

The Tide Light Rail Project Before-and-After Study (2015)

Norfolk, Virginia



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The Tide Light Rail Project; Norfolk, VA

The Tide is a 7.3-mile light rail line extending eastward from the western edge of downtown Norfolk, through downtown, and terminating at the Norfolk/Virginia Beach city line. The project was developed and built, and is now operated, by Hampton Roads Transit (HRT), the principal transit provider for the Hampton Roads area.

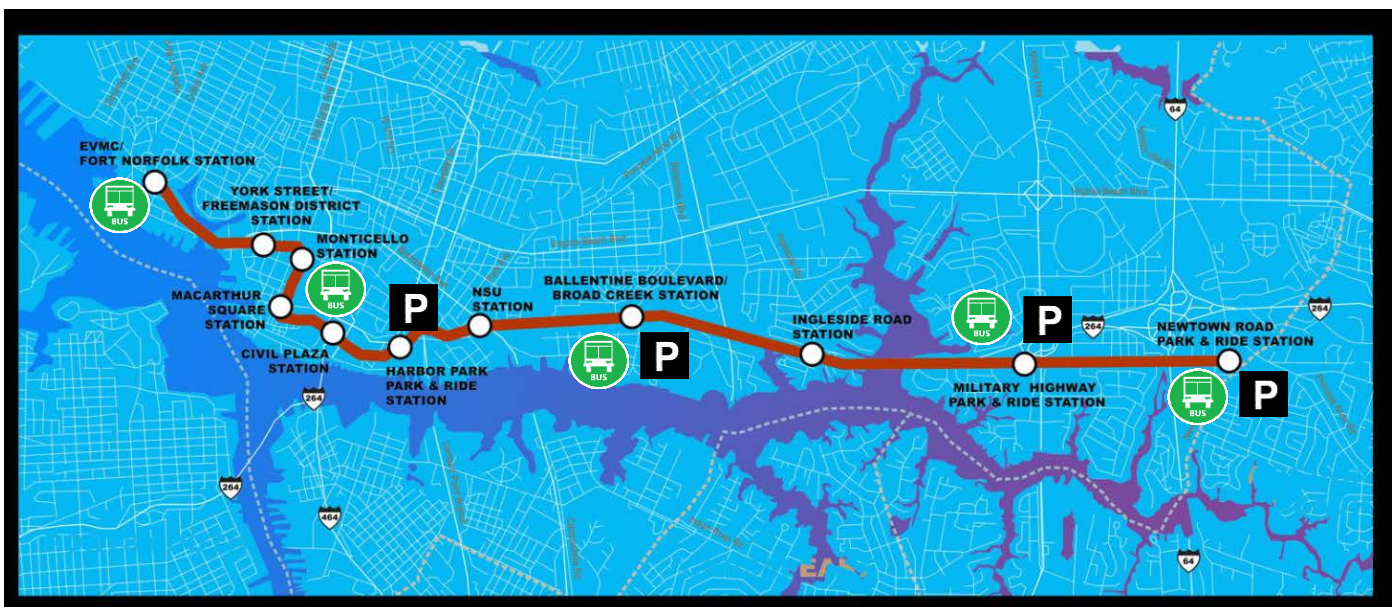
Planning for rail transit in the east-west corridor through Norfolk and Virginia Beach began in 1986. These efforts led to a Major Investment Study in 1997 that identified as the Locally Preferred Alternative a light rail line extending 18 miles from downtown Norfolk eastward to the Virginia Beach oceanfront.

In November 1999, a non-binding referendum in the City of Virginia Beach resulted in a majority vote against the rail proposal. In response, the Virginia Beach city council voted in February, 2000, to withdraw from the agreement with the City of Norfolk to build the project. The Norfolk city council subsequently voted to build the portion of the project located within the city.

The project entered into preliminary engineering in 2002, entered into final design in 2006, received a Full Funding Grant Agreement in 2007, and opened to service in 2011. The *before* milestone for this study was 2008 and the *after* milestone was 2013.

Physical scope

The figure is a map of the project, its 11 stations, and the east-west corridor it serves within the City of Norfolk. The line is double-tracked except for short distances of single track approaching both terminal stations and has over-head electrification throughout. The project is 7.34 miles long – at grade for 6.17 miles and on structures for 1.17 miles.



Map of The Tide Light Rail Project Showing Station Locations and Identifying Stations with Park-Ride Lots and Bus Connection

- The 0.7-mile segment west of downtown Norfolk runs at grade alongside an arterial street, includes a new level-crossing of Elizabeth Creek, passes through three traffic-signal-controlled street intersections, and has two stations.

