lanes).
- Assessing potential impacts on parking and vehicular, bicycle, and pedestrian mobility.
- Determining the feasibility and potential costs associated with at-grade crossings of the CSX tracks.
- Determining appropriate locations and designs for stations.

Tampa-Florida Scenario

Alignment Description. The Tampa Street-Florida Avenue scenario follows a general alignment from Franklin Street to Florida Avenue for northbound tracks and Tampa Street for southbound tracks to Laurel Street. From south to north, the alignment extends from the existing single track on Franklin Street at the Selmon Expressway turns east along the south side of Brorien Street then turns north onto Florida Avenue.

Along Florida Avenue, tracks run along the western most travel lanes to Fortune Street where the line could continue one block north or turn east to provide a direct connection to the Marion Transit Center. From the Marion Transit Center, the tracks turn west along the Laurel Street alignment to Tampa Street and turn to run south along the eastern most travel lanes of Tampa Street. At the Tampa Street-Whiting Street intersection, the scenario includes an option to 1) run east in the center of Whiting Street and turn south to run along the west side of Franklin Street or 2) to continue south along Tampa Street and turn southwest and run the north side of the Selmon Expressway ramp then turn south to run along the west side of Franklin Street. From north of the Franklin Street-Brorien Street intersection, the alignment would continue south along the west side of Franklin Street and cross Franklin Street to connect to the existing tracks in the Dick Greco Plaza Station.

For this scenario, it is assumed four new stations would be constructed along the Tampa Street-Florida Avenue pair and one new station would be located close to the Marion Transit Center. The existing station and tracks between Brorien Street and Whiting Street would remain in place for use for the staging of vehicles during special events or as an alternative northern terminus for service running between the Fort Brooke Garage and locations to along the existing line. Further study is required to determine appropriate number, location, and design for stations.

The scenario requires the acquisition of rights-of-way in two locations, along the Laurel Alignment crossing property controlled by FDOT and along the north side of the Selmon Expressway ramp between Tampa Street and Ashely Street. The scenario accommodates both modern streetcar and light rail vehicles with minor adjustments to curb lines and streetscapes required at the following intersections: Fortune Street-Marion Street, Laurel Street-Marion Street, and Whiting Street-Franklin Street.

Conceptual Costs. Conceptual estimates of construction costs for this scenario resulted in a range of costs between $44.4M and $60.1M. The estimate include hard and soft costs associated with the construction of improvements but did not include an estimate of costs for the acquisition of right-of-way controlled by FDOT along the Laurel Street alignment or by private entities along the Selmon Expressway ramp between Tampa Street or Franklin Street.

Benefits and Challenges. Benefits and challenges associated with this scenario include the following:

- The central location of the alignments along Tampa Street and Florida Avenue provide serve to most of downtown and the pair results in a larger area served than the scenarios using single streets.
- The scenario provides the potential for high-capacity, double-track service extending from Dick Greco Plaza to the Marion Transit Center.
- Transit operations may benefit from colocation along Tampa Street and Florida Avenue as these streets are designed to carry high volumes of traffic with favorable signal timing.
- Right-of-way acquisition may result in increased project costs and longer time frames for design and engineering.
- Crossing CSX tracks in two places may constitute a greater challenge and expense than crossing at one location.

Topics for Future Study. Future study of the Tampa-Florida Scenario should focus on the following:

- Determining the optimal operating context along Tampa Street and Florida Avenue (i.e. fixed guideway versus shared lanes).
- Assessing ridership potential given the central location of the alignment and distance of stations from key destinations.
- Determining costs and feasibility of acquiring necessary right-of-way along the Laurel Street alignment and north side of the Selmon Expressway entrance ramp.
- Assessing potential impacts on parking and vehicular, bicycle, and pedestrian mobility.
- Determining the feasibility and potential costs associated with at-grade crossings of the CSX tracks.
- Determining appropriate locations and designs for stations.

Franklin Scenario

Alignment Description. The Franklin Street scenario follows an alignment from the existing terminus at the Fort Brooke Garage north along Franklin Street. From north to south, the alignment extends as single track from the existing terminus north through the two-block Esplanade between Whiting Street and Jackson Street then as double-track along Franklin Street to Laurel Street with an optional alignment running east along Harrison Street, north along Marion Street to the Marion Transit Center, and West along Scott Street.

Under this scenario, it is assumed the existing station at Franklin Street is removed, a replacement station is constructed on the CAMLS block, and two pairs of new stations are constructed along Franklin Street or along the alternative loop to the Marion Transit Center. Further study is required to determine appropriate number, location, and design for stations.

The scenario requires the acquisition of rights-of-way along the Esplanade and would require streetscape reconstruction through the Esplanade to accommodate single track and along much of the Franklin Street right-of-way to accommodate double-track. The scenario accommodates both modern streetcar and light rail vehicles with minor adjustments to curb lines and streetscapes required along the alternative loop at the following intersections: Harrison Street-Marion Street, Scott Street-Marion Street, and Scott Street-Franklin Street.

