Executive Summary

The proposed Broad Street Bus Rapid Transit (BRT) project requires investment in capital and operating expenses for a service that is expected to reduce travel times for transit users, increase property values, and reduce crashes along key segments of the corridor. Other tabulated costs include a marginal travel delay for motorists where a travel lane will be converted to a dedicated BRT lane. In all, the Broad Street BRT project will improve the mobility of regional and local transit users, develop a more efficient transit system, support existing transit oriented land use, support plans to generate new transit oriented development, and provide an attractive alternative to the automobile for east-west travel. Transit-dependent populations who live and or work on the corridor will benefit the most from this investment.

The anticipated project costs and benefits in this Benefit-Cost Analysis (BCA) are expressed in constant 2014 dollars. In instances where estimates or valuations were expressed in past or future dollars, the U.S. Bureau of Labor Statistics' Consumer Price Index for Urban Consumers (CPI-U) was used to adjust them to 2014 values.[1] Final benefits and costs are reported discounted to the year 2014 as specified in the Notice of Funding Availability.[2] The real discount rates used for this analysis were 7.0% and 3.0%, consistent with U.S. DOT guidance for TIGER grants and the OMB Circulars A-4 and A-94.[3] The BCA uses 2040 as a horizon year, representing 26 years from the project's start date.[4]

Table 1 identifies the various benefits, segmented by TIGER Evaluation Criteria, some of which are quantified and monetized in this BCA. Subsequent sections of the BCA detail all quantifiable benefits and costs, while the Excel workbook catalogues all assumptions, calculations, and results. Several other qualitative benefits, which could not be reasonably quantified under the scope of this analysis, are also identified in Table 1 and reflected in this BCA. All technical reports referenced in this BCA are attached included as an appendix or can be found on the project website at: http://study.ridegrtc.com/documents/.

[1] Bureau of Labor Statistics (BLS). Consumer Price Index (CPI) – All Urban Consumers. Series ID: CUUR0000SA0, Base Period: 1982-84=100.
[2] USDOT. Notice of Funding Availability for the Department of Transportation's National Infrastructure Investments under the Consolidated Appropriations Act, 2014. http://www.dot.gov/tiger/nofa
[3] Office of Management and Budget (OMB). OMB Circular A-4 and OMB Circular A-94. http://www.whitehouse.gov/omb/circulars_default
[4] USDOT. Benefit-Cost Analyses Guidance for TIGER Grant Applications. Page 2 states that "applicants must estimate both benefits and costs for each year after a project's start state and for a period of time of *at least* 20 years.

TABLE 1: PROJECT BENEFITS (MATRIX)

Current Status/ No Build & Problem to be Addressed	Change to No Build/Alternatives	Types of Impacts	Population Affected by Impacts	Economic Benefit (2014 Dollars)	Summary of Results (Net Present Values at 7% and 3% discount rates)	Page Reference in BCA
The Broad Street project corridor accounts for approximately 6% of the population and 25% of all jobs in the City of Richmond and Henrico County. Transit along the project corridor is currently characterized by slow bus speeds and long travel times for bus patrons, many of whom are disadvantaged. There are nearly 20,000 boardings and alightings on an average weekday along the Broad Street corridor. The majority of bus stops handle more than 50 boardings and alightings per day (150 - 2,000 in the downtown area). Over 15% of AM peak period buses cannot maintain their target average run times.	Reduced travel times along the corridor (14 minutes). Improved transit and vehicle operations in the corridor through the designation of an exclusive standard width bus lane, minimizing conflicts between automobiles and transit vehicles. Signal prioritization at intersections will help increase route efficiency. Consolidated stations and improved bus lanes downtown will enhance operations on Broad Street between 2nd and 14th Streets. A total of 11,900 daily linked trips are projected for the BRT system in the opening year, with 6,100 of those trips coming from zero-car households. Unique branding (stations, vehicles, guideway, signage, and marketing efforts) will help distinguish BRT and make it an attractive transportation alternative.	**State of Good Repair** • Asset management • Reduction in vehicles miles traveled	• GRTC system and its users • Corridor travelers (all modes)	• *Qualitative*	• *Qualitative impacts*	Pgs. 10-11
		Economic Competitiveness • Movement of workers or goods (travel time savings)	• Existing transit users who are expected to switch from Route 6 to BRT (2,560 riders)	• + $1.6 million, annually	• + $14.6 million at 7% • + $23.8 million at 3%	Pgs. 11-12
		Economic Competitiveness • Movement of workers or goods (travel time delays)	• Corridor motorists	• - $260,000, annually	• - $2.6 million at 7% • - $4.1 million at 3%	Pg. 8
		Economic Competitiveness • Economic productivity of land, capital, and labor (increased property values)	• Property owners along the corridor [1] (~ 3,000 residential properties, ~ 1,500 commercial properties)	• + $14.1 million - $16.6 million, annually (for six-year period)	• + $72.8 at 7% • + $83.0 million at 3%	Pgs. 13-16
		Economic Competitiveness • Development/redevelopment	• Property owners along the corridor [1] (~ 3,000 residential properties, ~ 1,500 commercial properties)	• *Qualitative*	• *Qualitative impacts*	Pg. 17
		Quality of Life • Mayor's Anti-Poverty Comm. • Increased transportation choices • Improved connectivity • Land use / econ. development	• Disadvantaged populations [2] Low-income: ~ 37,800 Minorities: ~ 13,350 • Metro-area residents	• *Qualitative*	• *Qualitative impacts*	Pgs. 18-19
		Environmental Sustainability • Reduced operating costs for owners of personal vehicles • Other environmental impacts	• New transit users (490 riders) • Metro-area residents	• + $119,000 annually • *Qualitative*	• + $1.1 million at 7% • + $1.8 million at 3% • *Qualitative impacts*	Pgs. 19-22
		Safety • Crash reduction	• Corridor motorists/transit users	• + $16,000 annually	• + $150,000 at 7% • + $245,000 at 3%	Pgs. 22-24

[1] Source: City of Richmond and Henrico County Assessment Data (2009)

Note: + Indicates benefits; - indicates costs

[2] Source: 2010 U.S. Census, based on population within 1/2 mile of proposed BRT stations

The majority of the project costs apply to construction and operating expenses for the BRT system. In addition, the project construction and design elements could contribute to marginal travel delays for motorists. The anticipated project costs are summarized in Table 2 below and can also be found in the Excel workbook (Tabs 3 and 4).

TABLE 2: SUMMARY OF COSTS

		Undiscounted Costs (2014 dollars)					
Calendar Year	Project Year	Engineering & Construction Costs *Tab 3 of workbook*	Operating Costs (Build-No Build) *Tab 3 of workbook*	Delay Costs for Motorists [1][2] *Tab 4 of workbook*	Total Costs	**Total Cost Discounted at 7%**	**Total Cost Discounted at 3%**
2014	0	$0	$0	$0	$0	$0	$0
2015	1	$9,721,718	$0	$0	$9,721,718	$9,085,718	$9,438,561
2016	2	$19,443,436	$0	$0	$19,443,436	$16,982,650	$18,327,303
2017	3	$19,443,436	$0	$259,598	$19,703,034	$16,083,545	$18,031,067
2018	4	$0	$355,635	$259,598	$615,233	$469,358	$546,626
2019	5	$0	$355,635	$259,598	$615,233	$438,652	$530,705
2020	6	$0	$355,635	$259,598	$615,233	$409,956	$515,248
2021	7	$0	$355,635	$259,598	$615,233	$383,136	$500,241
2022	8	$0	$355,635	$259,598	$615,233	$358,071	$485,670
2023	9	$0	$355,635	$259,598	$615,233	$334,646	$471,525
2024	10	$0	$355,635	$259,598	$615,233	$312,753	$457,791
2025	11	$0	$355,635	$259,598	$615,233	$292,293	$444,457
2026	12	$0	$355,635	$259,598	$615,233	$273,171	$431,512
2027	13	$0	$355,635	$259,598	$615,233	$255,300	$418,944
2028	14	$0	$355,635	$259,598	$615,233	$238,598	$406,741
2029	15	$0	$355,635	$259,598	$615,233	$222,989	$394,894
2030	16	$0	$355,635	$259,598	$615,233	$208,401	$383,393
2031	17	$0	$355,635	$259,598	$615,233	$194,767	$372,226
2032	18	$0	$355,635	$259,598	$615,233	$182,025	$361,384
2033	19	$0	$355,635	$259,598	$615,233	$170,117	$350,859
2034	20	$0	$355,635	$259,598	$615,233	$158,988	$340,639
2035	21	$0	$355,635	$259,598	$615,233	$148,587	$330,718
2036	22	$0	$355,635	$259,598	$615,233	$138,866	$321,085
2037	23	$0	$355,635	$259,598	$615,233	$129,781	$311,733
2038	24	$0	$355,635	$259,598	$615,233	$121,291	$302,654
2039	25	$0	$355,635	$259,598	$615,233	$113,356	$293,839
2040	26	$0	$355,635	$259,598	$615,233	$105,940	$285,280
Total		**$48,608,590**	**$8,179,610**	**$6,230,341**	**$63,018,541**	**$47,812,954**	**$55,055,096**

[1] 46.56 hours per day x 365 days (assumption is intentionally conservative since delays are minimal during weekends/holidays).
[2] 16,994 hours of delay per year x ((% personal travelers x $12.63) + (% business travelers x $25.65))

Table 3 quantifies the anticipated project benefits. The assumptions used to monetize these benefits are conservative and reflect the guidance issued by the U.S. Department of Transportation (USDOT). In cases where USDOT guidance was unavailable or not applicable, the BCA relied on case study analyses and professional research. The assumptions are described in the **Long-Term Benefits** section of this report and are also shown in the Excel workbook (Tabs 5-12).

