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Benefit Cost Analysis Memorandum

The Wilmington Rail Realignment Project

2018 CRISI Grant Application

Prepared for the City of Wilmington by AECOM

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Table of Contents

Exhibits

Executive Summary

This memorandum describes the results of a benefit-cost analysis (BCA) that was conducted for the Wilmington Rail Realignment Project to support the Track 2 – PE/NEPA grant application on behalf of the City of Wilmington for the FRA's 2018 Consolidated Rail Infrastructure and Safety Improvements (CRISI) program. This analysis was conducted in accordance with the 2018 Benefit-Cost Analysis Guidance for Discretionary Grant Programs and includes estimated benefits and costs based on the best available data at this stage of the planning process. Estimated capital outlays are expected to begin in 2025 and the new rail and transit system line could begin operations in 2028. All values are in 2017 dollars discounted to 2018, and cover a 30-year analysis period.

Exhibit 1 presents the Impact Matrix, which describes the baseline, the Project as a whole, and the estimated results.

Exhibit 1 – Impact Matrix

Current Status/Baseline & Problem to be Addressed	Change to Baseline or Alternatives	Types of Impacts	Affected Population	Economic Benefit (Net Present Values, $2017 M)		Page Reference in BCA
				Discounted at 7%	Discounted at 3%	
To access the Port of Wilmington (NC), freight trains must currently travel over 10 miles through downtown Wilmington, crossing 36 downtown at-grade crossings. The at-grade crossings frequently cause traffic delays, present a safety risk, and reduce the quality of life for the 50,000 residents in the study area. Due to increasing volumes at the Port, the impacts are expected to worsen in the coming decades.	The Project would include approximately 7 miles of new single-track operations between Davis Yard and the Port of Wilmington, reducing the distance by nearly 4 miles and avoiding 36 downtown at-grade crossings. The removal of freight from downtown would allow that rail line to be used for transit, which could further alleviate congestion downtown.	**Effects on System and Service Performance**				
		Freight train operating cost savings	Freight operators	$11.5	$28.3	11
		Effects on Safety, Competitiveness, Reliability, Trip or Transit Time, and Resilience				
		Expected crash cost savings by avoiding conflicts with trains	Auto and Truck Drivers in Wilmington	$2.0	$4.9	12
		Value of passenger time saved as a result of avoiding train delay	Auto and Truck Drivers in Wilmington	$193.5	$602.4	13
		Vehicle operating cost savings as a result of avoiding train delay	Auto and Truck Drivers in Wilmington	$19.8	$61.6	14
		Emissions saved as a result of avoiding train delay	Wilmington Residents and Visitors	$1.7	$5.4	14
		Value of improved fire truck response time	Wilmington Residents and Visitors	$0.1	$0.3	14
		Value of improved EMS response time	Wilmington Residents and Visitors	$4.2	$9.8	14
		Reliability benefit	Roadway users and non-users	$210.2	$558.8	15
		Train emissions savings	Wilmington Residents and Visitors	$18.9	$46.4	15
		Residual value	Taxpayers	$22.7	$100.4	16
		Efficiencies from improved integration with other modes				
		Total expected benefits of transit system	Wilmington Residents and Visitors	$68.6	$158.5	16

Exhibit 2 summarizes the long-term outcomes of the Project. Taken in total, the Project provides $553.4 million in benefits over the analysis period using a 7 percent discount rate. Compared to a similarly discounted cost estimate, the Benefit-Cost Ratio for the Project is 1.12, a solid return on this critical investment for the region. This ratio rises to 2.33 when benefits and costs are discounted at 3 percent. The net benefits of the Project are $546.7 million using a 7 percent discount rate and $1.56 billion using a 3 percent discount rate.

Exhibit 2 – Costs and Key Benefits Delivered by Long-Term Outcomes (2028 – 2057)