Conceptual Costs. Conceptual estimates of construction costs for this scenario resulted in a range of costs between $37.8M and $40.2M. The estimate includes hard and soft costs associated with the construction of improvements but does not include costs for the acquisition of right-of-way controlled by private entities along the Esplanade. (According to City of Tampa representatives, the City controls a pedestrian easement through the Esplanade between Whiting Street and Jackson Street but does not have rights to construct transit in the easement.)

Benefits and Challenges. Benefits and challenges associated with this scenario include the following:

- The Franklin Street scenario provides the most direct alignment alternative and its central position provides direct service to hotel, office, and residential properties in the heart of downtown.
- The single track section of the alignment through the Esplanade limits the extension's potential capacity, and double-tracking would require significant reconstruction of plaza improvements and acquisition of additional right-of-way.
- Streetscape reconstruction could have a negative impact on the emerging concentration of retail and restaurant businesses along Franklin Street.

- Right-of-way acquisition may result in increased project costs and longer project delivery time frames.

Topics for Future Study. Future studies of this scenario should focus on the following:

- Determining the optimal operating context along Franklin Street (i.e. fixed guideway versus shared lanes).
- Determining costs and feasibility of acquiring necessary right-of-way along the Esplanade.
- Assessing ridership potential given the central location of the alignment and distance of stations from key destinations.
- Assessing potential impacts on parking and vehicular, bicycle, and pedestrian mobility.
- Assessing the impact on existing retail and restaurants along Franklin Street.
- Determining the feasibility and potential costs associated with at-grade crossings of the CSX tracks.
- Determining appropriate locations and designs for stations.

Marion Scenario

Alignment Description. The Marion Street scenario follows an alignment from Franklin east to Whiting Street then north along the Marion Street Transitway and Marion Street to the Marion Transit Center. North to south, the alignment begins south of the existing terminus and extends the double track section to Whiting Street, then turns north on the Marion Street Transitway and extends to the Marion Transit Center. The scenario includes an option to extend the southbound track on the west side of Franklin Street from Whiting Street to Dick Greco Plaza, thus allowing for a double track system from the Plaza to Marion Transit Center.

Under this scenario, it is assumed the existing station at Franklin Street is removed, a replacement station is constructed on the CAMLS block, two pairs of new stations are constructed along Marion Street, and one pair is constructed at the Marion Transit Center. For stations locations along the Marion Street Transitway, the study assumes the transit way would be widened to allow buses to streetcar stations along curb lines with center lanes allowing buses to pass the stations. Further study is required to determine appropriate number, location, and design for stations.

The scenario does not require the acquisition of rights-of-way and is designed to accommodate both modern streetcar and light rail vehicles with minor adjustments to curb lines and streetscapes required at the following intersections: Whiting Street-Franklin Drive and Whiting Street-Marion Street Transitway.

Conceptual Costs. Conceptual estimates of construction costs for this scenario resulted in a range of between $37.8M and $51.1M. The estimate includes hard and soft costs associated with the construction of improvements as well as costs for the reconstruction of streetscapes where stations are proposed along the Marion Street Transitway. The estimate does not include costs associated with extending the southbound tracks to Dick Greco Plaza.

Benefits and Challenges. Benefits and challenges associated with this scenario include the following:

- The Marion Street scenario provides direct service to the Marion Transit Center but its eastern location is the furthest away from destinations along the Riverwalk and Ashley Drive.
- Adjustments to the tracks in Franklin Street to provide for a double track extension would allow for high capacity service between Franklin Street and the Marion Transit Center.
- The project has the potential to be integrated with a project to improve bus operations along the Marion Street Transitway.

Topics for Future Study. Future studies of this scenario should focus on the following:

- Determining the optimal operating context along Marion Street north of the Marion Street Transitway (i.e. fixed guideway versus shared lanes).
- Assessing ridership potential given the eastern location of the alignment and distance of stations from key destinations along the Hillsborough River.
- Assessing potential impacts on traffic operations, bus transit operations, and pedestrian mobility.
- Determining the feasibility and potential costs associated with at-grade crossings of the CSX tracks.
- Determining appropriate locations and designs for stations.

Summary of Costs

The construction costs estimates for each scenario were based on a conceptual level of planning and design and were developed using available data regarding costs incurred for recently completed transit system projects in the United States. As future design and engineering efforts are undertaken and more detailed investigation occurs regarding such matters as utility conflicts, alignment alternatives, and right-of-way and property acquisition requirements, project estimates would be updated to account for conditions and design details not typically addressed at this high level of study. Table 2 below provides the range of potential costs for each scenario.