TABLE 3: SUMMARY OF BENEFITS

		Undiscounted Benefits (2014 Dollars)						
Calendar Year	Project Year	Travel Time Benefits for Transit Users [1][2] *Tab 5 of Workbook*	Property Value Benefits [3][4] Tabs 6,7 *of workbook*	User Benefits [4] *Tab 8 of workbook*	Crash Reduction Benefits [6] *Tabs 9-12 of workbook*	Total Benefits	**Total Benefit Discounted at 7%**	**Total Benefit Discounted at 3%**
2014	0	$0	$0	$0	$0	$0	$0	$0
2015	1	$0	$14,132,855	$0	$0	$14,132,855	$13,208,276	$13,721,219
2016	2	$0	$14,606,306	$0	$0	$14,606,306	$12,757,713	$13,767,844
2017	3	$0	$15,095,617	$0	$0	$15,095,617	$12,322,520	$13,814,628
2018	4	$1,582,198	$15,601,320	$118,643	$16,315	$17,318,476	$13,212,182	$15,387,241
2019	5	$1,582,198	$16,123,964	$118,643	$16,315	$17,841,120	$12,720,472	$15,389,907
2020	6	$1,582,198	$16,664,117	$118,643	$16,315	$18,381,273	$12,248,218	$15,394,027
2021	7	$1,582,198	$0	$118,643	$16,315	$1,717,156	$1,069,358	$1,396,205
2022	8	$1,582,198	$0	$118,643	$16,315	$1,717,156	$999,400	$1,355,538
2023	9	$1,582,198	$0	$118,643	$16,315	$1,717,156	$934,019	$1,316,057
2024	10	$1,582,198	$0	$118,643	$16,315	$1,717,156	$872,915	$1,277,725
2025	11	$1,582,198	$0	$118,643	$16,315	$1,717,156	$815,808	$1,240,510
2026	12	$1,582,198	$0	$118,643	$16,315	$1,717,156	$762,438	$1,204,378
2027	13	$1,582,198	$0	$118,643	$16,315	$1,717,156	$712,559	$1,169,299
2028	14	$1,582,198	$0	$118,643	$16,315	$1,717,156	$665,943	$1,135,242
2029	15	$1,582,198	$0	$118,643	$16,315	$1,717,156	$622,376	$1,102,177
2030	16	$1,582,198	$0	$118,643	$16,315	$1,717,156	$581,660	$1,070,075
2031	17	$1,582,198	$0	$118,643	$16,315	$1,717,156	$543,607	$1,038,907
2032	18	$1,582,198	$0	$118,643	$16,315	$1,717,156	$508,044	$1,008,648
2033	19	$1,582,198	$0	$118,643	$16,315	$1,717,156	$474,808	$979,270
2034	20	$1,582,198	$0	$118,643	$16,315	$1,717,156	$443,746	$950,747
2035	21	$1,582,198	$0	$118,643	$16,315	$1,717,156	$414,716	$923,056
2036	22	$1,582,198	$0	$118,643	$16,315	$1,717,156	$387,585	$896,171
2037	23	$1,582,198	$0	$118,643	$16,315	$1,717,156	$362,229	$870,069
2038	24	$1,582,198	$0	$118,643	$16,315	$1,717,156	$338,531	$844,727
2039	25	$1,582,198	$0	$118,643	$16,315	$1,717,156	$316,385	$820,123
2040	26	$1,582,198	$0	$118,643	$16,315	$1,717,156	$295,686	$796,236
Total		**$36,390,544**	**$92,224,180**	**$2,728,796**	**$375,238**	**$131,718,758**	**$88,591,193**	**$108,870,025**

[1] 6 minutes saved per day x 365 days x 2,560 riders
[2] 93,195 hours saved per year x ((% personal travelers x $12.63) + (% business travelers x $25.65))
[3] Property value premium (residential = 1.4% per year; office and retail = 2.4% per year) applied to 2015 - 2020 (6 year period)
Assumptions detailed on Page 13 of this BCA
[4] Assumes that property value benefits are reduced by 50.0% to account for capitalized travel benefit
[5] 490 "choice riders x 3.24 miles x $.20 per mile x 365 days
[6] FHWA crash reduction factors (ranging from 8% to 31%) were applied to the average annual crash rates (and costs) along the corridor
The "Long-Term Benefits" section of this BCA and the Excel workbook provide additional detail

Per USDOT guidance, all project benefits and costs were discounted to current dollars using the recommended 7.0% discount rate and the alternative 3.0% discount rate. The net present values and the corresponding BC ratios, comparing the discounted benefits and costs, are summarized in Figure 1 below.

FIGURE 1: NET PRESENT VALUES OF BENEFITS AND COSTS AND ANTICIPATED BC RATIOS

Net Present Value 7% Discount Rate

- Net present value of costs: $47.8 million
- Net present value of benefits: $88.6 million
- Total net present value of benefits including costs: $40.8 million
- **BC Ratio: 1.85**

Net Present Value 3% Discount Rate

- Net present value of costs: $55.1 million
- Net present value of benefits: $108.9 million
- Total net present value of benefits including costs: $53.8 million
- **BC Ratio: 1.98**

Project Summary

Existing Conditions

The annual ridership of GRTC Route 6 (existing primary route on Broad Street) has averaged about 1,000,000 riders since 2005, despite the long travel times and travel time variability in the corridor. A typical bus trip from downtown Richmond to the Willow Lawn retail center is approximately 30 to 40 minutes, while the same trip by car is typically 10 to 15 minutes. The existing volume of transit ridership on Broad Street buses demonstrates the demand for increased and more efficient transit services in the project area.

Over 20 bus routes operate along Broad Street for some portion of their alignment, including as many as 48 buses operating during peak times in the business district. The existing transit service in the corridor generally provide stops every 1-2 blocks, minimizing walk distance for patrons and maximizing accessibility to transit within each route's service area. This service pattern also leads to slow bus speeds and long travel times for bus patrons in the corridor.

For the purposes of this application and BCA, the No-Build Alternative assumes that:

- Route 6 will continue to offer on-board fare collection and operate under its current service plan with a corridor travel time of 36.3 minutes.
- Property values will increase at a base rate of 3.2% per year.[5]
- Vehicular crashes will continue at the same rate as in recent years (2009-2013).

[5] Baseline estimates were derived from the Case-Shiller Home Price Indices, which measure 100-year national housing trends. The Case-Shiller estimates an average annual growth rate of roughly 3.35 percent. This rate is consistent with that used by Henrico County for property value projections. Source: Schiff, Peter. "Home Prices are Still Too High." Wall Street Journal. December 2010.

Project Description

Greater Richmond Transit Company (GRTC), with support from the Department of Rail and Public Transit (DRPT), the City of Richmond, and Henrico County, will improve transit service along this corridor with **Broad Street Bus Rapid Transit.** The BRT will serve a high-density 7.6-mile corridor and bring the first fixed guideway transit service to the Richmond region, one of only 13 metropolitan regions of over one million without such service.

The corridor accounts for over 6% of the population and 25% of the jobs in the two-locality region (City of Richmond and Henrico County). The BRT will improve access to prominent historic districts, such as Jackson Ward and Carver, historically African-American neighborhoods located north of Broad Street. In addition, the BRT will serve major destinations such as Rocketts Landing, the Shockoe Bottom mixed-use district, Main Street Station (Amtrak), the state government complex along Broad and 14th Streets, Virginia Commonwealth University (VCU) Medical Center and MCV Campus, City Hall, the Greater Richmond Convention Center, VCU Monroe Park Campus, and The Shops at Willow Lawn.

Project Justification

Both regional and local issues drive the need for improvements to transit service along the Broad Street corridor. Regionally, there are significant commuter markets outside the project area with insufficient transit access to employment, shopping and service opportunities on the Broad Street corridor. Existing regional commuters are able to use I-95, I-64, and I-195 to access Broad Street by vehicle, but all of these interstates have segments performing at failing levels of service (LOS F).

Currently, all buses must operate in mixed traffic conditions through most of the corridor. Bus running times can vary widely depending on traffic conditions in the corridor. More than 15% of AM peak period buses cannot maintain their scheduled run times, and the travel times for buses is highly variable. The combination of these factors increases travel times and decreases service reliability in the corridor. These effects lengthen the time the largely transit-dependent riders must spend to access jobs, educational resources, and shopping.

Transit is underserved and upward mobility is limited in the Richmond metropolitan area. The Broad Street BRT will help add rungs to the "ladders of opportunity" in a region that ranks 85th out of 100 in upward mobility by improving access to jobs, education, and retail for transit dependent populations.[6] The upgraded BRT service will reduce travel times between homes and jobs, thereby increasing worker productivity. Finally, the project will offer a high quality alternative to the automobile and provide a unique service that, when combined with compatible land use policies, can help stimulate investment along a corridor where over 20% of the land is underutilized.

[6] Harvard University. Equality of Opportunity Project. 2014. http://www.equality-of-opportunity.org/index.php/city-rankings/city-rankings-100

Other Alternatives Considered

Implementation of both BRT and Light Rail Transit (LRT) were studied relative to the Broad Street Corridor. However, LRT was only considered feasible after 2031 given its substantially higher capital and operating costs. BRT shares right-of-way features with LRT, but not guidance or propulsion. BRT's service characteristics can be nearly identical to LRT. Speedy operation is achieved with dedicated right-of-way; longer stop spacing, traffic signal priority at intersections; and off-board fare collection with multiple points of entry/exit for rapid boarding. Additionally, both stations and vehicles are distinctively branded similar to rail transit services to attract greater ridership.

Project Costs

Capital and Operating Costs

The construction cost and schedule for the Build Alternative is based on project scoping and costing efforts. Project development activities and construction are expected to span from 2014 to 2018. Total construction costs are projected to be $48.6 million (2014 dollars). Table 4 below shows the anticipated capital costs, segmented by category or element.