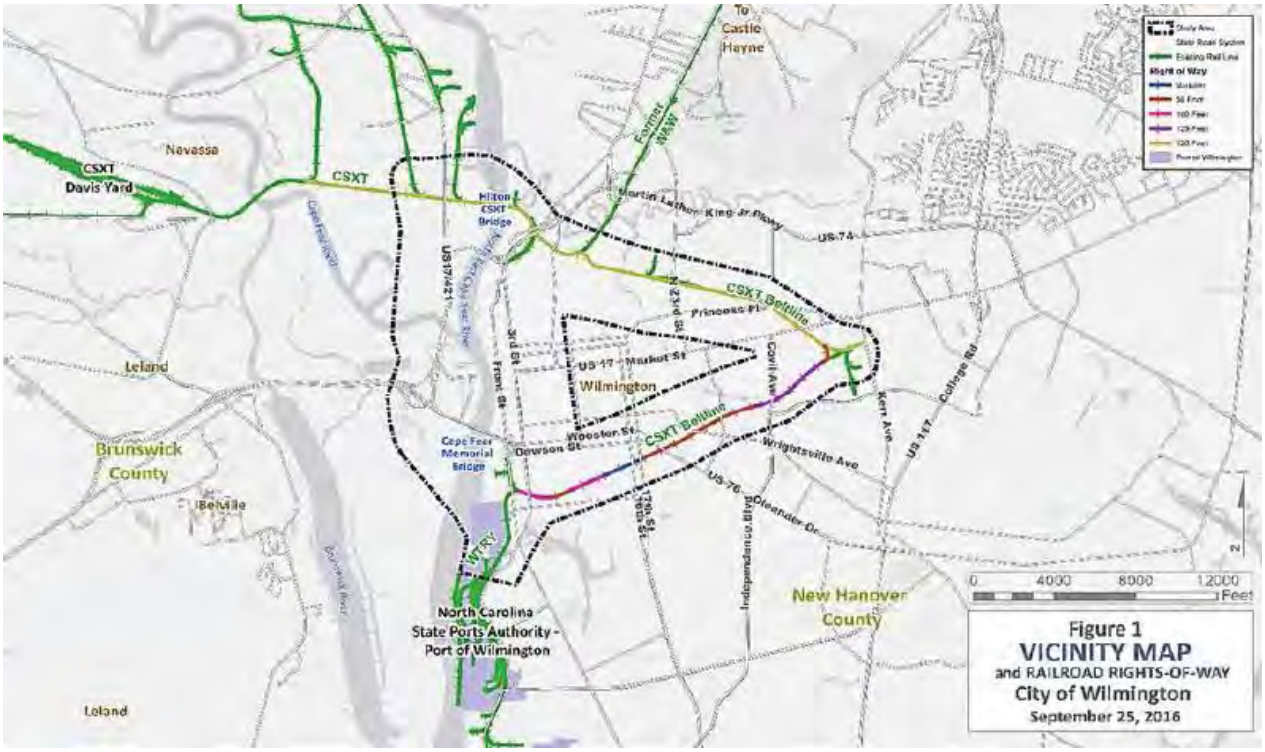
	7% Discount Rate	3% Discount Rate
Costs (2017 $M)		
Capital Costs	$489.2	$669.5
Total Capital Costs	$489.2	$669.5
Benefits (2017 $M)		
Ability to Meet Existing or Anticipated Demand		
Benefits captured under *Effects on Safety, Competitiveness, Reliability, Trip or Transit Time, and Resilience* and *Efficiencies from improved integration with other modes*		
Effects on System and Service Performance		
Freight train operating cost savings	$11.5	$28.3
Sub-total	*$11.5*	*$28.3*
Effects on Safety, Competitiveness, Reliability, Trip or Transit Time, and Resilience		
Grade Crossing Benefits		
Expected crash cost savings by avoiding conflicts with trains	$2.0	$4.9
Value of passenger time saved as a result of avoiding train delay	$193.5	$602.4
Vehicle operating cost savings as a result of avoiding train delay	$19.8	$61.6
Emissions saved as a result of avoiding train delay	$1.7	$5.4
Value of improved fire truck response time	$0.1	$0.3
Value of improved EMS response time	$4.2	$9.8
Reliability benefit	$210.2	$558.8
Train emission savings	$18.9	$46.4
Residual value	$22.7	$100.4
Sub-Total	*$473.3*	*$1,390.1*
Efficiencies from improved integration with other modes		
Total expected benefits of transit system	$68.6	$158.5
Sub-Total	*$68.6*	*$158.5*
Outcome		
Total Benefits	$553.4	$1,576.9
O&M Costs	-$6.7	-$15.0
Net Benefits	**$546.7**	**$1,561.9**
Capital Costs	**$489.2**	**$669.5**
Net Present Value (2017 $M)	**$57.4**	**$892.4**
Benefit-Cost Ratio	**1.12**	**2.33**

1. Introduction

The Wilmington Rail Realignment Project would remove daily freight trains from downtown Wilmington by providing a more direct route for trains from the Davis Yard to the Port of Wilmington. This will avoid conflicts with automobiles and pedestrians in the downtown area. The removal of freight trains downtown would allow for the rail to be repurposed for transit use, which supports mobility and creates much less impact than the daily freight trains.

The current route is owned and operated by CSX, and existing trains must slowly traverse through the City of Wilmington in a "V" shape, crossing 36 at-grade crossings. Trains frequently block crossings, causing delays and safety risks for drivers and pedestrians, and the two daily trains[1] blow their whistles four times for each grade crossing. The more direct route on the west side of the Cape Fear River would avoid the conflicts and save train operating time. In addition, the route would allow for more growth at the Port of Wilmington and provide an opportunity to reuse the line for transit. Exhibit 3 illustrates the study area.

Exhibit 3 – Project Study Area



Source: Wilmington Rail Realignment and Right of Way Use Alternatives Feasibility Study, City of Wilmington, June 2017

The Project would include approximately 4 to 5 miles of new single-track operations between Davis Yard and the Port of Wilmington, reducing the distance by nearly 4 miles and avoiding 36 at-grade crossings. There are three alignment alternatives recommended for further study, with each having varying degrees of impacts to estuarine and marine waters, wetlands, businesses, residences, conservation easements, tourist attractions, and highway infrastructure. Grade separations and one new movable bridge across the Cape Fear River would be constructed for the realignment. For the purposes of this analysis, all three alignment alternatives are considered to have approximately equal benefits. The average of the three rough order of magnitude cost estimates is used in the BCA.

The Project's benefits and costs are based on the City of Wilmington's *Wilmington Rail Realignment and Right of Way Use Alternatives Feasibility Study* from June 2017. The study recommended three alignment alternatives for further study, and also estimated freight benefits under two scenarios: no Port expansion

[1] As reported by the Port of Wilmington. CSX has noted that up to six trains operate on the line daily.

and Port expansion. For this analysis, it is assumed that the port Expansion scenario will occur, which entails the Port of Wilmington expanding to accommodate all of the state's container volume demand as described in the *North Carolina Maritime Strategy*.[2] Under this scenario, the Port projects container volumes to reach 1.3 million TEUs by 2050.

The analysis considers increasing numbers and lengths of trains through the City of Wilmington, further exacerbating the delays, emissions, and vehicle operating costs at crossings. In addition, the population of the tri-county region consisting of New Hanover, Brunswick, and Pender Counties is expected to grow by 52 percent between 2010 and 2040 on the low end.[3] With a compound annual population growth rate of 1.4 percent per year, traffic and delays can be expected to grow by at least that amount.