- The 1.5-mile alignment through downtown is generally located within public-street rights of way, primarily in reserved center lanes. One 0.2-mile segment operates in mixed traffic lanes and two short segments are located in exclusive off-street right of way. Intersections are traffic-signal controlled and left turns across the tracks are generally permitted. The downtown segment includes three stations.
- From the eastern edge of downtown, the line transitions from city streets via a 0.8-mile segment past the Harbor Park baseball stadium at grade and onto an elevated alignment comprising viaduct, retained fill, and bridges above several streets and an active railroad. This segment has two stations including the only elevated station at NSU.
- The aerial structure touches down at the site of the line's maintenance and control facility in an abandoned former railroad right of way in which the line continues 4.4 miles to its terminus at Newtown Rd. This segment has seven at-grade street crossings that are fully controlled by gates and signals. It also includes three structures – two rebuilt bridges over watercourses and a new overpass of an active railroad.

The project's 11 stations have passenger shelters, ticket vending machines, bench seating, lighting, and an information kiosk. Ramps to low platforms provide full access and level boarding with low-floor vehicles. Nine stations have one-car platforms; two have 2-car platforms (MacArthur in downtown and NSU on the aerial section – both in locations where any future station lengthening would be particularly disruptive). Four stations have park-ride lots, as indicated on the project map above, with 100 to 270 spaces each, totaling 780 spaces. Parking is free.

The project scope includes nine transit vehicles. Each vehicle is double-articulated, low-floor, and 94 feet long; seats 68 passengers within a total capacity of 160-180 passengers; and has four doors on each side. Peak service requires six vehicles; so three vehicles are spares and provide extra capacity for special-event services.

In downtown Norfolk, train signals are coordinated with traffic signals and provide signal priority to trains. In the former railroad right-of-way east of the NSU station, an automatic block signaling (ABS) system is used for train control.

The Tide's facility for vehicle maintenance, vehicle storage, and train operations is located just east of NSU Station on a seven-acre site. The maintenance shop is approximately 28,000 square feet. HRT leases a second maintenance facility to house systems maintenance and provide warehouse storage for maintenance of way material and spare parts.

In terms of its principal characteristics, the predicted scope of the project matched the actual scope at all three milestones during development of the project. The predictions anticipated 7.3-mile project with 11 stations, nine vehicles, a principally at-grade alignment, and a maintenance and storage facility. However, the predicted scope at all three milestones consistently understated the actual design requirements for many elements of the scope. This persistent problem appears to have had two sources.

- First, in an effort to meet FTA's cost-effectiveness criteria for advancing the project into preliminary engineering, HRT downsized many elements of the project to reduce its estimated costs. The downsized elements remained part of the scope definition through subsequent milestone reviews at PE-entry, FD-entry, and the FFGA. Many of these elements were restored or upgraded after the FFGA in response to operational requirements, safety reviews, building codes, and other realities. These post-FFGA adjustments included

the block signaling system from Harbor Park Station to Newtown Road Station, an operations control center, improved coordination of rail/roadway traffic signal priority in downtown, a robust communications system, and expanded facilities and equipment for maintenance and storage.

- Second, the project experienced additional post-FFGA scope additions in response to requests by the City of Norfolk and NSU to add elements not anticipated at any project-development milestone. HRT was responsive to these requests to satisfy the interests of major stakeholders (and, in the case of the city, issuers of permits and inspections) but at the cost of unanticipated scope additions. Principal changes in this category include a complete revision of all station shelter and platform railing designs; the addition of the Newtown Road Operator's restroom; a change to brick facades for buildings in the operations and maintenance facility; a change to black-colored overhead catenary system poles in downtown Norfolk; a change to red-colored surface concrete in embedded track in downtown Norfolk; a non-revenue siding track; a significant increase in hazard mitigation signage, fencing, and barriers; the addition of visual screening along the tracks adjacent to I-264; additional fencing, crossing gates, sidewalk railings, signage, and barriers to prevent pedestrians from entering the ROW and to prevent incidents between trains and personal vehicles.

While these late additions to the scope did not change the general characteristics of the project, they significantly revised many of its physical features, added time for these changes to be incorporated late in project design (and, in some instances, during construction), and increased the professional engineering services needed to effect the changes.

Capital cost

The actual cost of the project was \$314.6 million in year-of-expenditure (YOE) dollars for a construction period extending between 2008 and 2012, inclusive. The aggregate unit cost of the transit project in YOE dollars was \$43.1 million per mile -- \$38.2 million per mile without the vehicles. These average unit costs are generally consistent with the actual costs of other light rail lines built in the same time period.