TABLE 4: ESTIMATED CAPITAL COSTS: BUILD ALTERNATIVE

Category/Element	Cost 2014 $
Guideway & Track Elements	$4,020,632
Stations, Stops, Terminals, Intermodal	$3,923,321
Support Facilities	N/A
Sitework & Special Conditions	$11,190,785
Systems	$9,548,610
Row, Land, Existing Improvements	$1,805,337
Vehicles	$9,605,863
Professional Services [1]	$6,014,534
Unallocated Contingency	$2,499,510
Total Project Cost	**$48,608,590**

Source: Broad Street Rapid Transit Study,
Capital Cost Technical Report. Page 1. October 2013.
Deflated to 2014 dollars using average annual CPI (2004-2013)
[1] As discussed in the application, costs are reduced by the amount of the $4 million PE portion of Professional Services, as these funds are already committed.
See Tab 3 of the Excel workbook (C15,C22,C23,C24,C25)

The Build Alternative, with enhanced BRT service and increased efficiency, is estimated to cost less than one percent (0.8%) more than the No Build Alternative to operate, equivalent to an additional $355,635 per year.[7] Table 5 shows the anticipated operating cost (2014 dollars) for each alternative, including the increased costs associated with the BRT route.

TABLE 5: ESTIMATED OPERATING COST
NO-BUILD AND BUILD ALTERNATIVES

	Cost 2014 $
No-Build	$45,465,615
Build	$45,821,251
Net Increase	**$355,635/year**

Source: Broad Street Rapid Transit Study, Operating and Maintenance Cost Technical Report, Page 5. October 2013.
Deflated to 2014 dollars using average annual CPI (2004-2013)
See Tab 3 of the Excel workbook (Cells C32,C33)

Travel Time Costs: Motorist Delay

Travel time costs to automobile passengers occur in the portion of the corridor where a travel lane in each direction is replaced with the median-running BRT. In this portion of the corridor from Thompson Street to Adams Street, through traffic would be limited to the remaining two lanes in each direction on Broad Street.

The intersection level of service analysis, conducted during the environmental impact analysis stage of the project, indicates that BRT would have marginal operational impacts; only two of 23 intersections would experience a reduction in LOS to D or worse with the facility. In order to quantify the anticipated cumulative auto user travel time costs, a simulation analysis was conducted to reflect:

- What are the typical increases in intersection delay to autos during peak periods with the BRT facility?
- What is the cumulative delay to autos moving through the corridor, in light of simulated traffic patterns (i.e., cars turning onto and off of the Broad Street corridor)?

The available simulation model reflects AM and PM peak period conditions. The 24-hour delay was interpreted from the peak hour data. Auto occupancy was also considered in order to arrive at person-hours of impact. The methods and results to develop the 24-hour auto user travel time costs calculations are provided below.

Peak Hour Simulations

The same peak hour Synchro/Simtraffic models that were used for the traffic operations analysis in the Transportation Systems Technical Report were used to calculate the impacts to automobile travel along the section of Broad Street with proposed exclusive BRT lanes (from Thompson Street to Adams Street). The simulation was used to output total delay in hours along this section for both the AM and PM peak hours. The total delay between the No-Build and Build Alternatives were compared to determine the change in delay. The results of the analysis are provided in Table 6.

[7] The increased operating costs for the Broad Street BRT are partially offset by service efficiencies on Route 6. These service efficiencies, representing an adjusted service plan, are enabled by BRT's additional service and improved efficiency.

TABLE 6: ANTICIPATED MOTORIST DELAY

Negative User Benefit	Period	No-Build Alternative	Build Alternative	Difference
Number of Vehicles Impacted	AM Peak	1477 vehicles	1428 vehicles	-49 vehicles
	PM Peak	1754 vehicles	1764 vehicles	+10 vehicles
Average Delay per Vehicle in the Corridor	AM Peak	58 seconds	65 seconds	+7 seconds
	PM Peak	71 seconds	82 seconds	+10 seconds
Total Delay for Simulated Traffic in the Corridor	AM Peak	23.8 hours	25.8 hours	+2.0 hours
	PM Peak	34.6 hours	40.2 hours	+5.6 hours

Source: Broad Street Rapid Transit Study, Anticipated Motorist Delay Technical Report, Page 2. 2011. (BCA Appendix A)
See Tab 4 of the Excel workbook.

Off-peak hour delay was estimated based on the peak hour delay as hourly traffic volumes corridor-wide are not available for the whole day. The associated increases in delay (below) are conservative in nature.[8]

- Negligible from 12:00 a.m. to 6:00 a.m.
- Equal to the AM peak hour delay of 2.0 hours of delay from 6:00 a.m. to 11:00 a.m.
- Equal to the average of the AM & PM peak hour delay of 3.8 hours of delay from 11:00 a.m. to 1:00 p.m.
- Equal to the AM peak hour delay of 2.0 hours of delay from 1:00 p.m. to 4:00 p.m.
- Equal to the AM peak hour delay of 5.6 hours of delay from 4:00 p.m. to 6:00 p.m.
- Equal to the AM peak hour delay of 2.0 hours of delay from 6:00 p.m. to 8:00 p.m.
- Negligible from 8:00 p.m. to 12:00 a.m.

Total increase in delay for the 24-hour period is estimated at 38.8 hours of delay for vehicles. Using a vehicle occupancy rate of 1.2 persons per vehicle, the total increase in person hours of delay for the Build Alternative versus the No-Build Alternative equates to **47 hours of delay** over a 24-hour period.

The USDOT also provides an estimated composite value for "all purpose" travel (weighing personal and business), however, this value seems to substantially understate the number (and weight) of commuters along the Broad Street corridor. In order to ensure that benefits and costs are consistently measured, the calculations rely on comparable assumptions as described in the travel time savings section (see Long-Term Benefits).[9] While the travel time savings for transit riders are assumed to begin in 2018, the travel time delays for motorists are expected to occur as early as 2017. This assumption accounts for the travel time delays associated with construction activities along the median-running segment of the corridor.[10] It is estimated that BRT can contribute to 16,994 hours of motorist delay per year, equivalent to $259,598 in annual costs (Table 7) (Tab 4 of Excel Workbook).

[8] Broad Street Rapid Transit Study, Anticipated Motorist Delay Technical Report, Page 2. 2011. (BCA Appendix A)
[9] When monetizing travel time delays, the BCA relied on the National Household Travel Survey (NHTS). In the case of personal vehicle trips, the extracted data suggests that 20.3% of all personal vehicle trips are for the purpose of "earning a living."
[10] Construction activities are not expected to require significant lane closures, with the exception of the median-running segment of the corridor. Here, traffic delays during construction will likely be comparable to the traffic delays experienced once the BRT is in operation (since the median-running lanes will be closed to traffic during construction and operation).

TABLE 7: TRAVEL TIME COSTS FOR MOTORISTS

Calendar Year	Project Year	Hours of Delay [1]	Travel Time Costs Actual (2014 $) [2]	Travel Time Costs Discounted at 7%	Travel Time Costs Discounted at 3%
2014	0	$0	$0	$0	$0
2015	1	$0	$0	$0	$0
2016	2	$0	$0	$0	$0
2017	3	16,994	$259,598	$211,909	$237,569
2018	4	16,994	$259,598	$198,046	$230,649
2019	5	16,994	$259,598	$185,089	$223,931
2020	6	16,994	$259,598	$172,981	$217,409
2021	7	16,994	$259,598	$161,664	$211,077
2022	8	16,994	$259,598	$151,088	$204,929
2023	9	16,994	$259,598	$141,204	$198,960
2024	10	16,994	$259,598	$131,966	$193,165
2025	11	16,994	$259,598	$123,333	$187,539
2026	12	16,994	$259,598	$115,264	$182,077
2027	13	16,994	$259,598	$107,724	$176,773
2028	14	16,994	$259,598	$100,676	$171,625
2029	15	16,994	$259,598	$94,090	$166,626
2030	16	16,994	$259,598	$87,935	$161,773
2031	17	16,994	$259,598	$82,182	$157,061
2032	18	16,994	$259,598	$76,806	$152,486
2033	19	16,994	$259,598	$71,781	$148,045
2034	20	16,994	$259,598	$67,085	$143,733
2035	21	16,994	$259,598	$62,696	$139,546
2036	22	16,994	$259,598	$58,595	$135,482
2037	23	16,994	$259,598	$54,761	$131,536
2038	24	16,994	$259,598	$51,179	$127,705
2039	25	16,994	$259,598	$47,831	$123,985
2040	26	16,994	$259,598	$44,702	$120,374
Total		**407,866**	**6,230,341**	**2,600,586**	**4,144,053**

[1] 46.56 hours per day x 365 days (assuming 365 days is intentionally conservative since delays are minimal during weekends and holidays). Tab 4 of Excel workbook (Cells D28,B33)
[2] 16,994 hours of delay per year x ((% personal travelers x $12.63) + (% business travelers x $25.65)) Tab 4 of Excel workbook (Column J and cells G49)

Long-Term Benefits

State of Good Repair

The Broad Street BRT will enhance the performance of Richmond's existing transportation system. States of good repair benefits include asset management for buses, reduced vehicle miles traveled, and return of public investment.

Asset Management

In 2010, the Federal Transit Administration (FTA) indicated that over 40% of bus assets were in poor condition or approaching poor condition. According to the FTA Asset Management Guide, there is an estimated backlog of approximately $80 billion in deferred maintenance and replacement needs.[11] To maintain a State of Good Repair, GRTC has established maintenance and replacement policies for its buses including the following:

- Preventive maintenance inspections every 6,000 miles with AVM2 vehicle monitoring devices;
- Overhauls based on oil sample results from inspections (approximately 20-24 per year); and
- Replacement every 12 years.

GRTC anticipates reduced transit operating costs from travel time savings. The Broad Street BRT will use compressed natural gas (CNG) powered vehicles. GRTC is phasing in CNG vehicles to replace its entire fleet, and instituting BRT service will speed that process. The planned conversion to CNG is expected to lower unit fuel costs throughout the GRTC system.