Table 2: Capital Cost Ranges for Extension Scenarios

Scenario	*Conceptual Costs (2014)*		*Notes*
	Low Range	*High Range*	
Ashley	$40,800,000	$55,200,000	• Includes costs for relocation of Whiting Street Station.
Tampa-Florida	$44,400,000	$60,100,000	• Includes cost for southbound track on Franklin to the Dick Greco Plaza. • Does not include costs for right-of-way for alignment along Selmon Expressway ramp between South Tampa Street and South Franklin Street.
Franklin	$37,800,000	$40,200,000	• Does not include costs for right-of-way through the Esplanade between Whiting Street and Jackson Street.
Marion	$37,800,000	$51,100,000	• Does not include cost for optional southbound track on Franklin to the Dick Greco Plaza.

Notes:
Estimate assumes extension uses existing heritage streetcar vehicles and maintenance and storage facility.
The estimate includes hard costs, soft costs, and contingencies.
The estimate does not include costs for right-of-way acquisition.

IV. EXISTING SYSTEM UPGRADE

This study also assessed the potential to upgrade the existing system to operate modern streetcar and/or light rail vehicles. The assessment focused on defining conceptual level costs for purchasing new vehicles, reconstructing horizontal curves, upgrading power sources and systems, adjusting stations, and expanding the existing Maintenance and Storage Facility or constructing a new one to service and store larger vehicles.

A review of requirements to upgrade the system is provided by topic below.

Modern Streetcar Vehicle Procurement

This study identified requirements if the system operator were to acquire modern streetcar vehicles that fall in the range of those either in operation or under consideration for procurement by streetcar systems around the country. Some typical dimensions and geometric constraints of these cars are listed in Table 3 below

Table 3. Modern Streetcar Vehicle Characteristics and Requirements

Vehicle Characteristic	*Design Requirement*
Length	66-80' (20-24m)
Width	8.1-8.7' (2.46-2.65m)
Minimum Horizontal Curve Radius	65-82' (20-25m)
Minimum Vertical Curve Radius, Crest	800-1,200' (250-350m)
Minimum Vertical Curve Radius, Sag	800-1,200' (250-350m)
Minimum Frog Number	4
Track Gauge	4'8.5" (1435mm)
Average Track Superelevation	1" (25mm)
Maximum Track Superelevation	3" (75mm)
Maximum Gradient	9%
Reverse Vertical Curves	Either a crest and sag of 800' (250m) separated by a tangent section of 7.5m or a crest and sag of 1,200' (350m) separated by no tangent track
Compound Curves	A 60-82' (18-20m) horizontal curve superimposed on a 1,500 (450m) vertical crest or sag
Current Collector	Pantograph

As stated above, new track on any extension should be designed within these parameters, while the track in the existing line at several locations would require reconstruction to meet horizontal curvature requirements for new vehicles. If all forms of modern streetcars in operation and being purchased in the US are to be considered, then all curves should be designed with a minimum radius of 82' (25m). This high end of the range is typical for light rail vehicles, including the Siemens Short S70, which has been promoted for use in streetcar service and, in fact, is the vehicle purchased for the Atlanta Streetcar. Siemens has indicated that, with some minor modification, this vehicle can negotiate 65' (20m) curves. Therefore, it is suggested that this value be assumed as the minimum for the existing section and the new extension. Larger radius curves are desired wherever possible to reduce or eliminate the possibility of wheel squeal.

Based on recent orders for new streetcars in small quantities, a cost of $4M each is assumed for the purchase of modern streetcar vehicles and it is likely that at least 8 vehicles would need to be purchased to support service on the existing system plus an extension to Marion Transitway. (Further study is required to determine the appropriate number vehicles to support planned levels of service.) The cost of the new streetcars may be offset somewhat by the salvage value from liquidating the existing Gomaco cars. It is assumed that the existing cars were purchased in 2002 for a unit price of about $565,000. Absent a condition inspection and assessment, and information regarding major overhauls, a depreciated value estimate using several methodologies resulted in a range of value per liquidated Gomaco car of between $226,000 and $485,000. As there have been no recent sales of similar used cars, it is difficult to determine a true market value.

Additional study is required to determine the appropriate vehicle type, number of vehicles required to support planned levels of service, the estimated cost for procurement and purchase of tools, spare parts, and testing equipment, and the number and market value of existing vehicles to be taken out of service.

Track Upgrades

Although the gauge and profile of tracks on the existing system can accommodate modern streetcar and light rail vehicles, the horizontal curve radius of the track in several locations is too small to meet turning radius requirements for larger vehicles. As mentioned previously, 66' (20m) is considered the minimum turning radius to accommodate modern streetcar vehicles and 82' (25m) is considered the minimum required to accommodate light rail vehicles.

The existing system includes several locations where the horizontal curvature of tracks falls below the 82' (25m) minimum radius for light rail vehicles and five of these locations fall below the 66' (20m) minimum radius for modern streetcar vehicles. The locations with inadequate horizontal curvatures include the following turns:

- The intersection of Old Water Street and Channelside Drive (curve 1025/50' radius);
- The turns to the south and north of the roundabout at Channelside Drive and Cumberland Avenue (curve 1042 - 50' radius and curve 1045 - 65' radius);
- The turns at the "S" curve at the crossing of the CSX Tracks (curve 1093 - 50' radius and curve 1094 - 80' radius);
- The turn at the intersection of 13th Street and 8th Avenue (curve 1102 – 50' radius).
- The turns into and out of the existing maintenance and storage facility.