The removal of freight from downtown would allow the existing rail line to be used for transit. The transit benefits estimated for the Project assume operations of a streetcar (or similar) system. The Project provides benefits for the City of Wilmington and greater region in the following ways:

- **Ability to Meet Existing or Anticipated Demand**: the Project allows for the growth in CSX freight trains both in quantity and in length while reducing the risk of rail-auto conflicts and delays in downtown Wilmington.
- **Effects on System and Service Performance**: the more direct route for CSX between the Port of Wilmington and Davis Yard allows for time savings for freight trains.
- **Effects on Safety, Competitiveness, Reliability, Trip or Transit Time, and Resilience**: removing freight trains from operating in Wilmington provides safety, travel time savings, vehicle operating cost savings, and emissions savings at the grade crossings. In addition, fire and emergency response time is improved in the study area when freight trains are not blocking at-grade crossings, thereby saving lives and property; reliability of travel downtown improves; train idling and therefore emissions are reduced; and finally, properties adjacent to the rail line would increase in value as noise and other nuisances are removed. The project also provides residual benefits.
- **Efficiencies from Improved Integration with Other Modes***:* the Project would remove freight trains and instead use the existing rail line for a local streetcar transit system, providing benefits to both visitors and residents. The Project would also eliminate the need for two grade separation projects at Independence Boulevard, saving the state and taxpayers money.

2. Benefit Analysis Framework

The benefits analysis was conducted using the Benefit-Cost Analysis Guidance for Discretionary Grant Programs document as a guide for preferred methods and monetized values. The parameters of the benefits analysis follow the protocols set by the Office of Management and Budget (OMB) Circular A-94 as well as the recommended benefit quantification methods by the USDOT, the United States Army Corps of Engineers, the Federal Emergency Management Agency, and U.S. Department of Agriculture, Forest Service. Generally, standard factors and values accepted by federal agencies were used for the benefits calculation except in cases where more Project-specific values or prices were available. In all such cases, modifications are noted and references are provided for data sources. The analysis develops a conservative estimation of the benefits and assesses some of the benefits qualitatively. As additional project information is developed, the actual total benefits may be greater than depicted in the results.

The baseline assumes that the Project would not be built and current conditions and operations would continue in the project area. Under the baseline, the purpose of and need for the Project would not be met and would generally be limited to the operation and maintenance of existing infrastructure. The Project was compared to the baseline to identify benefits and costs. Under the baseline scenario, approximately four trains of 3,500 feet in length grow to ten trains of 10,000 feet in length in 2050.

[2] The North Carolina Maritime Strategy, June 26, 2012, Table 75
[3] New Hanover County Population and Demographics, https://maps.nhcgov.com/population-demographics/

A custom model was developed to estimate the future benefits for the Project. Benefits were estimated over a 30-year period of analysis beginning when construction ends and concluding after 30 full years of operations. The construction period is assumed to be from 2025 through 2027, with operations assumed to begin on the new rail line in early 2028. The base year is 2018 and all values were discounted to the base year.

The benefits are expressed in constant 2017 dollars, which avoids forecasting future inflation and escalating future values for benefits and costs accordingly. The gross domestic product chained price index from the OMB was used to adjust past cost estimates or price values into 2017 dollar terms (OMB, 2018).

The use of constant dollar values requires the use of a real discount rate for discounting to the present value. Projects expecting to use federal funding are required to use a 7 percent discount rate. A 3 percent discount rate was also used.

3. Analysis Assumptions

A list of assumptions for the Project is provided in the BCA workbook (see Inputs tab in the file Wilmington_CRISI_BCA.xlsx) as well as in Exhibit 4.

Exhibit 4 – BCA Calculation Inputs

Input	Value	Source
General		
Discount Rate	7%	2018 BCA Guidance for Discretionary Grant Programs
Discount Rate	3%	2018 BCA Guidance for Discretionary Grant Programs
Deflator	See "Deflator" Sheet	https://www.whitehouse.gov/sites/whitehouse.gov/files/omb/budget/fy2018/hist10z1.xls
Dollar Year	2017	
Discount Year	2018	
Population growth rate	1.41%	Source: Pender, New Hanover and Brunswick 3 county region, low growth 2040 projections https://maps.nhcgov.com/population-demographics/
Annualization factor	365	
Transit Annualization Factor	260	
Weeks per year	52	
O&M costs per year	$1,000,000	Assumption
Safety		
AIS 0 (2017$) per vehicle	$4,327	BCA Guidance for Discretionary Grant Programs - 2018
AIS 1 (2017$)	$28,800	BCA Guidance for Discretionary Grant Programs - 2018
AIS 2 (2017$)	$451,200	BCA Guidance for Discretionary Grant Programs - 2018
AIS 3 (2017$)	$1,008,000	BCA Guidance for Discretionary Grant Programs - 2018
AIS 4 (2017$)	$2,553,600	BCA Guidance for Discretionary Grant Programs - 2018
AIS 5 (2017$)	$5,692,800	BCA Guidance for Discretionary Grant Programs - 2018
AIS 6 - Fatality (2017$)	$9,600,000	BCA Guidance for Discretionary Grant Programs - 2018
Total dollar loss due to fire station shutdown (2015$)	$12,727	Source: City of Wilmington, Wilmington Rail Realignment and Right of Way Use Alternatives Feasibility Study (2017)
Total dollar loss due to fire station shutdown (2017$)	$13,095	Adjusted by GDP Deflator
Cost of lives lost due to increased EMS respond time (2015$)	$471,981	Source: City of Wilmington, Wilmington Rail Realignment and Right of Way Use Alternatives Feasibility Study (2017)