Reduction in Vehicles Miles Traveled

The BRT system is expected to provide transit passengers with an enhanced and efficient bus service along the existing GRTC routes on Broad Street, 14th Street, and Main Street. The BRT can be expected to reduce regional vehicle miles traveled (VMT) in part because it supports mixed-use development in a corridor that serves the major regional employment center. Specifically, the Richmond Regional Planning District Commission (RAMPO) land use forecasts indicate an improved jobs-housing balance and increased land use densities in the corridor. The RAMPO forecasts predict a 22.0% increase in population and a 13.0% increase in jobs in the corridor from 2008 to 2035, improving the jobs to population ratio from 2.31 to 2.14. However, the population forecasts may be understated. The MPO forecasts predict an annual average growth rate of 0.4% for the City of Richmond from 2008 to 2035 whereas Census estimates from 2010 to 2013 show an average annual growth rate of 1.6%. The BRT project has the potential to draw more of the anticipated residential development into mixed-use along the corridor, enabling more trips via transit and lower rates of vehicle ownership - both of which would reduce VMT.

Economic Competitiveness

Movement of Workers or Goods – Travel Time Benefits (Quantified)

The Broad Street BRT can result in other ongoing benefits for users of the BRT system. It will take bus riders less time to travel along the BRT route from Willow Lawn to Rocketts Landing. It is estimated that under the No-Build Alternative, it will take 36.4 minutes to travel the entire length of the route. With the BRT, travel time is reduced to 22.4 minutes—a savings of 14 minutes. However, not all riders will travel the entire route. The National Transit Database (NTD) indicate that a typical rider in the GRTC system traveled an average 3.25 miles per trip.[12] Assuming BRT riders on the Broad Street corridor travel a similar length, an average rider can save about 6 minutes. With the development of BRT, it is anticipated that 440 riders will stay with the current bus service (Route 6), and 2,560 riders will switch to BRT service.[13] Given these assumptions, Broad Street BRT can save riders a total of 93,195 hours per year.

The USDOT recommends monetized travel time values equivalent to $12.63 (2014 dollars) per hour for personal travel and $25.65 (2014 dollars) per hour for business travel. The USDOT also provides an

[11] National State of Good Repair Assessment, FTA, 2010; and, Status of the Nation's Highways, Bridges and Transit, Conditions and Performance, FHWA, 2013.
[12] National Transit Database, 2009-2013. Using NTD data (corridor specific data were unavailable), a weighted average for four years (3.25) was developed based on the total passenger miles divided by the total unlinked passenger trips.
[13] Broad Street Rapid Transit Study Transportation System Technical Report, January 2014. Pages 36-37.

estimated composite value for "all purpose" travel (weighing personal and business), however, this value seems to substantially understate the number (and weight) of commuters along the Broad Street corridor.[14] As such, this BCA relied on extracted data from the National Household Survey to accurately reflect a higher proportion of commuter trips.[15] Given the estimates for hours saved and hourly values, it is anticipated that BRT can account for $1.6 million in travel time savings per year (Table 8). The Excel workbook (Tab 5) includes all assumptions and calculations.

TABLE 8: TRAVEL TIME BENEFITS FOR TRANSIT USERS

Calendar Year	Project Year	Hours Saved [1]	Travel Time Savings Actual (2014 $) [2]	Travel Time Savings Discounted at 7%	Travel Time Savings Discounted at 3%
2014	0	$0	$0	$0	$0
2015	1	$0	$0	$0	$0
2016	2	$0	$0	$0	$0
2017	3	$0	$0	$0	$0
2018	4	93,195	$1,582,198	$1,207,051	$1,405,762
2019	5	93,195	$1,582,198	$1,128,085	$1,364,818
2020	6	93,195	$1,582,198	$1,054,285	$1,325,066
2021	7	93,195	$1,582,198	$985,313	$1,286,471
2022	8	93,195	$1,582,198	$920,853	$1,249,001
2023	9	93,195	$1,582,198	$860,611	$1,212,623
2024	10	93,195	$1,582,198	$804,309	$1,177,304
2025	11	93,195	$1,582,198	$751,691	$1,143,013
2026	12	93,195	$1,582,198	$702,515	$1,109,722
2027	13	93,195	$1,582,198	$656,556	$1,077,400
2028	14	93,195	$1,582,198	$613,604	$1,046,019
2029	15	93,195	$1,582,198	$573,461	$1,015,552
2030	16	93,195	$1,582,198	$535,945	$985,973
2031	17	93,195	$1,582,198	$500,883	$957,256
2032	18	93,195	$1,582,198	$468,115	$929,374
2033	19	93,195	$1,582,198	$437,491	$902,305
2034	20	93,195	$1,582,198	$408,870	$876,024
2035	21	93,195	$1,582,198	$382,121	$850,509
2036	22	93,195	$1,582,198	$357,123	$825,737
2037	23	93,195	$1,582,198	$333,760	$801,686
2038	24	93,195	$1,582,198	$311,925	$778,336
2039	25	93,195	$1,582,198	$291,519	$755,666
2040	26	93,195	$1,582,198	$272,447	$733,657
Total		**2,143,495**	**$36,390,544**	**$14,558,532**	**$23,809,275**

[1] 6 minutes saved per day x 365 days x 2,560 riders
Tab 5 of Excel workbook (cells B11,B12,B13)
[2] 93,195 hours saved per year x ((% personal travelers x $12.63) + (% business travelers x $25.65))
Tab 5 of Excel workbook (cells C20,C21,J54).

[14] USDOT. TIGER BCA Resource Guide, 2014. http://www.dot.gov/policy-initiatives/tiger/tiger-bca-resource-guide-2014
[15] National Household Travel Surveys (NHTS). Data Extraction Tool. http://nhts.ornl.gov/det/Extraction3.aspx. Assumes 33.4% of all transit trips are for the purpose of "earning a living."

Economic Productivity of Land, Capital, and Labor

Increased Property Values (Quantified)

Few research studies have focused on quantifying economic impacts associated with bus rapid transit systems. Given these data constraints, the GRTC and the City of Richmond conducted an exhaustive quantitative analysis of one particular BRT route: the Euclid Corridor (HealthLine BRT) in Cleveland, Ohio. While no two corridors are identical in form, level of investment, and function, Cleveland's Euclid Corridor, operating from the Central Business District (CBD) to East Cleveland and serving prominent educational and healthcare institutions, is perhaps the most comparable to Richmond's Broad Street Corridor. The Euclid findings, discussed below, were applied to specific components of the Broad Street analysis. This data analysis was supplemented by interviews with planning and economic professionals in the City of Richmond and Henrico County.

Real estate was studied in the Broad Street and Euclid corridors to measure property value growth with, and without BRT. For the Broad Street Corridor, anticipated growth was based on historic trend data. Meanwhile, the Euclid study, comparing property value appreciation in the BRT corridor to that in the surrounding cities, was used to measure BRT's potential impact on property values. This impact (or premium), when annualized, was subsequently applied to the Broad Street Corridor's Build Alternative.

Prior to analyzing BRT's role in stimulating property values (and tax revenues) along the Broad Street Corridor, this study first attempted to forecast property value appreciation under current, baseline conditions. In doing so, the study relied on 100-year national trend data and assumed an average annual increase of roughly 3.4%.[16] The 3.4% annual growth rate was applied to the retail, office and residential markets and ultimately represented the baseline growth estimates for the Build and No Build Alternatives.[17]

Meanwhile, the study also compared the property value appreciation along the Euclid Corridor to that in Cleveland and East Cleveland (used as the "control" for the analysis), thereby providing an indication of BRT's capacity to increase property values. The Euclid Corridor findings, measuring BRT's annual induced impact (CAGR) over six years (2005 to 2011), were applied to the Broad Street study area's Build Alternative. This approach accounted for post-BRT trends in Cleveland, as well as local trends in the Broad Street Corridor. Cleveland's Euclid Corridor has seen a surge in property values since 2005 (year of HealthLine construction), particularly when compared to the corridor's surrounding cities (Cleveland and East Cleveland). The detailed assessment findings, discussed in the next paragraph, are relatively consistent with that of light rail. A recent University of Oregon study highlights evidence of light rail's impacts on property values, showing that single-family properties located near a station sell at premiums of upward to 10.0%.[18] Multi-family homes and commercial properties (near stations) have exhibited even higher property value premiums. Meanwhile, the *Columbia Pike Transit Initiative- Return*

[16] Baseline estimates were derived from the Case-Shiller Home Price Indices, which measure 100-year national housing trends. The Case-Shiller estimates an average annual growth rate of roughly 3.35 percent. This rate is consistent with that used by Henrico County for property value projections. Source: Schiff, Peter. "Home Prices are Still Too High." Wall Street Journal. December 2010. http://online.wsj.com/article/SB10001424052702304173704575578190261574342.html

[17] Compound Annual Growth Rate (CAGR): Captures the year-over-year growth rate of appreciation and accounts for compounding.

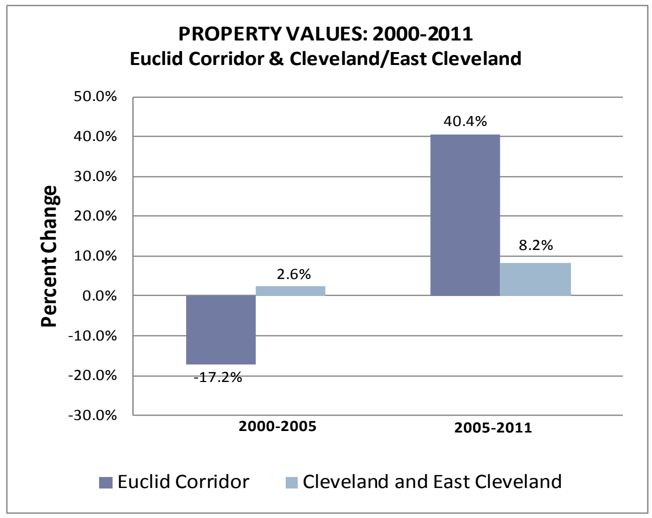
[18] Ickler, Megen; Hodel, Peter. "The Value of Bus Rapid Transit: Hedonic Price Analysis of the EmX in Eugene, Oregon." Department of Economics; Honors Papers. University of Oregon, 2012.

on Investment Study, projected impacts based on a conservative scenario (4.0% premium) and an aggressive scenario (10% premium).[19]

Cuyahoga County's assessment database was analyzed in geographic information system (GIS) software to compare the aggregate property value growth (Per Square Foot – PSF) in the Euclid Corridor (study area) to that of Cleveland and East Cleveland, as a whole.[20] The data indicate that study-area property values declined by 17.2% from 2000 to 2005, while the cities' property values increased by 2.6% over the same time period (Figure 2). However, the study-area property values increased dramatically by 40.4% from 2005 to 2011, while the cities' property values increased marginally by 8.2%.