To support the use of larger vehicles at these locations, new tracks, track bed, and overhead power would need to be constructed. In addition, these upgrades may require street and streetscape reconstruction and right-of-way acquisition, especially in constrained locations such as the roundabout on Channelside Drive and the turns in Ybor City.

The conceptual cost estimate for upgrading the existing system includes costs for the new tracks, track bed, and overhead power as well as the removal of existing tracks and street reconstruction but does not account for other costs which may be incurred, including the costs for right-of-way acquisition or major intersection reconfiguration as may be required at the roundabout or near the CSX crossing.

Station Upgrades

To support larger vehicles, significant improvements to existing stations would be required. These improvements, reflected in the cost estimate for the upgrade, include the removal of the high block platform for ADA access to the existing high floor vehicles and the potential for platform raising and lengthening to serve longer vehicles. Detailed design requirements can not be defined until a specific vehicle type is selected so the conceptual cost estimates include a preliminary cost per station to account for a range of potential upgrades.

Traction Power System Upgrade

Existing System. The existing traction power system on the existing line consists of two 1,500kW substations, traction power substation (TPSS) North and TPSS South, that operate at a nominal 600Vdc. TPSS North is located under the Selmon Expressway near East Adamo Street, and TPPS South is situated in the north end of the parking lot between Channelside Drive and East York Street. The substations are arranged so that each feeds one power section. The substations and respective power sections are electrically isolated from each other using a section insulator and a normally open isolating switch. In the event of an outage of one substation, the sections may be tied together by closing the isolating switch, essentially reconfiguring the entire traction power system as one large power section drawing from the one operating substation.

The distribution system consists of a single 4/0 overhead contact wire for each direction of travel running the entire length of the streetcar line through both single and double track sections. There is a parallel cable from near Cumberland Avenue to the yard area which is run in a duct bank tapped to the overhead system at varying intervals. The contact wires for each direction of travel are also tapped frequently to permit current sharing between the conductors. In the single track areas, both 4/0 contact wires are supported side-by-side in the same plane and centered above the track. The trolley car operates with a trolley pole and shoe so it will track along the contact wire uniformly throughout the single track areas.

Power Systems Upgrade. For the existing line, the assumed improvement would be to increase the size of the contact wire from 4/0 to 350kcmil on the existing overhead catenary system (OCS) and to develop a power section layout that would take advantage of the benefit of having two substations feeding a power section whenever possible. This would involve moving the section insulator from between the two substations to out in front of them.

In addition, as there are several types of modern streetcar vehicles in service throughout the US and it is not yet known which type would be selected, it is difficult to precisely quantify the vehicle's impact on the existing traction power system. The rating of the 1,500kW substations likely would not be an issue

for supplying adequate power. Rather, the concern with the existing system would be how the traction power system performs during a substation outage scenario where the distance from the existing substation to the end of the line would reach at least 1.6 miles. This distance, coupled with the increased current demand of the modern streetcar, is likely to strain the OCS and would result in a voltage drop and a weaker train voltage profile. Therefore, the addition of another substation cannot be ruled out, and smaller (500kW) substations may be required to strengthen the existing section.

Overhead Contact System Upgrade. The OCS on the existing system consists of simple trolley wire mounted on brackets over the centerline of track. The hardware that clamps to the contact wire and keeps it in position is designed for operation with trolley pole current collectors. These are rollers or 'shoes' at the end of spring loaded poles mounted to the roofs of the streetcars. The trolley poles only operate in one direction, angled toward the rear of the car in the direction of travel. Therefore, for bi-directional operation, each Gomaco car is equipped with two trolley poles.

Modern streetcars are equipped with a pantograph, which can operate in either direction. This device consists of a bar of carbon-based conducting material that is mounted on a frame that is attached to a hinged tube assembly. The assembly is spring-loaded and presses the 'carbon' up against the overhead wire. A typical pantograph frame is about 5'6" wide with ends tapered downward.

To upgrading the existing system to support modern streetcar vehicles, the existing trolley overhead system for trolley collector poles would be converted to an OCS for pantograph operations. Doing so requires changing out the trolley wire positioning devices (called 'registrations') and supports, replacing all the existing trolley special work (frogs and crossings) with OCS contact wire bridges or knuckles, making minor modifications to pull-off wires, or 'guys', at turns, and possibly re-tensioning the conductor wire.