Input	Value	Source
Cost of lives lost due to increased EMS respond time (2017$)	$485,647	Adjusted by GDP Deflator
Train Operating Data		
Total train operations, CSX R-1 Row 419 p 60/123	$2,100,650,000	CSX R-1 2016, https://www.csx.com/index.cfm/investors/annual-materials/
Train hours in road service, CSX R-1 Row 115 page 95/123	3,642,886	CSX R-1 2016, https://www.csx.com/index.cfm/investors/annual-materials/
Operating expense per train hour (2016$)	$577	CSX R-1 2016, https://www.csx.com/index.cfm/investors/annual-materials/
Operating expense per train hour (2016$)	$587	
Horsepower per locomotive	6,000	GE AC6000CW Locomotive, http://www.trainweb.org/csxrailfan/nov99/ac60/ac60.html
Locomotives per train	2	Assumption
Share of >1 Locomotives attributed to labor	64.1%	CSX R-1 2016, Analysis of train operation costs
Number of trains per day (2028-2039)	4.4	Source: TrainsPerDay tab
Number of trains per day (2040-2049)	8.2	Source: TrainsPerDay tab
Number of trains per day (2050+)	9.6	Source: TrainsPerDay tab
Days of train operations per week	7	
Time savings per train (round trip)	2	Source: City of Wilmington, Wilmington Rail Realignment and Right of Way Use Alternatives Feasibility Study (2017)
Value of Passenger Time (hourly) $2017	$14.80	2018 BCA Guidance for Discretionary Grant Programs; https://www.transportation.gov/sites/dot.gov/files/docs/mission/office-policy/transportation-policy/284031/benefit-cost-analysis-guidance-2018_0.pdf
Emissions Rates and Values		
VOC Value of Emissions (2017$) per short ton	$1,905	BCA Guidance for Discretionary Grant Programs - 2018
NOx Value of Emissions (2017$) per short ton	$7,508	BCA Guidance for Discretionary Grant Programs - 2018
PM Value of Emissions (2017$) per short ton	$343,442	BCA Guidance for Discretionary Grant Programs - 2018
SOx Value of Emissions (2017$) per short ton	$44,373	BCA Guidance for Discretionary Grant Programs - 2018
Conversion rate for Metric tons to Short Tons	1.1015	BCA Guidance for Discretionary Grant Programs - 2018
Train emission rates g/per brake horsepower (PM10)	0.18	US EPA, Office of Transportation and Air Quality, Emissions Factors for Locomotives, EPA-420-F-09-025, April 2009, p.2, http://www.epa.gov/nonroad/locomotv/420f09025.pdf
Train emission rates g/per brake horsepower (NOX)	4.95	US EPA, Office of Transportation and Air Quality, Emissions Factors for Locomotives, EPA-420-F-09-025, April 2009, p.2, http://www.epa.gov/nonroad/locomotv/420f09025.pdf
Train emission rates g/per brake horsepower (CO)	1.28	US EPA, Office of Transportation and Air Quality, Emissions Factors for Locomotives, EPA-420-F-09-025, April 2009, p.2, http://www.epa.gov/nonroad/locomotv/420f09025.pdf
Train emission rates g/per brake horsepower (HC)	0.26	US EPA, Office of Transportation and Air Quality, Emissions Factors for Locomotives, EPA-420-F-09-025, April 2009, p.2, http://www.epa.gov/nonroad/locomotv/420f09025.pdf
Transit Benefit		
Economic Benefits of Transit System (2015$)	$7,660,297	Source: City of Wilmington, Wilmington Rail Realignment and Right of Way Use Alternatives Feasibility Study (2017)
Economic Benefits of Transit System (2017$)	$7,882,092	Adjusted by GDP Deflator

It should be noted that the Project would result in disbenefits to the environment with the construction of the new rail line because the new alignment is proposed to traverse through sensitive wetland environments. At this point of project development, there is insufficient information available to monetize these potential impacts and possible mitigation efforts and therefore, it is excluded from the analysis.

In addition, the Project constructs and operates a new transit system, but because there is insufficient information as to the technology, operations, ridership, fares, and frequencies, detailed transit benefits and disbenefits are not possible at this time. The monetized transit benefits attempt to quantify a rough order of magnitude of benefits for the project.

The working assumption at this stage of planning is that the environmental impacts could be negative and that the transit benefits would be positive on net, offsetting the negative environmental impacts. Moreover, the environmental impacts could be mitigated with additional analysis.

4. Benefits Methods

The methods used to estimate the benefits of the Project are described in the following sections. The benefits are based on those estimated in the *Wilmington Rail Realignment and Right of Way Use Alternatives Feasibility Study* (Feasibility Study) conducted in June 2017, with some adjustments. It is important to note that the Project is seeking funding to conduct NEPA/PE, which will refine the project alignment and the associated costs and benefits. As a result, the analysis presented here is based on the best information and assumptions available to date.

Ability to Meet Existing or Anticipated Demand

The Project would allow for increasing volumes of freight trains to travel between the Davis Yard and the Port of Wilmington without further disruption to vehicle operations in the City of Wilmington. The capacity of the line is 12 trains per day, and according to the Feasibility Study; the expanding demand for rail traffic in the corridor is shown in Exhibit 5. These rail volumes are inclusive of container, bulk, and breakbulk trains. The container trains and associated benefits are interpolated using a straight-line between 2028 and 2040, and 2040 and 2050. Trains after 2050 are assumed to be held constant.

Exhibit 5 – Trains per Day and Length of Trains

Year	Bulk	Container	Total	Number of Rail Cars
2028	3	1.4	4.4	70
2040	3	5.2	8.2	141
2050	3	6.6	9.6	200

Source: interpretation of Feasibility Study

These train volumes are conservative because the Port of Wilmington is expected to expand shipments of wood pellets and plastics, among other commodities, and CSX has indicated they would like to utilize the corridor for the maximum 12 trains per day. CSX has begun running its daily Queen City Express intermodal train between the Port of Wilmington and Charlotte,[4] and has been working towards providing additional connections to the Midwest through its National Gateway Corridor improvements that supports growing manufacturing and consumer demand.[5]

Train lengths today are averaging 3,500 feet, or about 70 rail cars per train. To assume train lengths do not begin to grow until after 2028, as this analysis does, conservatively ignores the probable growth over the next ten years. In addition, CSX plans to grow trains to 10,000 feet (200 rail cars), or just under the

[4] Caroline Curran, Crain's, "The Queen City shifts from traditional transportation options," September 13, 2017, https://www.crains.com/article/news/queen-city-shifts-traditional-transportation-options

[5] NCDOT 2015 Comprehensive State Rail Plan, Chapter 2, https://www.ncdot.gov/divisions/rail/Pages/rail-plan.aspx

two-mile maximum. It is assumed this is done by 2050 and held constant thereafter. It is assumed that the Port expansion condition would accommodate all rail traffic.

While the Project would support the Port's ability to meet anticipated demand, and benefits could be captured in this section, the benefits resulting from the Project's expanded capacity are quantified and described under *Effects on System and Service Performance* and *Effects on Safety, Competitiveness, Reliability, Trip or Transit Time, and Resilience* in the succeeding portions of this memorandum.