When segmented by land use, commercial property values (PSF) increased by 45.2% in the Euclid Corridor and by 26.9% in the cities. Meanwhile, residential property values (PSF) increased by 9.1% in the corridor and by 0.6% in the cities. When annualized at a compounded rate (CAGR), the corridor's commercial and office properties received a 2.4% annual premium *over* the cities' comparable market segment. The corridor's residential properties received a 1.4% annual premium *over* the cities' residential properties. The Euclid Corridor premiums, measuring the potential induced impact of the BRT investment, were subsequently applied to Richmond's Build Alternative.

FIGURE 2: CHANGE IN PROPERTY VALUES ALONG THE EUCLID CORRIDOR



Source: Cuyahoga County Auditor, Fiscal Officer

Richmond Study Area, Property Value Impacts: The Euclid Corridor findings, when applied to the growth projections along the Broad Street corridor, indicate that BRT could reasonably increase property values by $72.8 million, discounted at 7.0% over 26 years. The following assumptions were used when applying the Euclid Corridor findings to the Broad Street BRT study area. The assumptions are conservative and strictly apply to land values.

- In projecting baseline growth, this study relied on 100-year national trend data and assumed an average annual property value increase of roughly 3.4%.
  - The 3.4% annual growth rate was applied to the retail, office and residential markets and ultimately represented the baseline growth estimates for the No-Build and Build Alternatives.
  - The study only considered land values (not the associated improvements).
- Pursuant to USDOT guidance, property value premiums (derived from the Euclid Corridor analysis) were applied as one-time "stock" benefits, divided over a six-year period. In efforts

[19] Fairfax County, Virginia; Arlington County, Virginia; Washington Metropolitan Area Transit Authority. "Columbia Pike Transit Initiative: Return on Investment Study. July 2012.
[20] The Euclid "study area" properties were analyzed at a ¼ mile buffer from the Euclid Avenue HealthLine.

to maintain a conservative approach, the premiums were not treated as a stream of benefits. In other words, the projected property values did not accrue the benefits that were already assigned to previous years.

  - Office and retail properties received a 2.4% premium for six consecutive years, beginning in 2015 and ending in 2020.
  - Residential properties received a 1.4% premium for six consecutive years, beginning in 2015 and ending in 2020.

- The "induced" property value benefits were reduced by 50.0% to account for capitalized travel benefits since a portion of impacts can be attributed to improved accessibility. The study assumed 50.0% attribution based on the 25.0%-75.0% range mentioned in *USDOT's 2010 Benefit/Cost Analysis Workshop*.[21]

Table 9 summarizes the anticipated property value impacts along the Broad Street BRT corridor. Meanwhile, the Excel workbook (Tabs 6 and 7) identifies the key assumptions and highlights the calculations.

[21] Department of Transportation and Texas Transportation Institute. Benefit/Cost Analysis for Transportation Infrastructure: A Practitioner's Workshop. Washington, D.C. May 17, 2010.

TABLE 9 – ANTICIPATED PROPERTY VALUE IMPACTS

		Undiscounted Values in 2014 Dollars				
Calendar Year	Project Year	Corridor Property Values (No-Build)	Corridor Property Values (Build) [1] [2]	Net Impact (Build - No-Build)	Net Impact (Build - No Build) Discounted at 7%	Net Impact (Build - No Build) Discounted at 3%
2014	0	$1,454,364,201	$1,454,364,201	$0	$0	$0
2015	1	$1,503,085,402	$1,531,351,113	$14,132,855	$13,208,276	$13,721,219
2016	2	$1,553,438,763	$1,582,651,375	$14,606,306	$12,757,713	$13,767,844
2017	3	$1,605,478,962	$1,635,670,196	$15,095,617	$12,322,520	$13,814,628
2018	4	$1,659,262,507	$1,690,465,147	$15,601,320	$11,902,173	$13,861,571
2019	5	$1,714,847,801	$1,747,095,730	$16,123,964	$11,496,164	$13,908,673
2020	6	$1,772,295,202	$1,805,623,437	$16,664,117	$11,104,005	$13,955,936
2021	7	$1,831,667,092	$1,831,667,092	$0	$0	$0
2022	8	$1,893,027,939	$1,893,027,939	$0	$0	$0
2023	9	$1,956,444,375	$1,956,444,375	$0	$0	$0
2024	10	$2,021,985,262	$2,021,985,262	$0	$0	$0
2025	11	$2,089,721,768	$2,089,721,768	$0	$0	$0
2026	12	$2,159,727,447	$2,159,727,447	$0	$0	$0
2027	13	$2,232,078,317	$2,232,078,317	$0	$0	$0
2028	14	$2,306,852,940	$2,306,852,940	$0	$0	$0
2029	15	$2,384,132,514	$2,384,132,514	$0	$0	$0
2030	16	$2,464,000,953	$2,464,000,953	$0	$0	$0
2031	17	$2,546,544,985	$2,546,544,985	$0	$0	$0
2032	18	$2,631,854,242	$2,631,854,242	$0	$0	$0
2033	19	$2,720,021,359	$2,720,021,359	$0	$0	$0
2034	20	$2,811,142,074	$2,811,142,074	$0	$0	$0
2035	21	$2,905,315,334	$2,905,315,334	$0	$0	$0
2036	22	$3,002,643,398	$3,002,643,398	$0	$0	$0
2037	23	$3,103,231,951	$3,103,231,951	$0	$0	$0
2038	24	$3,207,190,222	$3,207,190,222	$0	$0	$0
2039	25	$3,314,631,094	$3,314,631,094	$0	$0	$0
2040	26	$3,425,671,236	$3,425,671,236	$0	$0	$0
Total		**$62,270,657,339**	**$62,455,105,699**	**$92,224,180**	**$72,790,851**	**$83,029,871**

[1] Property value premium (residential = 1.4% per year; office and retail = 2.4% per year) applied to 2015 - 2020 (6 year period).
Tab 7 of Excel Workbook (Cells B103, B104)
[2] Assumes that property value benefits are reduced by 50.0% to account for capitalized travel benefit (Tab 6 of Excel workbook, cell M18)

Development and Redevelopment

Spin-off activity (new construction and rehabilitation) was also considered in this analysis; however, given the unpredictable nature of real estate development and the lack of supportive data, any quantitative projections would be highly speculative. The following qualitative discussion identifies the ways in which the Broad Street BRT could improve the integration of land use and transportation and stimulate development and redevelopment along the corridor.

The Broad Street Corridor can benefit from additional residential and commercial development. Following BRT construction, the Euclid Corridor in Cleveland attracted substantial investment.[22] As discussed earlier, the Euclid Corridor and the Broad Street corridor share many similarities. As was the case with certain sections of Euclid Avenue, downtown Broad Street was the former commercial anchor of the region, with multiple flagship department stores. However, with the rise of suburban shopping malls and increased reliance on automobiles of area residents, this once-vibrant segment experienced continuing decline. In recent years, some of those empty storefronts have been redeveloped into hotels and condominiums, especially in the vicinity of the Richmond Convention Center and Richmond Center Stage.

Bus rapid transit, if implemented effectively, could further enhance the corridor's image and stimulate residential demand, particularly for those residents seeking to reduce their dependence on automobiles. Given increased demand, residential vacancy will continue to fall, potentially paving the way for additional development and redevelopment. In fact, market activity suggests that this urban residential demand already exists. Discussions with real estate brokers confirm this trend.[23] For example, 700 City Centre, located two blocks from Broad Street, represents a significant mixed-use project. In addition, developers are in the process of converting the 9.6 acre Interbake facility (near Broad Street and the Boulevard) to approximately 180 apartments and nearly 40,000 square feet in retail. Conversations with the City also indicate that Scott's Addition, located north of Broad Street between I-195 and the Boulevard, could continue to attract investment, particularly as developers and creative entrepreneurs convert historic properties to residential uses.[24]

BRT will also increase mobility and accessibility for Henrico County residents, particularly as new projects come to fruition in the corridor. In addition to the activity at Rocketts Landing (the County's first Urban Mixed Use Project), several other notable projects have been proposed near the proposed BRT route.[25] The Faison School, located west of Willow Lawn, could see an additional 45 residential units and 10,000 square feet of commercial space. Meanwhile, Staples Mill Centre, located within ¾ mile of the proposed Willow Lawn terminus, represents a $434 million mixed use project and is scheduled to offer apartments (1,096 units), condos (571 units), townhouses (267 units), 60,000 square feet of office and 109,000 square feet of retail. The future residents of Staples Mill Centre will inevitably benefit from the availability of BRT service in the County.