With regard to registrations/supports, virtually every trolley wire 'ear' (contact wire clamp) would need to be replaced. This should not be a problem because the change to an OCS steady arm can be phased incrementally over time, without affecting existing trolley operations. This is accomplished by using OCS steady arms with slidable (adjustable) trolley ears. Trolley ears are perfectly suitable for pantograph operations. Initially, at any registration, the steady arm would be installed to clear the pantograph clearance envelope, but the trolley ear would be set to the existing stagger so that trolley poles can continue to operate. Then, during an overnight service closure, all of the trolley ears would be slid to a stagger scheme developed in an OCS upgrade design. From then on only pantographs can operate. The wire is staggered side to side off the centerline of track from pole to pole to allow the overhead wire to sweep across the pantograph carbon, enabling for uniform wear of this material.

Pantographs can operate over most designs of special work at very slow speed without the need for special carry-under skids. These are short runners that keep the pantograph away from hardware in the

air they should not touch. However, if skids are considered absolutely necessary, they can be used, but would need to be checked for alignment daily. For the conversion, each individual piece of special work would need to be changed out for a corresponding OCS design, with these OCS assemblies installed following the conclusion of all trolley pole operations. Once the conversion is accomplished, guy-networks can be simplified and conductor re-tensioning may be necessary.

At this stage of the planning, it is assumed any extension to the system would likely be configured differently to the existing installation and would employ a different style of OCS to cater to the heavier power demands of the anticipated new streetcars as well as the pole types and pole spacing that would best fit the selected alignment alternative. The upgraded OCS would need an increased copper cross-section as one option, either employing a low-profile catenary or, as a minimum, a 350kcmil contact wire.

Further study and modeling is required to determine the preferred technical solution to design an appropriate traction power system for the extension and complete power upgrades and conversion to OCS for the existing line. Such analysis would include load flow modeling of the entire system and a detailed investigation existing hardware.

Maintenance and Storage Facility

Based on an initial evaluation, it appears the existing maintenance and storage facility on 7th Avenue in Ybor City would need to be expanded or replaced to serve larger transit vehicles. The existing facility, including both the enclosed building with service bays and outdoor yard and tracks, was designed to support general maintenance, repair, cleaning, and storage of the existing heritage streetcar vehicles. The existing vehicles are less than 50’ in length and require only 50’ turning radii while modern streetcar and light rail vehicles can be as long as 100’ in length per vehicle and require 82’ radii for turns. Consequently, an assessment of options for renovations, expansion, or replacement can not be performed until a preferred vehicle type is determined and decisions are made regarding the optimal number vehicles to maintained planned levels of service.

As requirements for a maintenance and storage facility cannot be defined until further planning is complete, the conceptual estimate for the system upgrade includes a very preliminary cost for facility renovations or replacement. And as the study does not address potential locations for a new facility or costs for property acquisition, real estate costs and the additional track feet and power to access a new facility are not included.

Summary of Costs

The following table provides a summary of conceptual construction costs for upgrades to the existing system to accommodate modern streetcar vehicles. The estimate was based on a conceptual level of planning and design and was developed using available data regarding costs incurred for recently completed transit system projects in the United States. As future design and engineering efforts are undertaken and more detailed investigation occurs regarding such matters as vehicle types and right-of-way and property acquisition requirements, project estimates would be updated to account for conditions and design details not typically addressed at this high level of study. Table 4 below provides the estimate of potential costs for the upgrades.

