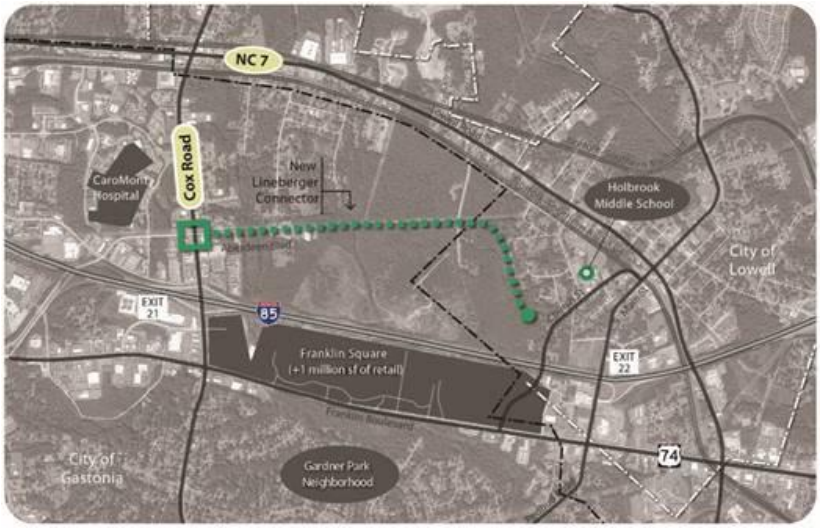
Kimley»Horn

MEMORANDUM

To:	Rusty Bost, City of Gastonia
From:	Jonathan Guy
	Kimley-Horn and Associates, Inc.
Date:	July 7, 2021
Subject:	Benefit Cost Analysis Technical Documentation for RAISE Grant Application for the Lineberger Connector Project

Introduction and Background

This technical memorandum serves as a supplement to the benefit-cost analysis (BCA) for the Rebuilding America Infrastructure with Sustainability and Equity (RAISE) Grant application for the Lineberger Industrial Site. It has been prepared in response to the requirements of the United States Department of Transportation's RAISE additional guidance and application requirements.



The project analyzed in the BCA is the improvement of the intersection between Aberdeen Boulevard and Cox Road and the extension of the connector roadway into the Lineberger Industrial Site, a marquee development in the cities of Gastonia and Lowell, North Carolina. The proposed improvement would implement a reduced conflict intersection design through a quadrant left configuration. This design would take left-turning movements from Westbound Aberdeen Boulevard and convert them to a through movement and a right-turn movement through a new connector roadway. Further project details are available in the RAISE application.

This memo is a companion piece to the BCA spreadsheet that is being submitted simultaneously with the RAISE application and details the actual calculations of benefits and costs.

Determination of Benefit Cost Analysis Time Period

Based on USDOT guidelines for Benefit Cost Analysis, the benefit-cost period was set at 20 years from the opening of the Lineberger Connector project (approximately 2026). This represents a period during which the long-term impacts can be confidently forecasted. The initial costs of construction are applied to the year during which construction begins. The immediate job creation and subsequent economic productivity that occurs as a result of construction activities is also applied during the year in which construction begins. Annual project costs and benefits are calculated beginning in the opening year and for each subsequent year in the 20-year analysis period.

All costs and benefits were estimated in 2020 dollars. Costs and benefits are valued in the year they occur and discounted to year 2020 to represent value. A discount rate of 7% was used per USDOT guidelines.

Description of Base Case Scenario and Build Alternative

Assumption: This BCA compares the base case of the transportation network (existing conditions with programmed roadway projects) without the construction of the Lineberger Connector project to the "build alternative" of the transportation network enhanced by the proposed Lineberger Connector project (Build).

The base case scenario is further described as:

- Identical roadway networks and intersections, and the operation of these networks, for the duration of the analysis period with the exception of programmed roadway improvements
- Population, employment, and household growth are consistent with regional forecasts for years beyond 2020
- Traffic volume growth that is consistent with observed regional growth trends

The build case scenario is further described as:

- Consistent model assumptions, parameters, and inputs with the base case alternative except for the changes in the transportation network or other data that are directly attributable to the Build Scenario
- Construction and opening of the Lineberger Connector Project
    - Construction for the Lineberger Connector project is anticipated to begin in 2024 and the project will open in 2026
- Once opened, the proposed Lineberger Connector project will:
    - Improve overall mobility along Cox Road,
    - Reduce conflicts between vehicles on Cox Road and Aberdeen Boulevard
    - Reduce emissions by reducing delay and congestion at the intersection and along Cox Road

Near-term job creation and economic productivity will occur because of construction activities. The roadway and intersection improvements will also have long-term effects on housing, employment, jobs, property values, and other economic productivity factors over the respective service life of the project.