Furthermore, BRT can help increase sales at current establishments and potentially trigger additional retail development. Willow Lawn, an outdoor shopping center with grocery stores, pharmacies, and

---

[22] The Cleveland Plain Dealer conducted a thorough analysis of development along the Euclid Corridor (2008). The following link shows the map of development activity: http://media.cleveland.com/pdextra/other/Euclid.pdf
[23] This is based on informal conversations with local residential and commercial brokers (CB Richard Ellis).
[24] Based on discussions with the City's Planning Department, and Economic and Community Development Department.
[25] Source: Henrico County Planning Department.

restaurants, could see higher sales due to enhanced accessibility. In addition, continued residential development may lead to increased demand for retail, restaurants and services. Ultimately, higher retail sales and additional business development will yield higher taxes (sales, meal, admission, and BPOL) for the local governments.

While news of the proposed BRT route is not necessarily stimulating current investments, the case study research shows that BRT can act as a catalyst for new development initiatives and, in some cases, increase the pace of development. As seen in Cleveland, BRT helped cultivate development in MidTown, which had previously been a neglected segment of the Euclid Corridor. The creative investments ultimately led to the emergence of the “Health-Tech Corridor (HTC).” The three-mile, 1,600-acre section has attracted tremendous investment, including 210,000 square feet of new office, lab and flex space that is slated to open in 2012 at 80.0% occupancy. Baiju Shah, BioEnterprise President and co-creator of the HTC, remarked that “we wouldn’t have expected this type of thing until five or so years out.” He believes that the HealthLine BRT served as an impetus for developers looking to invest in projects along the corridor.[26]

BRT’s success as a development catalyst ultimately depends on complementary land use policies, supportive economic development strategies and the type of service which is provided.[27] Local market conditions will also determine the timing and magnitude of development. As residential activity increases in downtown Richmond, the retail market will likely respond to the increased demand for local goods and services.

The proposed BRT investment, with 14 stations, 10-minute headways in the peak period and 15-minute headways the remainder of the day, over 3 miles of dedicated lanes, and amenities that resemble light rail service, represents a substantial and permanent transportation investment that has the ability to be a catalyst for higher density growth and greater commercial activity in the corridor. To reach its full potential, however, the lessons learned from other BRT systems indicate that community partnerships are essential, as are the complementary policies and investments noted above.

Quality of Life

The Mayor’s Anti-Poverty Commission

In the spring of 2011, Mayor Dwight C. Jones launched an Anti-Poverty Commission, called the **Maggie L. Walker Initiative for Expanding Opportunity and Fighting Poverty.** The Commission consisted of forty community members including elected officials, nonprofit and community organization leaders, clergy, and academics. The initiative includes a long-term goal to reduce poverty and an immediate impact action step to connect residents to sustainable living wage employment. The initiative focuses on resources and investments that build an effective ladder out of poverty, and provide the supports necessary to City residents to climb that ladder. *The initiative’s Citizen Advisory Board identified bus rapid transit as one of the highest priority action items.*

Specifically, the initiative recommends developing a regional bus rapid transit system to unite the regional economy, bolster ecological sustainability, and allow car-less city residents to access suburban job opportunities. The BRT, if implemented, would improve mobility along a high-density corridor by

[26] Hellendrung, Jason. HealthLine Drives Growth in Cleveland. Urban Land Institute. July 13, 2012.
[27] Peterson, Sarah Jo. Bus Rapid Transit and Land Use. Urban land Institute (ULI). Page 81. July/August 2010.

increasing travel efficiency and comfort between various neighborhoods and activity centers, such as the retail center at Willow Lawn. Further, it represents the foundational segment of a regional BRT system.

Transportation Choices

The Broad Street BRT will particularly benefit the low-income and other disadvantaged groups in the corridor by providing additional transportation choice, faster travel times to access jobs along the corridor, improved station areas for transfers to other routes and the induced added development that will increase the supply of jobs in the corridor. The BRT fares will be the same as local GRTC bus fares (currently $1.50) and are therefore equally affordable as current transit service. Low-income households, minority populations and zero-car households are prominent in the corridor. Overall, approximately 46.0% of the population in the corridor is minority. Of the twenty-eight census tracts within the BRT project area, eleven tracts have higher than average levels of minority populations. The predominant minority in corridor is African-American. On average, 20.0% of households within the city are low income (earn less than 60.0% of the citywide median income). Within the BRT corridor, five census tracts have low-income household levels higher than 20.0%.

Connectivity

The study area corridor provides 1,562 affordable housing units, accounting for approximately 9.0% of the total units. Meanwhile, the share of affordable housing in the City of Richmond and Henrico County is lower, with a 7.0% allocation. The higher proportion of affordable housing units in the corridor, combined with the observations about income and transit-dependency, support the conclusion that the projects' benefits provide transportation choices to those residents in greatest need of mobility.

Land Use Planning and Economic Development

Density of households, jobs, and activities within a station area and the mix of land uses directly influence the level of transit usage. These attributes are critical to the initial and continued success of transit. In the Broad Street BRT corridor, much of the land-use density and mix and multimodal connectivity is already supportive of transit. The highest residential densities for both 2008 and 2035 are located between the Robinson and Adams Stations and the highest residential densities located at Adams. In addition, employment densities exceed 25,000 jobs per square mile from Shafer Street station to Main Street Station, and numerous areas to the west of downtown have job densities over 10,000 jobs per square mile.[28]

Environmental Sustainability

Energy Efficiency Improvements and Reductions in Oil Dependence and Emissions

User Benefits for New Transit Users

It is anticipated that the BRT will help attract riders who would otherwise use personal vehicles for commuting or other purposes. These riders would benefit from savings in vehicle maintenance, fuel, and vehicle wear and tear. Professional studies suggest that vehicles cost $0.20 per mile (2014 dollars).[29] While it is challenging to predict the number of choice riders, the Broad Street Bus Rapid Transit

[28] Broad Street Rapid Transit Study: Station Selection Report

[29] American Automobile Association (AAA). "Your Driving Costs." 2013. https://exchange.aaa.com/wp-content/uploads/2013/04/Your-Driving-Costs-2013.pdf. The AAA study shows that an average vehicle costs 20.42 cents per mile to operate. This BCA conservatively excludes ownership costs since the BRT's choice riders will likely continue to own a vehicle.

Transportation Systems Technical Report estimated 2015 ridership on GRTC bus routes, with and without BRT. When evaluating anticipated ridership on comparable east-west routes (parallel to the proposed BRT), the results suggest that the BRT could reasonably attract 490 "choice riders." Assuming these new riders travel similar lengths (3.25 miles) to existing corridor riders, the choice riders could reduce total vehicle miles by 581,000 miles per year – equivalent to $118,643 in motor vehicle operating costs per year (Table 10).

TABLE 10: USER BENEFITS FOR NEW TRANSIT RIDERS (REDUCED OPERATING COSTS FOR MOTORISTS)

Calendar Year	Project Year	Motorist Operating Cost Savings Actual (2014 $) [1]	Motorist Operating Cost Savings Discounted at 7%	Motorist Operating Cost Savings Discounted at 3%
2014	0	$0	$0	$0
2015	1	$0	$0	$0
2016	2	$0	$0	$0
2017	3	$0	$0	$0
2018	4	$118,643	$90,512	$105,413
2019	5	$118,643	$84,591	$102,343
2020	6	$118,643	$79,057	$99,362
2021	7	$118,643	$73,885	$96,468
2022	8	$118,643	$69,051	$93,658
2023	9	$118,643	$64,534	$90,930
2024	10	$118,643	$60,312	$88,282
2025	11	$118,643	$56,367	$85,710
2026	12	$118,643	$52,679	$83,214
2027	13	$118,643	$49,233	$80,790
2028	14	$118,643	$46,012	$78,437
2029	15	$118,643	$43,002	$76,153
2030	16	$118,643	$40,189	$73,935
2031	17	$118,643	$37,559	$71,781
2032	18	$118,643	$35,102	$69,690
2033	19	$118,643	$32,806	$67,661
2034	20	$118,643	$30,660	$65,690
2035	21	$118,643	$28,654	$63,777
2036	22	$118,643	$26,779	$61,919
2037	23	$118,643	$25,027	$60,116
2038	24	$118,643	$23,390	$58,365
2039	25	$118,643	$21,860	$56,665
2040	26	$118,643	$20,430	$55,014
Total		**$2,728,796**	**$1,091,692**	**$1,785,372**

[1] 490 "choice riders x 3.25 miles x $.20 per mile x 365 days.
Tab 8 of Excel workbook (Cells B4,B6,B8,B10)

There are other benefits that are not quantified in this analysis. For example, motorists can enjoy faster travel times as more people utilize the Broad Street BRT. It is also expected that BRT-induced efficiencies will help reduce average dwell times for other buses on the corridor. Specifically, the consolidation of stops in the improved downtown bus lane will result in fewer stops for all buses from 4th to 14th Streets. Furthermore, at those consolidated stop only electronic fare media will be accepted, which should reduce the amount of time that local buses spend at platforms/stops. All together, these improvements will reduce bus queuing at some of the corridor's busiest bus stops and transfer points. The associated travel time savings for other bus routes and passengers, while not quantified by this study, could lead to additional productivity gains.

Other Environmental Impacts

The Broad Street BRT will avoid adverse impacts to sensitive environmental resources. After identification studies and project coordination between GRTC, the DRPT, the FTA, and project team stakeholders, the Virginia Department of Historic Resources (DHR) issued a Finding of No Adverse Effect for this project on May 11, 2011. On April 10, 2014, FTA issued a letter establishing a finding that the project meets the criteria for a Class II documented Categorical Exclusion as set forth in 23 CFR 771.118(d). Table 11 summarizes some of BRT's anticipated environmental impacts.