Table 4: Capital Costs for Upgrades to Accommodate Modern Streetcar Vehicles

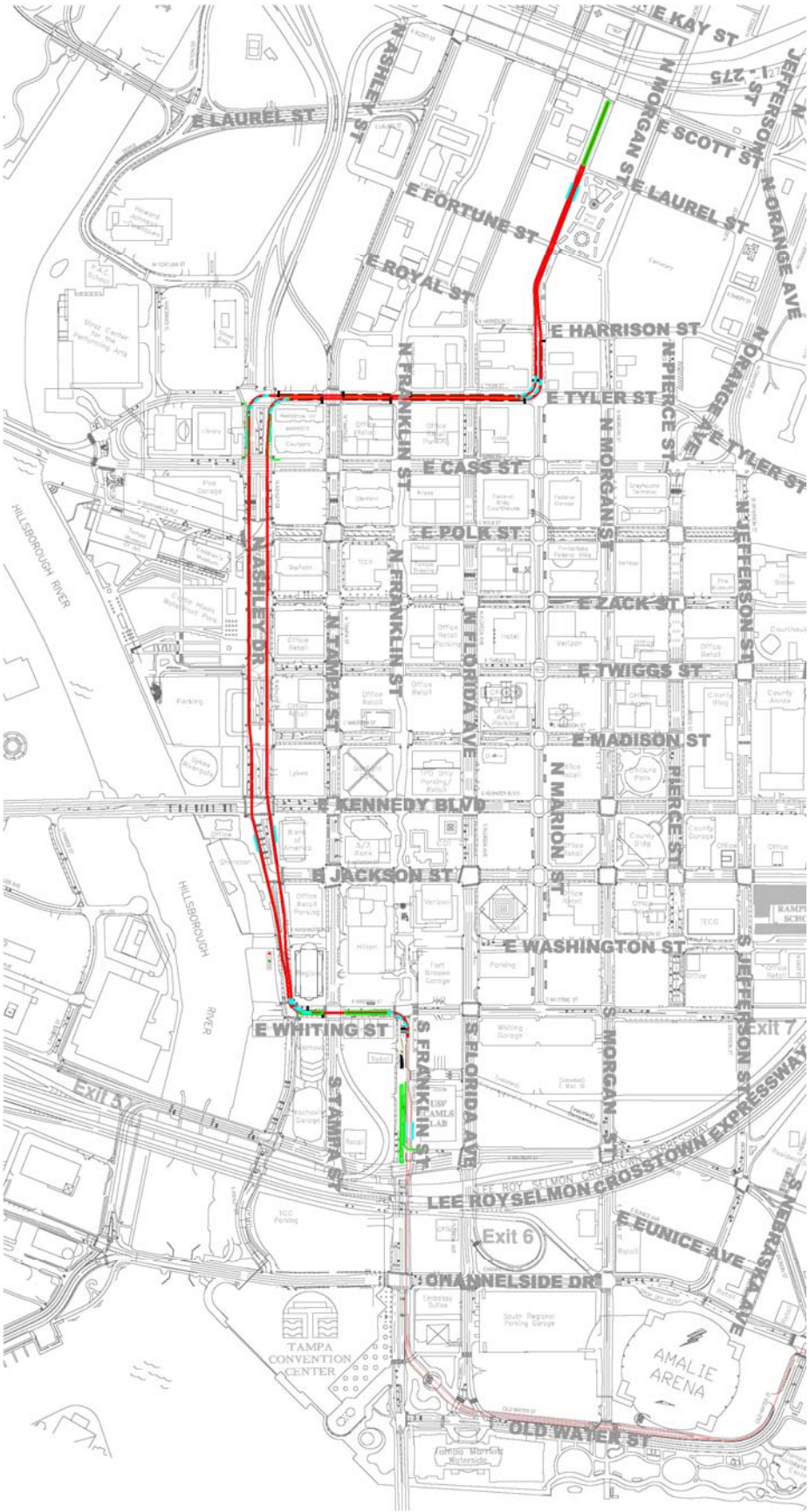
Improvement	Capital Cost (2014)	Notes
Track and Power Upgrades	$18,400,000	• Includes costs for reconstructing curves and upgrading the existing traction power system.
Modern Streetcar Vehicles (8)	$32,000,000	• Includes cost of acquisition of eight new modern streetcar vehicles but is not discounted to account for the potential sale of existing vehicles.
Maintenance and Storage Facility	$11,200,000	• Includes costs for renovation of the existing facility or construction of a new facility but does not include costs for land acquisition or tracks and power to access a new facility.
Total	**$61,600,000**	

Notes: .