Predictions of project costs in YOE dollars throughout project development consistently underestimated the actual cost outcome – by \$120 million (37 percent) at PE-entry, \$79 million (25 percent) at FD-entry, and \$83 million (26 percent) at the FFGA.

- At PE entry, 54 percent of the underestimate was caused by underestimates of scope and unit prices; 34 percent was caused by an underestimate of the actual schedule for FTA reviews and ratings, project development and construction; and 12 percent was caused by underestimates of actual cost-inflation of heavy construction during the construction period.
- At FD entry and the FFGA when the project neared the beginning of construction, nearly all (94 percent) of the underestimate was caused by underestimates of scope and unit prices. Predicted costs of inflation were close to the actual outcome because predicted inflation rates were higher than actual rates and mostly offset the effects of a predicted schedule that did not anticipate the additional delays that would occur during project construction.

In addition to the incremental costs of the scope additions documented in the physical-scope section above, other effects contributed to the underestimates of costs, including:

- Project delays and change orders resulting from unexpected utility relocations, accompanied by right-of-way acquisition during construction;
- Schedule delays, utility conflicts, and environmental efforts;
- Added professional services resulting from schedule delays, contractor change orders and claims, project extensions, design additions and changes during construction; and
- Uncertainties among both HRT internal staff and the consultant team regarding FTA documentation requirements and strict adherence to the FFGA, resulting in some confusion in monitoring capital costs during project execution.

Discontinuities in FTA’s assignment of project management oversight contractors meant that FTA was unable to provide timely and effective oversight of problems in realistic definitions of project scope, adherence to schedule, and containment of project costs.

Transit service

The Tide operates seven days per week, providing service between 6:00 a.m. and 11:00 p.m. Monday through Thursday, 6:00 a.m. and 12:00 midnight Friday and Saturday, and 11:00 a.m. and 9:00 p.m. on Sunday. Headways between trains are 15 minutes throughout the week except for 3.5-hour intervals of 10-minute headways during both mornings and evenings on weekdays. End-to-end running time on The Tide is approximately 26 minutes, including dwell times at stations, for an average speed of approximately 16.3 mph. With layovers at the terminal stations, the total round trip running time is 60 minutes. Six one-car trains provide service during peak periods; four one-car trains provide service at all other times. The one-trip fare is \$1.75 and a day pass for unlimited travel is \$4.00, both identical to fares for local bus routes.

Bus connections are available at eight of The Tide’s 11 stations. HRT made 21 bus-service changes between the August 2011 initiation of light rail service and the August 2013 “after” milestone to integrate The Tide into the bus system. In general, the adjustments were minor – limited rerouting of existing routes so that they could stop at a nearby station and expanded hours of service early and late in the day to provide bus connections throughout The Tide’s daily schedule. Only one existing route was truncated at a rail station and three new routes were implemented to provide feeder service to The Tide’s terminal stations. HRT continued service on the three long-distance bus routes in the corridor running parallel to The Tide.

Overall, HRT’s adjustments to the bus system were modest in scope and scale, largely for two reasons. First, The Tide provides new transit service in a new east-west transit corridor – the former railroad right of way. As a result, no existing bus routes became redundant as they could with rail lines introduced on or near arterials streets. Second, the initial segment of The Tide is relatively short. As a result, speed advantages on the largely exclusive rail right of way are limited in the amount of travel time that they can accumulate. Consequently, while it was useful to provide opportunities for bus-rail transfers, truncations of bus routes at rail stations made sense in few circumstances.

Predicted service levels for The Tide across all three project-development milestones matched actual service levels closely. Four differences are:

- The predictions anticipated 7.5-minute light rail headways in the peak periods while actual peak-period headways are 10 minutes. The longer headways are the consequence of recommendations by the state’s rail safety oversight process.

- The predictions anticipated faster running speeds for The Tide and end-to-end runtimes of approximately 23 minutes compared to actual runtimes of 26 minutes. The slower actual running speeds are also the consequence of recommendations from the state’s rail safety oversight process and the downtown traffic-signal system that actually provides only signal priority for trains rather than the predicted signal pre-emption.
- The predictions anticipated that off-peak trains would begin their return trips immediately from the terminal stations. Actual service includes the customary layover time at each terminal.
- The predictions anticipated an earlier end of light rail service on weeknights and a later start of service on Sundays.