TABLE 11: SUMMARY OF BROAD STREET BRT ENVIRONMENTAL EFFECTS

Environmental Resource	Summary of Effects
Land Use, Zoning, and Economic Development	The Broad Street BRT is expected to encourage more intense, compact development in localized activity centers around the station areas. This will help to discourage sprawl and will support redevelopment goals and land use policies outlined in local plans.
Social Impacts and Community Facilities	The Broad Street BRT would contribute to improved transit access, mixed-use development, and connectivity of neighborhoods to community facilities within the study area and greater metropolitan region.
Displacements and Relocations	No residential, business, industrial, or non-profit property acquisitions or displacements are predicted to occur.
Environmental Justice	Broad Street BRT would support the predicted increases in population and employment by increasing accessibility to jobs, community facilities, and other services in the study area and throughout the region. Environmental justice populations would share in the benefits.
Historic Properties	The Virginia Department of Historic Resources (DHR) has provided a conditional determination of no effect or no adverse effect for the historic architectural resources within the project corridor. During construction, if subsurface impacts deeper than one foot are planned anywhere along the project corridor, an archaeologist will monitor all excavations to identify and evaluate subsurface remains.
Visual and Aesthetic Resources	NEPA and Council on Environmental Quality (CEQ) regulations address visual impacts under the heading of aesthetics and 23 USC 109(h) cites "aesthetic values" as a matter that must be fully considered in developing a project. The Broad Street BRT would not result in any substantial direct, indirect, or temporary construction impacts to visual and aesthetic resources.
Floodplains	Floodplain mapping produced by the Federal Emergency Management Agency (FEMA) indicates the presence of Special Flood Hazard Areas (100-year floodplains) within the study corridor. Only the new Bus Rapid Transit stations at Main Street Station and Rocketts Landing would be constructed within the 100-year floodplain. Construction of these two stations will have minimal impacts to the floodplain with fewer than 2,310 square feet of construction within the floodplain. No substantial effects on natural or beneficial floodplain values and no changes in base flood elevations are anticipated.

Environmental Resource	Summary of Effects
Hazardous Materials	Land disturbing activities under the BRT project are limited to small areas outside of the roadway right-of-way for new stations and potential traffic operational improvements. The majority of the project would remain within the existing roadway and right-of-way. In areas where there would be ground disturbing activities, a Phase I Environmental Site Assessment (Phase I ESA) will be conducted to determine the nature, extent of contamination, and mitigation measures, if any.
Air Quality	The BRT project is not expected to cause or contribute any violations of National Ambient Air Quality Standards (NAAQS). Regional levels of criteria pollutants and Mobile Source Air Toxins (MSATs) would likely improve as a result of new abatement technologies and implementation of laws or regulations aimed at improving air quality, as well as the implementation of compressed natural gas (CNG)-powered bus fleet by GRTC. Roadway conditions along Broad Street are forecasted to remain at good levels of service, further supporting cleaner air.
Noise and Vibration	The noise analysis indicates that there are noise sensitive receptors (predominantly residential) within the project corridor. No severe or moderate noise impacts are anticipated from BRT operation.
Energy	It is likely that the BRT will use less energy than the existing bus services on Broad Street.

Safety – Crash Reduction (Quantified)

According to the FHWA, a crash reduction factor (CRF) is the percentage crash reduction that might be expected after implementing a given countermeasure at a specific site. While FHWA does not provide specific crash reduction factors for BRT service, the agency does identify reduction factors for improvements that often accompany bus rapid transit systems. In efforts to remain conservative, this analysis only reflects the anticipated reduction in crashes along the median-running and curb-running segments of the project. Historical crash data (2009 to 2013), obtained through the City of Richmond Police Department, were used to evaluate the average annual crashes and associated costs along these two segments of the BRT corridor. The Excel workbook (Tabs 11 and 12) highlights the year, type, and cost of all crashes along the median-running and curb-running segments of the corridor.

The median guideway for the BRT service would run from Thompson Street to Adams Street, a length of 2.5 miles. The median guideway would take one general purpose lane and convert it to a dedicated bus lane, reducing the general travel lanes from three to two in each direction. At certain intersections, the bus lane would be open for left turning vehicles to enter and make turns. Elsewhere along this section, left turns would be prohibited. In essence, the median guideway improvements maximize the capacity of the existing infrastructure, which is expected to help increase safety along the corridor. The effect of this change, strictly from a general traffic perspective, is similar to a road diet in that the number of general travel lanes will be reduced by about one-third and left-turn conflicts will be reduced or eliminated along most of this section of the corridor. Road diets benefit bicyclists, pedestrians, and motorists by reducing vehicular speeds and improving mobility and access. For pedestrians, road diets provide a reduced crossing distance and consolidate midblock crossing locations. According to FHWA, road diets reduce vehicle speeds and potential interactions experienced during lane changes. This reduction in speed and conflict could reduce the number and severity of crashes. A recent FHWA report used case study data to estimate an 18.0% crash reduction factor for "road diets."[30] This 18.0% crash reduction factor was

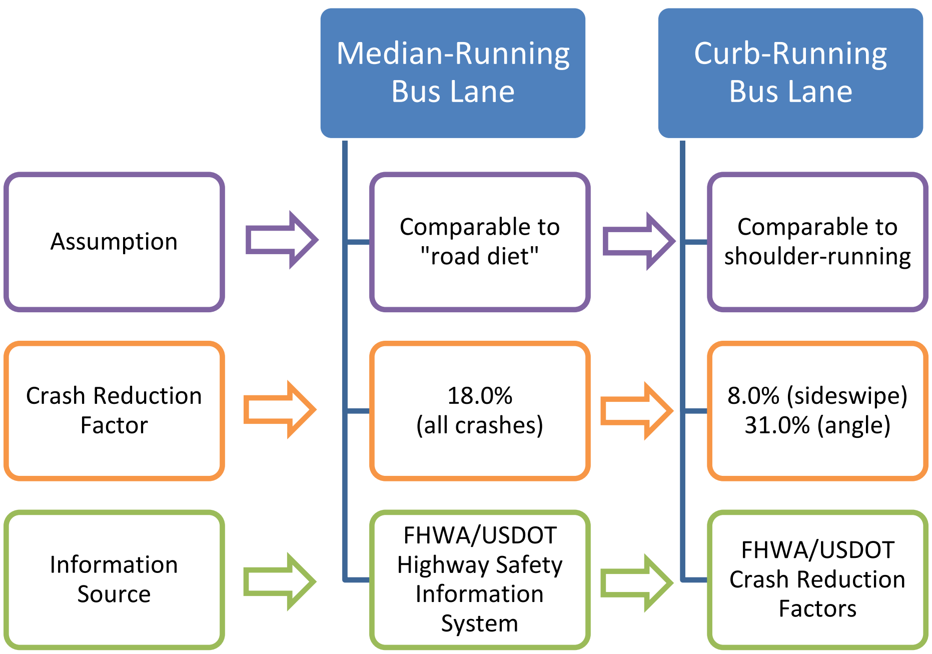
[30] FHWA, USDOT. "Evaluation of Lane Reduction 'Road Diet' Measures on Crashes." Highway Safety Information System (HSIS). http://www.fhwa.dot.gov/publications/research/safety/10053/10053.pdf. Date not listed.

applied to the average annual crashes (5.8 per year) along the median-running segment of the BRT corridor.

The curb-running guideway would run from 4th Street to 14th Street, a length of 0.6 miles. The FHWA reduction factor for the installation of shoulder bus lanes was used as a proxy for the anticipated crash reduction along this curb-running segment.[31] Specifically, an 8.0% crash reduction factor was applied to sideswipe crashes, while a 31.0% crash reduction factor was applied to angle crashes. The police crash data reported 17 sideswipe crashes and 4 angle crashes from 2009 to 2013. This BCA did not assume a reduction factor for rear-end crashes and other crash types because the FHWA does not assign a crash reduction factor for these other types. This BCA relied on the Police Department crash costs in lieu of the USDOT cost estimates for personal property damage. Crash cost estimates were inflated to 2014 dollars to ensure consistency.

These crash assumptions are highlighted in Figure 4 and also provided in the Excel workbook (Tab 10).

FIGURE 4: CRASH REDUCTION ASSUMPTIONS AND FACTORS FOR THE BROAD STREET BRT CORRIDOR



The Richmond Police Department data quantify the property damage associated with each crash. The average annual cost represents the No-Build costs in this analysis. While injuries were not sustained between 2009 and 2013 on the curb-running segment of the corridor, there were ten injuries on the median-running segment during that period. In efforts to remain conservative in claiming crash "benefits", this BCA assumed that all injuries were AIS Level 1 (Minor), equivalent to $28,017 per injury. The total monetized value of property damage and injuries under the No-Build scenario is equivalent to approximately $73,789 per year on the median-running segment and $15,742 per year along the curb-running segment. After applying the associated crash reduction factors, it is expected that BRT

[31] FHWA, USDOT. Desktop Reference for Crash Reduction Factors. http://safety.fhwa.dot.gov/tools/crf/resources/fhwasa08011/page3.cfm#linktarget_t7

can reduce these annual costs to $60,425 per year and $12,691 per year, respectively. In total, this reduction would equate to a monetized benefit of $16,315 per year, equivalent to a net savings of $150,119 over 26 years (at a 7.0% discount rate). Table 12 below shows the anticipated crashes in the No-Build and Build alternatives. The Excel workbook (Tabs 9-12) quantifies the assumptions and shows the calculations used to arrive at these conclusions.