1. The estimate includes hard costs, soft costs, and contingencies.

2. The estimate does not include costs for right-of-way acquisition.

Appendix: Conceptual Plans for Extension Scenarios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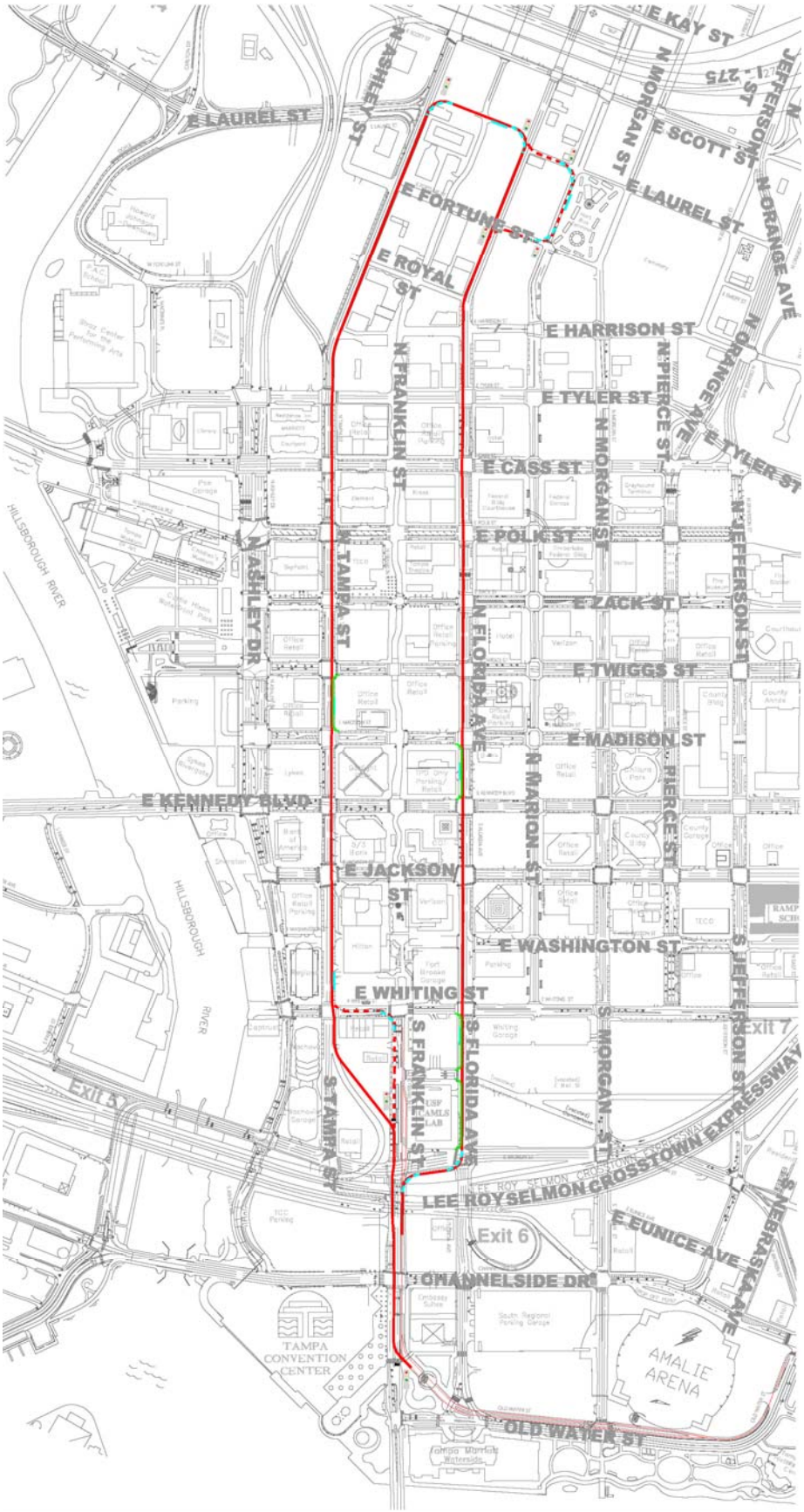