Effects on System and Service Performance

The Project would result in improvements to the system and freight service in the corridor, as well as the addition of rail transit services in the City of Wilmington. The benefits associated with rail transit services in the City of Wilmington are discussed and quantified in the Safety, Competitiveness, Reliability, Trip or Transit Time, and Resilience Section.

Freight Train Operating Cost Savings

To estimate the freight train impacts, it was necessary to estimate the amount of time saved per train in the corridor due to the realignment. Time savings per train is estimated to be at least two hours per round trip with the Project, based on the findings of the Feasibility Study. Because freight volume is expected to grow considerably with the Port expansion, the analysis assumed there would be 4.4 trains per day from 2028 to 2039, 8.2 trains per day from 2040 to 2049, and 9.6 trains per day from 2050 on. Trains after 2050 are assumed to be held constant.

The analysis assumed an operating cost of $587 per train hour, and was estimated by dividing the total train operating costs by the total train hours in road services reported by CSX in their 2016 Class 1 Railroad Annual Report, converted to 2017 dollars.[6] The analysis assumed two locomotives per train and 64 percent of the share of a locomotive's operating cost was attributed to non-locomotive-dependent costs.[7] Assuming the additional locomotive would not require additional labor, the analysis quantified total hourly operating costs for a train with two locomotives to be 1.36 times greater than the hourly operating cost of $587 per train hour, resulting in a total train operating cost per hour of $797. The analysis then multiplied time savings by hourly operating costs to quantify freight train operating cost savings. ***In total, freight train operating savings results in $11.5 million in benefits discounted at 7 percent.***

Effects on Safety, Competitiveness, Reliability, Trip or Transit Time, and Resilience

The effects on safety, competitiveness, reliability, trip or transit time, and resilience are quantified using the GradeDec Analysis. The Project would result in a number of benefits affecting safety, competitiveness, reliability, trip or transit time, and resilience and these effects are described here.

GradeDec Analysis

There are a number of grade crossings that will be affected as part of the Project. Interactions between the freight trains and road users at grade crossings generate negative community impacts through two primary highway-rail interactions: accidents and highway delays while crossings are blocked by trains. Highway delays at grade crossings increase travel times, vehicle operating costs, and emissions while vehicles idle at blocked grade crossings. These interactions are a safety concern for the community as well as a drain on its economic competitiveness, as productivity and access are negatively impacted. The Federal Railroad Administration (FRA) online tool GradeDec.NET[8] was used to estimate the benefits at

[6] Class 1 Railroad Annual Report to the Surface Transportation Board for the year ending December 30, 2016, CSX Transportation, https://www.csx.com/index.cfm/investors/annual-materials/.
[7] Based on analysis of CSX 2016 R1 train operating costs
[8] https://gradedec.fra.dot.gov/

the grade crossings. In order to model the benefits, GradeDec.NET was run assuming the crossings are all grade-separated as part of the Project.

Because no information is available on the new transit system's operating schedule or frequency, it is not included in the GradeDec.NET analysis; however, while it is noted that the streetcar system would still cause safety risks and vehicle delays in the corridor, they will be substantially less than the freight effects.

GradeDec Analysis Assumptions

The grade crossing analysis requires a number of assumptions; generally defaults were used, but the values of time, value of life, value of emissions, auto occupancy, annualization factor, and inflation were updated based on guidance and project-specific data as shown in Exhibit 4. The GradeDec.NET analysis was run with 2017 values and considers reallocating traffic due to the closures.

Because GradeDec.NET assumes a constant number of trains, three scenarios were run using the train volumes found in Exhibit 5. The results were interpolated using straight-lines between years. For example, the safety benefits for 2039 were calculated by using linear interpolation between the safety results found in 2020 for 4.4 trains per day and 2040 for 8.2 trains per day.

Grade Crossing Benefits

The benefits associated with removing freight trains from downtown Wilmington include:

- Safety
- Travel time savings
- Vehicle operating cost savings
- Vehicle emissions reductions

Network benefits are negligible and were excluded.

The benefits for removing freight trains from at-grade crossings in downtown Wilmington were estimated by using FRA's GradeDec.NET model. FRA's grade crossing analysis model estimates the net safety, travel time savings, vehicle operating cost savings, emissions savings, and network savings associated with proposed improvements to corridor grade crossings (e.g. removal of freight trains) between Build and No Build cases. GradeDec.NET requires the user to input baseline year data and projections of growth through the rest of the analysis period; GradeDec.NET then returns the net benefits of the Build versus the No Build. The annual benefits estimated with GradeDec.NET were discounted to 2018 outside of the GradeDec.NET tool. The printouts of the results for the analysis are included in the supplemental materials.

Exhibit 6 summarizes the GradeDec.NET benefits for the Project. The following sections detail how the grade crossing analysis was conducted.

Exhibit 6 – Net Grade Crossing Benefits

	Total $M 2017	
	@ 7% discount rate	**@ 3% discount rate**
Safety	$2.0	$4.9
Travel Time	$193.5	$602.4
Vehicle Operating Costs	$19.8	$61.6
Emissions	$1.7	$5.4
Total	**$217.1**	**$674.3**

Source: AECOM, totals may not sum due to rounding

Safety Benefits

The exposure of vehicles to grade crossings results in a greater likelihood of safety incidents as the number and length of trains traveling through the crossings grow. The risk of incidents would be

eliminated for the existing corridor in the Build compared to the No Build (baseline). This section summarizes the net safety benefits that result from the Project.

The safety impact was calculated using the GradeDec.NET analysis tool, which is based on the USDOT Accident Prediction and Severity Model (APS) and Resource Allocation Method. The APS methodology and the GradeDec.NET improvement are used to account for the time-of-day correlation factor between rail and highway traffic to predict the number of accidents by severity that would occur at crossings. The safety analysis methodology for grade crossings predicts the number of accidents each year based on the number of daily trains, the annual average daily traffic (AADT), the time-of-day exposure correlation factor, the number of tracks, and the number of highway lanes crossing the tracks.