The net effect of these differences is that the predictions overestimated by six percent the revenue-miles of service that The Tide provides, primarily because of the difference in weekday peak-period headways. Even so, the predictions underestimated by 12 percent the revenue-hours of service needed to provide the slightly reduced service because they anticipated faster average operating speeds.

Predicted changes to the bus system in conjunction with The Tide accurately anticipated the actual service outcomes. The anticipated strategic vision matched the actual outcome: that The Tide would be introduced with only minor adjustments to the existing bus routes in the corridor; few changes would be made to truncate existing routes and introduce new feeder routes; and those few changes would be focused at the two terminal stations.

Operating and maintenance costs

In 2013, annual operating and maintenance (O&M) cost of The Tide was \$9.5 million. Average aggregate unit O&M cost was \$318 per train-hour and, because trains comprise one light rail vehicle each, \$318 per vehicle-hour. O&M costs for the HRT bus system were \$46.2 million, excluding administrative costs. Bus-system costs increased by 6.0 percent compared to the \$43.6 million annual cost in 2009, before implementation of The Tide. The average unit cost of bus service increased over this interval increased from \$50.60 per revenue vehicle-hour in 2009 to \$58.19 per revenue vehicle-hour in 2013, and increase of 14 percent that outpaced the 8.5 percent general inflation over that time. The net outcome in total bus O&M costs therefore reflects real increases in the unit cost of service, partially offset by modest reductions in bus service.

Predicted O&M costs underestimated the actual outcome by \$1.9 million (20 percent, in inflation-adjusted 2013 dollars) at all three project-development milestones. Some \$1.5 million of the underestimate is insurance premiums for coverage above HRT’s self-insured level of \$2 million per incident. The other contributor to the underestimates of O&M cost is the underestimate of train-hours needed to provide the specified Tide service at lower-than-anticipated train speeds. These underestimates were partly offset by an overestimate of rail maintenance costs. The predictions at all milestones assumed that all maintenance would be contracted. Actual maintenance is uses a mix of staff and contractor maintenance at a lower-than-predicted cost.

Ridership

At the “after” milestone in the fall of 2013, The Tide carried 4,600 trips per average weekday. Ridership on The Tide averaged over 5,000 weekday trips at the time of its opening in 2011 and subsequently to over 6,000 weekday trips during the summer of 2012 because of aggressive fare

discounting that has since been discontinued. With the exception of the months of November, December, and January, which generally have lower ridership due to holidays and winter weather, ridership has stabilized to between 4,500 and 5,500 riders per day.

Some 61 percent of weekday trips on The Tide are attracted to the Norfolk core, an area that includes downtown Norfolk CBD, the Eastern Virginia Medical Center, and Norfolk State University. Another 10 percent Tide trips are attracted to other destinations within the immediate project corridor—areas within approximately one mile of a Tide station. Only 29% of Tide LRT trips are attracted to locations more than a mile from The Tide.

The residential locations of Tide riders are dispersed over a larger area. Only 35% of trips on the project are made by residents located within one mile of the nearest Tide station. The remaining 65% of Tide riders begin their trips more than a mile from the nearest Tide station meaning that a majority of users must drive or ride a bus to reach their home-end station.

Over half of all trips on The Tide are made by workers traveling to/from their place of work (43 percent) or students traveling to/from their college campus (19 percent). This orientation towards work and college trips is particularly pronounced for Tide riders who live outside the immediate Tide corridor. In contrast, residents of the corridor are more likely to also use The Tide for non-work trips.

Slightly more than half of all Tide trips are made by riders who are transit dependents – defined as travelers who are either members of zero-car households or do not possess a driver’s license. Transit dependent riders constitute a lower share of Tide trips to downtown Norfolk and a higher share for Tide trips to other parts of the region.

Most Tide riders (73 percent) travel to their first transit stop using a non-motorized mode – either walk or bike. Motorized access – driving or being dropped off – claims a 53 percent share only for Tide trips that begin outside of the immediate corridor and travel to the Norfolk core.

The introduction of The Tide appears to have resulted in a modest increase in transit ridership in the region. Weekday linked trips (not counting transfers) on the HRT transit system increased from 35,700 in 2011 to 38,700 in 2013, a gain of 8 percent. Most of this growth in overall transit ridership occurred in travel to the Norfolk core, where ridership increased from 5,800 to 8,000 weekday trips – a 38 percent gain.