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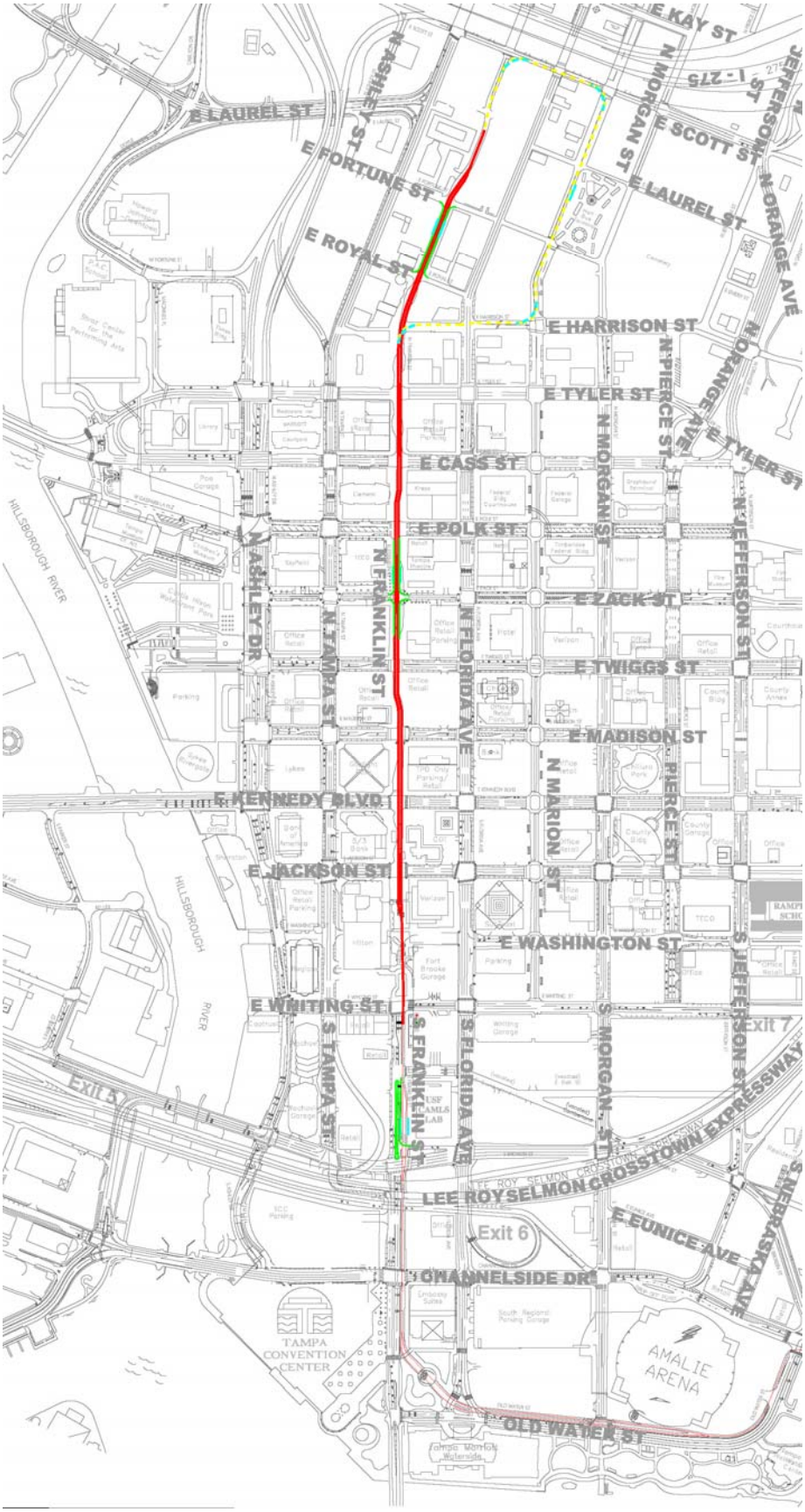
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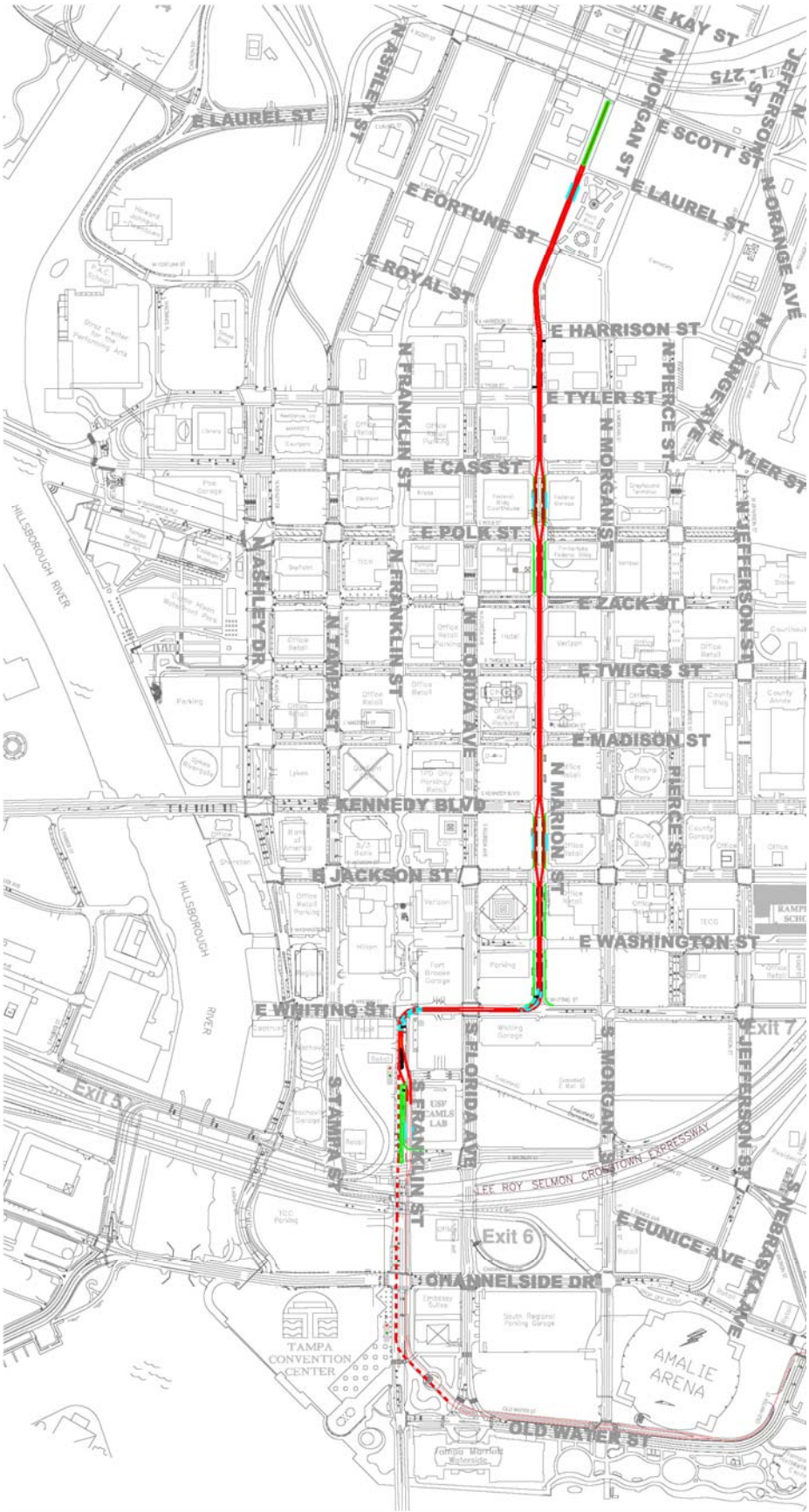
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