The predicted crashes are then allocated across categories of severity (fatal, injury, and property damage only [PDO]). The estimated crashes by severity are based on the maximum speed, APS factors for fatal accidents and casualty accidents for grade crossings, number of through trains, and number of tracks. Exhibit 7 shows the costs used in the analysis to value the incidents by severity.

Exhibit 7 – Costs of Safety Incidents by Severity

Cost	Thousands of 2017$
Fatal Crash	$ 9,600
Injury Crash (AIS 3)	$ 1,008
PDO Crash	$ 4.327

Source: 2018 TIGER and INFRA BCA Resource Guide

In order to estimate the safety benefits experienced at the crossing, a scenario was run in GradeDec.NET. The scenario establishes the Baseline for the existing rail traffic by predicting the safety costs associated with the existing alignment if the Project is not built compared to the Build which considers the same train traffic and auto traffic as the No Build but separates the crossings to represent removing the freight traffic from the corridor. GradeDec.NET produces the net benefits by subtracting the cost of accidents estimated for the Build from the baseline over the 30-year analysis period.

The net results are positive safety benefits due to the reduction in traffic interactions at the grade crossings, which eliminates the likelihood of highway-rail accidents. ***Discounting at 7 percent, the safety benefits yield $2.0 million in 2017 dollars.***

Travel Time Savings

The highway delays associated with grade crossings result in increased travel times for road drivers and their passengers as they wait for trains to travel through grade crossings. The travel time delays would be eliminated when the freight trains no longer operate in the corridor. This section summarizes the total net travel time savings benefits that result from the Project. Note that this estimate excludes the quantification of the disbenefits of running transit on the corridor because at this stage of project development, there is no estimate for the frequencies or type of system used; however, it can be assumed that a single vehicle street-car system will be used and therefore would result in minimal delays at crossings.

The travel time savings associated with the elimination of highway queuing at the grade crossings were calculated by GradeDec.NET based on:

- Trains per day, by time of day
- Train length
- Average speeds at crossings
- AADT distributed by time of day and segment (auto, truck, and bus)
- Number of highway lanes at crossings
- Average vehicle occupancy

Defaults were used except for train length and trains per day; both varied according to Exhibit 5. With this data, GradeDec.NET calculates the average grade crossing block time, the highway vehicle delay due to crossing closure by traffic segment, and the highway vehicle time in queue by traffic segment due to the blocked crossing. Once the delays and time in queue are known, the time savings is monetized as the product of the traffic segment time savings, the average vehicle occupancy (1.39[9]), traffic segment, and the value of time. See Exhibit 4 for the value of time by mode.

Due to the increasing traffic growth in the downtown area and the length and frequency of trains blocking crossings, there are positive travel time savings due to the reduction of delay at the grade crossings with the Project. ***Discounting at 7 percent, the travel time savings yields $193.5 million in 2017 dollars.***

Vehicle Operating Cost Savings

The highway delays associated with grade crossings result in greater vehicle operating costs due to idling times at grade crossings while vehicles wait for trains to travel through the crossings. This section summarizes the net vehicle operating cost savings benefits that result from the Project using GradeDec.NET.

In order to calculate the value of the vehicle operating costs associated with idling at the grade crossings, assumptions about the average fuel and motor oil burn rates as well as the price of gasoline, diesel, and motor oil must be established. The fuel and motor oil burn rates for each minute of idling are FRA national averages that are used as default values by the GradeDec.NET analysis tool. Default values were used for the gasoline and diesel prices per gallon and the price of motor oil per quart. Using these assumptions results in vehicle operating costs associated with auto and truck traffic idling during gate closure.

The net vehicle operating cost savings result from the elimination of rail-traffic interactions at the crossings, creating fewer highway traffic delays and less idling. ***Discounting at 7 percent, the vehicle operating cost savings yields $19.8 million in 2017 dollars.***

Highway Emissions Benefits

The highway delays associated with grade crossings result in greater vehicle emissions due to idling times at grade crossings while vehicles wait for trains to travel through the crossings. The highway emissions benefits associated with the elimination of highway queuing at the grade crossings come from GradeDec.NET. The vehicle emissions reduction is estimated using emissions rates from GradeDec.NET and monetized using pricing for the impact of carbon monoxide (CO), volatile organic compounds (VOC), nitrogen oxides (NOx), particulate matter (PM), and sulfur dioxide (SO_2) on community health, including human and environmental impacts.

Using the GradeDec.NET assumptions on the emission burn rates, GradeDec.NET estimates the net change in emissions between the Build and No Build, and the hedonic price of emissions were applied per ton. The 2017 prices for CO ($0), VOC ($1,905), NOx ($7,508), PM ($343,442), and SO_2 ($44,373) per ton used in the analysis are from the INFRA 2018 BCA Resource Guide.[10] ***The total emissions benefits from reduced idling time are $1.7 million discounted at 7 percent.***

In addition to CO, VOC, NOx, PM, and SO_2 reductions, carbon dioxide (CO_2) or greenhouse gas would also be reduced from less auto idling at the crossings. Because there is no official guidance on the value of CO_2 emissions reductions, this benefit was not quantified in the analysis.