Predictions of opening-year ridership are available for the FD-entry milestone. (HRT prepared only horizon-year predictions at PE-entry and adopted the FD-entry predictions for the later FFGA milestone.) At FD-entry, HRT projected that The Tide would carry 2,900 weekday trips, 37 percent below the actual 2013 ridership of 4,600 weekday trips. The accuracy of the prediction varies significantly across trip purposes:

- The predicted 2,200 weekday trips on The Tide between home and work were higher than actual work-trip ridership by 12 percent. The work-trip prediction correctly anticipated that the key attraction location for these trips would be the Norfolk core but over-estimated this market by 700 weekday trips.
- The predicted 180 Tide trips between home and non-work activities grossly underestimated the actual ridership of 2,000 weekday trips in this category. The reasons for this underestimate are not known with certainty. The most likely explanation is that the unique characteristics of attractions in the Norfolk core may not have been fully represented in the regional travel forecasting models used at the time. The Norfolk core includes

governmental centers, universities, major medical institutions, sports venues, performing arts venues, and regional shopping centers that draw visitors from a broader area than most non-work attractions in other parts of the region. Without specific representation in the ridership-forecasting methods, travel to these regional activity centers in downtown Norfolk was largely missing as a travel market from which The Tide actually attracts many trips. Reviews of the ridership forecasts by FTA staff missed this underestimated component of Tide ridership.

- The predicted 500 weekday trips between non-home activities closely approximated actual ridership of 570 non-home-based trips. The prediction correctly anticipated that most non-home-based ridership would occur to, from, or within the Norfolk core.

The other special market of interest in The Tide ridership forecasts was park-ride access at downtown fringe lots. This market was reasonably well developed by the early 2000s using electric buses to shuttle workers from fringe parking lots to downtown jobs. In the ridership forecasts, the market contributed a modest number of trips to the project. Currently, however, the fringe park-ride market has declined, the electric shuttle service has been discontinued, and fringe-park ride trips are largely absent in actual Tide ridership.

HRT employed conventional methods for predictions of Tide ridership. Since that time, these methods have generally evolved nationally to recognize travel for “special markets” like those in downtown Norfolk. These more detailed methods are less likely to miss the significant ridership contributions that these markets can make to new fixed-guideway transit projects.

Station-area Development

In 2008 at the *before* milestone, HRT prepared an inventory of planned developments within Tide station areas and then examined the status of those plans in 2013 at the *after* milestone. The 2008 inventory found 25 planned developments; by 2013, 13 had been built while 12 had not been built. The planned developments that were not built were a mix of sizes, scales and uses with no apparent commonalities that caused them to remain unbuilt.

Between 2008 and 2014, downtown Norfolk experienced a significant upward trend in development and redevelopment. Similar development surges have happened during this timeframe in downtowns throughout the country. The 2013 assessment was able to identify anecdotal evidence for a role of The Tide in final commitments to build three projects within one-half mile of a Tide station: a medical building with retail space and structured parking near the Eastern Virginia Medical Center station; a luxury apartment building in downtown; and a mixed-use tower in downtown with office, retail, and residential space along with 1,800 structured parking spaces. Developers specifically noted the proximity of Tide light rail service and their expectations that this proximity would enhance the marketability of their developments. Beyond these three developments, the 2013 assessment was unable to document evidence to indicate that the development that has happened in Norfolk since 2008 can be directly attributed to LRT. The development of MacArthur Center, a large-scale regional mall that opened in Norfolk’s central business district in March of 1999, was a critical first step in reversing the previous cycle of downtown disinvestment, and can be credited with beginning a cycle of reinvestment that has resulted in the renaissance of downtown Norfolk as a vibrant, mixed-use regional destination. Market forces catalyzed by the success of the MacArthur Center are responsible for this broader downtown renaissance; introduction of The Tide contributed to development decisions for at least some development projects in and near downtown.

Parking

City-controlled garages provide 90 percent of all spaces in the Norfolk CBD. Between 2008 and 2014, the number of spaces in city-controlled garages and lots increased by eight percent as the city opened two new garages and closed five lots/garages to make way for new development.

The Norfolk city council in 2005 adopted a Transit Oriented Downtown Parking Policy to encourage higher development densities, particularly near transit stations, and cap privately-controlled parking spaces in downtown at 3.7 spaces per 1,000 square feet of leasable office space. In 2014, the city council amended the zoning ordinance to lower by 25 percent the parking requirements for non-residential land uses within 1,500 feet of a rail station.

Analysis of changes in parking data between 2008 and 2014 has not been able to demonstrate any direct correlation, so far, between Tide rail service and parking supply, demand, and pricing in Norfolk's CBD.