TABLE 12: ANTICIPATED CRASH COST ESTIMATES: NO-BUILD AND BUILD

		Undiscounted Values (2014 $)				
Calendar Year	Project Year	No-Build	Build	Net Impact (Build-No Build)	Net Impact (Build-No Build) Discounted at 7%	Net Impact (Build-No Build) Discounted at 3%
2014	0	$0	$0	$0	$0	$0
2015	1	$0	$0	$0	$0	$0
2016	2	$0	$0	$0	$0	$0
2017	3	$0	$0	$0	$0	$0
2018	4	$89,431	$73,116	$16,315	$12,446	$14,495
2019	5	$89,431	$73,116	$16,315	$11,632	$14,073
2020	6	$89,431	$73,116	$16,315	$10,871	$13,663
2021	7	$89,431	$73,116	$16,315	$10,160	$13,265
2022	8	$89,431	$73,116	$16,315	$9,495	$12,879
2023	9	$89,431	$73,116	$16,315	$8,874	$12,504
2024	10	$89,431	$73,116	$16,315	$8,294	$12,140
2025	11	$89,431	$73,116	$16,315	$7,751	$11,786
2026	12	$89,431	$73,116	$16,315	$7,244	$11,443
2027	13	$89,431	$73,116	$16,315	$6,770	$11,110
2028	14	$89,431	$73,116	$16,315	$6,327	$10,786
2029	15	$89,431	$73,116	$16,315	$5,913	$10,472
2030	16	$89,431	$73,116	$16,315	$5,526	$10,167
2031	17	$89,431	$73,116	$16,315	$5,165	$9,871
2032	18	$89,431	$73,116	$16,315	$4,827	$9,583
2033	19	$89,431	$73,116	$16,315	$4,511	$9,304
2034	20	$89,431	$73,116	$16,315	$4,216	$9,033
2035	21	$89,431	$73,116	$16,315	$3,940	$8,770
2036	22	$89,431	$73,116	$16,315	$3,682	$8,515
2037	23	$89,431	$73,116	$16,315	$3,442	$8,267
2038	24	$89,431	$73,116	$16,315	$3,216	$8,026
2039	25	$89,431	$73,116	$16,315	$3,006	$7,792
2040	26	$89,431	$73,116	$16,315	$2,809	$7,565
Total		**$2,056,910**	**$1,681,673**	**$375,238**	**$150,119**	**$245,507**

FHWA crash reduction factors (ranging from 8% to 31%) were applied to the average annual crash rates (and costs) along the corridor
Tab 10 of Excel workbook (cells G14, G16, and B25) provides crash reduction factors

Conclusions

The Broad Street Bus Rapid Transit project is expected to cost roughly $48.6 million to construct and requires $355,635 in additional operating costs for the GRTC. The project will likely contribute to marginal traffic delays for motorists (approximately 17,000 hours per year), which, when monetized equate to nearly $260,000 per year. For the purposes of the BCA, the net project costs amount to $47.8 million (7.0% discount rate) or $55.1 million (3.0% discount rate). While the project requires notable investment, this BCA indicates that the benefits greatly outweigh the costs.

The project is expected to provide substantial benefits in the form of property value growth, travel time savings for current transit users, reduced vehicle operating costs for motorists who switch to BRT, and crash reductions along key segments of the corridor. When monetized, these benefits amount to nearly $88.6 million (7.0% discount rate) or $108.9 million (3.0% discount rate) – yielding a benefit-cost ratio of 1.85 to 1.98. Understanding the inherent risks of double-counting benefits, the assumptions used to quantify these benefits were conservative and pragmatic.

In addition to quantifiable impacts, the project offers considerable societal benefits along a culturally rich corridor. The Broad Street BRT will serve as a critical transit spine for the greater metropolitan area and has the capacity to increase connectivity, improve access to jobs, and enhance the quality of life for underserved residents. The BRT, strategically proposed along a high-density corridor, will serve prominent health care and educational institutions, multimodal centers and other major establishments, while helping stimulate additional investment along an important regional corridor for local residents and businesses.

References

American Automobile Association (AAA). "Your Driving Costs." 2013. https://exchange.aaa.com/wp-content/uploads/2013/04/Your-Driving-Costs-2013.pdf.

Broad Street Rapid Transit Study, Anticipated Motorist Delay Technical Report, Page 2. 2011. Attached as (BCA Appendix A)

Broad Street Rapid Transit Study Transportation System Technical Report, January 2014. Pages 36-37. http://study.ridegrtc.com/documents/

Broad Street Rapid Transit Study: Station Selection Technical Report. http://study.ridegrtc.com/documents/

Bureau of Labor Statistics (BLS). Consumer Price Index (CPI) – All Urban Consumers. Series ID: CUUR0000SA0, Base Period: 1982-84=100.

Excel Workbook for the Broad Street BRT Benefit-Cost Analysis. http://study.ridegrtc.com/documents/

Fairfax County, Virginia; Arlington County, Virginia; Washington Metropolitan Area Transit Authority. "Columbia Pike Transit Initiative: Return on Investment Study. July 2012.

FHWA, USDOT. "Evaluation of Lane Reduction 'Road Diet' Measures on Crashes." Highway Safety Information System (HSIS). http://www.fhwa.dot.gov/publications/research/safety/10053/10053.pdf. Date not listed.

FHWA, USDOT. Desktop Reference for Crash Reduction Factors. http://safety.fhwa.dot.gov/tools/crf/resources/fhwasa08011/page3.cfm#linktarget_t7

Harvard University. Equality of Opportunity Project. 2014. http://www.equality-of-opportunity.org/index.php/city-rankings/city-rankings-100

Hellendrung, Jason. HealthLine Drives Growth in Cleveland. Urban Land Institute. July 13, 2012.

Ickler, Megen; Hodel, Peter. "The Value of Bus Rapid Transit: Hedonic Price Analysis of the EmX in Eugene, Oregon." Department of Economics; Honors Papers. University of Oregon, 2012.

National Household Travel Surveys (NHTS). Data Extraction Tool. http://nhts.ornl.gov/det/Extraction3.aspx.

National State of Good Repair Assessment, FTA, 2010; and, Status of the Nation's Highways, Bridges and Transit, Conditions and Performance, FHWA, 2013.

National Transit Database, 2009-2013.

Office of Management and Budget (OMB). OMB Circular A-4 and OMB Circular A-94. http://www.whitehouse.gov/omb/circulars_default

Peterson, Sarah Jo. Bus Rapid Transit and Land Use. Urban land Institute (ULI). Page 81. July/August 2010.

Richmond Regional Planning District Commission. Plan2035. http://www.richmondregional.org/MPO/LRTP/plan2035/plan2035_Chapters.htm

USDOT. Notice of Funding Availability for the Department of Transportation's National Infrastructure Investments under the Consolidated Appropriations Act, 2014. http://www.dot.gov/tiger/nofa

USDOT. Benefit-Cost Analyses Guidance for TIGER Grant Applications. http://www.dot.gov/sites/dot.gov/files/docs/TIGER%20BCA%20Guidance%202014.pdf

USDOT. TIGER BCA Resource Guide, 2014. http://www.dot.gov/policy-initiatives/tiger/tiger-bca-resource-guide-2014

USDOT and Texas Transportation Institute. Benefit/Cost Analysis for Transportation Infrastructure: A Practitioner's Workshop. Washington, D.C. May 17, 2010.

BENEFIT-COST ANALYSIS APPENDIX A

BROAD STREET CORRIDOR RAPID TRANSIT STUDY: ANTICIPATED MOTORIST DELAY

Introduction

Negative user benefits to automobile passengers occur in the portion of the corridor in which a travel lane in each direction is replaced with the median-running BRT. In this portion of the corridor from Thompson Street to Adams Street, through traffic would be limited to the remaining two lanes in each direction on Broad Street.

The Intersection level of service analysis indicates that there would be very minor degradation of operations with the construction of the BRT facility; only two of 23 intersections would experience a reduction in LOS to D or worse with the facility. To answer the question of the cumulative auto user disbenefit, simulation analysis was conducted to reflect:

- What are the typical increases in intersection delay to autos during peak periods with the BRT facility?
- What is the cumulative delay to autos moving through the corridor, in light of simulated traffic patterns (i.e., cars turning onto and off of the Broad Street corridor)

The available simulation model reflects AM and PM peak period conditions. The delay during those periods can be quantified, but the 24-hour delay had to be interpreted from the peak hour data. Auto occupancy also has to be considered to arrive at person-hours of impact. The methods and results to develop the 24-hour auto user disbenefit calculation are provided below.

Peak Hour Simulations

The same peak hour Synchro/Simtraffic models that were used for the traffic operational analysis were used to calculate the impacts to automobile travel along the section of Broad Street with proposed exclusive BRT lanes (from Thompson Street to Adams Street). The simulation was used to output total delay in hours along this section for both the AM and PM peak hours. The total delay between the build condition and the no-build condition were compared to determine the change in delay. The results of the analysis are provided in the following table.

Negative User Benefit	Period	No-Build Condition	Build Condition	Difference
Number of Vehicles Impacted	AM Peak	1477 vehicles	1428 vehicles	-49 vehicles
	PM Peak	1754 vehicles	1764 vehicles	+10 vehicles
Average Delay per Vehicle in the Corridor	AM Peak	58 seconds	65 seconds	+7 seconds
	PM Peak	71 seconds	82 seconds	+10 seconds
Total Delay for Simulated Traffic in the Corridor	AM Peak	23.8 hours	25.8 hours	+2.0 hours
	PM Peak	34.6 hours	40.2 hours	+5.6 hours

Off-peak hour delay was estimated based on the peak hour delay as hourly traffic volumes corridor-wide are not available for the whole day. It was assumed that increases in delay would be for a worse case:

- Negligible from 12:00 a.m. to 6:00 a.m.
- Equal to the AM peak hour delay of 2.0 hours of delay from 6:00 a.m. to 11:00 a.m.
- Equal to the average of the AM & PM peak hour delay of 3.8 hours of delay from 11:00 a.m. to 1:00 p.m.
- Equal to the AM peak hour delay of 2.0 hours of delay from 1:00 p.m. to 4:00 p.m.
- Equal to the AM peak hour delay of 5.6 hours of delay from 4:00 p.m. to 6:00 p.m.
- Equal to the AM peak hour delay of 2.0 hours of delay from 6:00 p.m. to 8:00 p.m.
- Negligible from 8:00 p.m. to 12:00 a.m.

Total increase in delay for the 24 hour period is estimated at 38.8 hours of delay for vehicles. Using a vehicle occupancy rate of 1.2 persons per vehicle, the total increase in person hours of delay for the build condition versus the no-build condition equates to 47 hours of delay. Therefore the user benefits for the proposed BRT system would be reduced by 47 hours to account for delay increases to persons traveling within the general travel lanes.