Emergency Services Savings

The high volume trains that frequently travel through Wilmington present a safety issue for the citizens of Wilmington as frequent train crossings can delay fire trucks and ambulances from accessing citizens and

[9] USDOT 2018 Benefit-Cost Analysis Guidance for Discretionary Grant Programs, https://www.transportation.gov/sites/dot.gov/files/docs/mission/office-policy/transportation-policy/284031/benefit-cost-analysis-guidance-2018.pdf

[10] USDOT 2018 Benefit-Cost Analysis Guidance for Discretionary Grant Programs, https://www.transportation.gov/sites/dot.gov/files/docs/mission/office-policy/transportation-policy/284031/benefit-cost-analysis-guidance-2018.pdf

properties during emergencies. This negative impact has been studied and documented in numerous other locations across the country as well.[11] The impacts were quantified in the Feasibility Study based on FEMA's *BCAR: Development of Standard Economic Values* to quantify the impacts associated with delayed response times from road closures during train crossings. The total cost of lives lost due to increased emergency medical services response time came to $485,600 annually when adjusted to 2017 dollars, and the loss to fire stations was $13,100 annually.[12,13] The analysis grew the annual safety impacts of the Project by 1.4 percent over the course of the analysis period, proportional to the projected population growth of Wilmington in that time period. ***In total, the Project would reduce the cost of lives lost due to increased EMS and fire response time by $4.3 million discounted at 7 percent.***

Reliability Benefit

The removal of freight trains through downtown will allow for more reliable auto travel through town. Because of uncertainty with the train delays, drivers must factor in a "buffer" time to auto travel in order to be on time to their destination. By building in the buffer, travelers arrive early some days, which is valuable time they could be using for other activities besides auto travel.[14] Without detailed traffic studies of the corridor, the buffer time is assumed to be about 6 minutes per trip for this analysis, and a conservative 10 percent of the 2028 daily traffic at the crossings is assumed to save buffer time when the trains are rerouted out of town. In reality, given that crossings may be blocked for up to 25 minutes or more and that 36 adjacent crossings are blocked, 10 percent is a low share.[15] Multiplying the time savings by the value of time for personal travel as shown in Exhibit 4 results in the estimated reliability benefit. This estimate grows by 1.4 percent per year as the population grows in the three-county region. Because the reliability benefit only considers personal travel and ignores business and truck value of time, it is conservative. ***The total reliability benefit associated with the Project is $210.2 million, discounted at 7 percent.***

Train Emissions Savings

Reducing train trip time would lead to a reduction in train emissions. The analysis used annual freight locomotive hours saved, as described under operating cost savings, and emission rates in grams per brake horsepower hour to quantify emissions reductions.[16] The analysis assumed the horsepower of CSX locomotives to be 6,000, based on the power of GE AC6000CW locomotives.[17] Exhibit 8 below lists emissions rates for Tier 2 Line-Haul locomotives.

Exhibit 8 – Emission Rates for Tier 2 Line-Haul Locomotives (g/hpr)

	PM10	NOX
Tier 2 Line-Haul Locomotive	0.18	4.95

Source: GE AC6000CW, American Rails, https://www.american-rails.com/ge-ac6000cw.html.

The value of emissions savings (VOC, NOx, and PM) were estimated using emissions costs from USDOT's 2018 BCA guidance, and are summarized in Exhibit 4. ***In total, the Project results in net emissions savings of $18.9 million when discounted at 7 percent.***

[11] Federal Railroad Administration, Impact of Blocked Highway/Rail Grade Crossings on Emergency Response Services, August 2006, https://iowadot.gov/iowarail/resources/publications/blocked_crossings_emergency_response.pdf
[12] City of Wilmington, Wilmington Rail Realignment and Right of Way Use Alternatives Feasibility Study (2017).
[13] FEMA Benefit-Cost Analysis Re-engineering (BCAR), Development of Standard Economic Values, December 2011.
[14] USDOT Office of Operations, Travel Time Reliability, https://ops.fhwa.dot.gov/publications/tt_reliability/TTR_Report.htm
[15] Ingram, Hunter, Star News Online, "*With talk of 10,000-foot trains, can Wilmington avoid traffic gridlock?*", March 2, 2018, http://www.starnewsonline.com/news/20180302/with-talk-of-10000-foot-trains-can-wilmington-avoid-traffic-gridlock
[16] US EPA, Office of Transportation and Air Quality, Emissions Factors for Locomotives, EPA-420-F-09-025, April 2009, p.2, http://www.epa.gov/nonroad/locomotv/420f09025.pdf
[17] GE AC6000CW, American Rails, https://www.american-rails.com/ge-ac6000cw.html.

Residual Value

Construction of the new track, overpass structures, roadway, transit structures, and right of way results in residual value after the end of the 30-year analysis period, because the useful life of the Project elements is greater than 30 years.[18] Right of way does not depreciate, so the full value of the right of way acquired for the Project was also included in the residual analysis. The remaining value of the right of way, track, structures, roadway, and transit structures was summed and discounted from the last year of the 30-year analysis period. ***The value of the remaining useful life for the Project is $22.7 million when discounted at 7 percent.***

Efficiencies from Improved Integration with Other Modes

Once the rail realignment is complete, the existing rail corridor would be utilized for transit, presenting benefits to commuters and citizens of Wilmington, as well as visitors.

Transit Benefits

The addition of a transit line through Wilmington would present benefits of a modal shift by taking cars off the local roads in favor of the transit line. This would result in further emissions reductions, would alleviate congestion, improve quality of life and public health, and would increase property values that are located within proximity to transit stations.

The Feasibility Study quantified annual transit benefits[19] to be $7.9 million annually, when adjusted to 2017 dollars. The analysis grew the annual transit benefits of the Project by 1.4 percent over the course of the analysis period, proportional to the projected population growth of Wilmington in that time period before discounting to 2017 dollars. ***In total, the Project would result in $68.6 million in transit benefits when discounted at 7 percent.***

Qualitative Benefits

With construction of the Project, there would be reduced conflicts downtown between auto and rail traffic. As a result, the scope and/or cost of some other transportation projects may be affected. For example, the Independence Boulevard Extension project[20] in downtown Wilmington is currently expected to include two grade separations where Independence Boulevard crosses the rail line; however, because of the Project eliminating the freight conflict, the grade separations may not be needed, potentially saving taxpayers money.

In addition, because the Project allows for freight trains to save time by going around Wilmington, there may be additional efficiencies gained at the Port of Wilmington. While it has been noted that the Port will expand to meet both growing import and export demand, it is not possible to quantify the efficiency gains at this time.[21] [22]

Finally, property values are affected by the removal of freight nuisance noise and emissions, as well as the addition of transit service. In the past two decades, property values have appreciated faster in urban, compact cities than in suburbs or rural areas, and in 2015 the average home value in cities grew by 11.3 percent compared to a 6.7 percent appreciation in the suburbs.[23] If the City of Wilmington experiences urban infill and mixed use development to support transit, as prioritized in the Create Wilmington

[18] BEA Rate of Depreciation, Service Lives, Declining-Balance Rates, and Hulten-Wykoff Categories, http://www.bea.gov/scb/account_articles/national/wlth2594/tableC.htm
[19] RTA, New Orleans UPT/French Quarter Streetcar TIGER Grant Application, September 15, 2009
[20] NCDOT Independence Boulevard Extension Project Highlights, https://www.ncdot.gov/projects/independence-boulevard/Pages/project-highlights.aspx
[21] City of Wilmington, Wilmington Rail Realignment and Right of Way Use Alternatives Feasibility Study (2017).
[22] NCDOT 2015 Comprehensive State Rail Plan, Chapter 2, https://www.ncdot.gov/divisions/rail/Pages/rail-plan.aspx
[23] Litman, Todd, "Selling Smart Growth," The Victoria Transportation Institute, 2018, http://www.vtpi.org/ssg.pdf.

Comprehensive Plan, property values could increase with the addition of a new transit line, resulting in additional property premium benefits not quantified in this analysis.[24]

5. Costs

The Project has two cost components: the initial capital costs and ongoing operating and maintenance (O&M) costs. The components used in this analysis are described in this section.

Capital Costs

The rough order of magnitude capital costs for the Project include the costs for track, structures, site-work, and roadway. At this stage of project development, a 40 percent contingency is assumed. For completeness, right of way and utilities were added assuming that they will make up 8 percent of the total rail project costs, or 4 percent each. Capital costs were given in 2016 dollars and converted to 2017 dollars using the GDP deflator, resulting in a total cost of $705.8 million.

The costs of transit are based on the recommended Alternative 3 rough order of magnitude cost of $136.5 million (2017 dollars), and do not include real estate, railroad right-of-way and track usage. The 35 percent contingency is assumed to cover those items.

The capital costs are applied over the three-year project construction period, beginning in 2025 and ending in 2027. ***The total capital cost for the Project discounted at 7 percent is $489.2 million.***

Annual Operating and Maintenance Costs

The Project would require annual and periodic operating and maintenance (O&M) expenditures to maintain the new bridge and track, as well as the existing track and new transit operations. At this stage of project development, O&M expenditures are unknown; therefore, the BCA assumes that annual O&M will be $1 million per year. ***The O&M costs over the analysis period and discounting at 7 percent is $6.7 million.***

6. BCA Results

The analysis results in a Project BCA ratio of nearly 1.12 when discounted at a rate of 7 percent, and increases to 2.33 when discounted at 3 percent. Exhibit 9 displays a summary of the BCA results for the Project.

[24] City of Wilmington, Create Wilmington Comprehensive Plan, 2016, http://flipbook.wilmingtonnc.gov/pdt/policies/files/assets/basic-html/page-1.html.

Exhibit 9 – BCA Results

	7% Discount Rate	3% Discount Rate
Costs (2017 $M)		
Capital Costs	$489.2	$669.5
Total Capital Costs	$489.2	$669.5
Benefits (2017 $M)		
Ability to Meet Existing or Anticipated Demand		
Benefits captured under *Effects on Safety, Competitiveness, Reliability, Trip or Transit Time, and Resilience* and *Efficiencies from improved integration with other modes*		
Effects on System and Service Performance		
Freight train operating cost savings	$11.5	$28.3
Sub-total	*$11.5*	*$28.3*
Effects on Safety, Competitiveness, Reliability, Trip or Transit Time, and Resilience		
Grade Crossing Benefits		
Expected crash cost savings by avoiding conflicts with trains	$2.0	$4.9
Value of passenger time saved as a result of avoiding train delay	$193.5	$602.4
Vehicle operating cost savings as a result of avoiding train delay	$19.8	$61.6
Emissions saved as a result of avoiding train delay	$1.7	$5.4
Value of improved fire truck response time	$0.1	$0.3
Value of improved EMS response time	$4.2	$9.8
Reliability benefit	$210.2	$558.8
Train emission savings	$18.9	$46.4
Residual value	$22.7	$100.4
Sub-Total	*$473.3*	*$1,390.1*
Efficiencies from improved integration with other modes		
Total expected benefits of transit system	$68.6	$158.5
Sub-Total	*$68.6*	*$158.5*
Outcome		
Total Benefits	$553.4	$1,576.9
O&M Costs	-$6.7	-$15.0
Net Benefits	**$546.7**	**$1,561.9**
Capital Costs	**$489.2**	**$669.5**
Net Present Value (2017 $M)	**$57.4**	**$892.4**
Benefit-Cost Ratio	**1.12**	**2.33**

7. List of Supporting Documents and Attachments

BEA Rate of Depreciation, Service Lives, Declining-Balance Rates, and Hulten-Wykoff Categories, http://www.bea.gov/scb/account_articles/national/wlth2594/tableC.htm

Caroline Curran, Crain's, "The Queen City shifts from traditional transportation options," September 13, 2017, https://www.crains.com/article/news/queen-city-shifts-traditional-transportation-options

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USDOT Benefit-Cost Analysis (BCA) Resource Guide, March 1, 2016, https://www.transportation.gov/sites/dot.gov/files/docs/BCA%20Resource%20Guide%202016.pdf

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US EPA, Office of Transportation and Air Quality, Emissions Factors for Locomotives, EPA-420-F-09-025, April 2009, p.2, http://www.epa.gov/nonroad/locomotv/420f09025.pdf

White House Office of Management and Budget. Historical Tables, Table 10.1 – Gross Domestic Product and Deflators Used in the Historical Tables 1940-2021.
https://www.whitehouse.gov/omb/budget/Historicals

Attachments:

Wilmington_CRISI_BCA excel workbook

GradeDec Output Reports:

4.4tpd2028.pdf

8.2tpd2040.pdf

9.6tpd2050.pdf