Sensitivity

A number of the calculations and estimates used in this BCA are subject to variability due to uncertainty within some key assumptions. Where possible, efforts were made to use values and constants from nationally recognized and accepted sources (i.e. Environmental Protection Agency, Department of Transportation, etc.). In some cases, after careful consideration of a range of values and forecasts, the more conservative estimates were used so as not to misrepresent the quantifiable benefits. This methodology and the corresponding results represent an attempt to comprehensively and accurately estimate the quantifiable benefits of this project.

Benefit Cost Analysis Methodology

The remainder of this technical memorandum introduces the general assumptions and specific inputs that were used in the BCA. Each calculated benefit was categorized under one of the long-term outcomes as suggested in the DOT guidelines: value of travel time savings, vehicle costs savings, safety benefits, emissions reduction benefits, other issues benefits estimation. The individual benefits and costs were used to describe a total monetary benefit for each long-term outcome and for the project. Costs and benefits were also computed for near-term economic impacts.

It should be noted that there are a number of benefits under each category that were not easily quantifiable. The RAISE application qualitatively describes these additional benefits that are not fully captured with the benefit cost analysis or documentation.

GENERAL ASSUMPTIONS

There are many assumptions that served as the basis for calculated costs and benefits. This section of the technical memorandum describes these key assumptions and how they were used in the BCA.

1. The Lineberger Connector project is expected to increase the VMT on Cox Road, US 74, and Lowell Road associated with the Lineberger Industrial park development. However, due to the creation of jobs local to the region, an expected decrease in the VMT on I-85 is anticipated. The projected land uses around the Lineberger Connector will likely attract local traffic to and from Gaston County and away from Mecklenburg County, therefore a reduction in the total VMT is expected. For this BCA, we used a trip generation and trip distribution to estimate the change in VMT. Approximately 40% of the site trips for the Lineberger property are expected to be local trips, 25% are expected to come from the east along I-85 and 35% are expected to come from the west along I-85 prior to Mecklenburg County. The Lineberger property is expected to generate 6,783 daily trips. Therefore, the following calculations and assumptions were used to calculate the change in VMT.

    - Distance from Charlotte to Gastonia~22 miles
        - 6,783 Daily trips * 40% of trips being taken away from I-85*44 round trip miles from Gaston County to Mecklenburg County=119,381
    - Local distances traveled to the site~10 miles
        - 6,783 Daily trips * 60% of trips being added to the network * 20 round trip local miles from around Gaston County= 81,396
    - Therefor the net VMT= 119,381-81,396= ***37,985 less VMT.***

2. The benefits for many equations may be quantified using the calculated net VMT for each year and a rate or equation that relates VMT to the specific cost or benefit.

3. The increased travel time for each study road network was assumed to be 5 minutes, except on I-85 in which the decreased travel time was assumed to be 1 minute. It is likely that 5 minutes is a conservative estimate because the Lineberger Connector will provide more connectivity for drivers, therefore decreasing the number of time-consuming congested trips.

4. Based off the site network and site layout for the Lineberger property 5% of the trips for the connector are proposed to be personal while 95% are expected to be business trips.

VALUE OF TRAVEL TIME SAVINGS

The value of travel time savings is vital to networks that provide increased connectivity throughout a corridor. The Lineberger Connector project is expected to provide a decrease in travel times along Interstate 85 by increasing network connectivity and local job growth.

The total travel time savings through the reduction of delay associated with the project is projected to be $11,216,608 in present dollar value. This is calculated based on a savings of vehicle hours traveled (for both passenger cars and trucks) against the AADT under no-build and build scenarios.

SAFETY BENEFITS

The DOT supports projects that predictably reduce the number, rate, and severity of surface transportation-related crashes, injuries, and fatalities among drivers. The quantitative safety measures of the Aberdeen Boulevard & Cox Road quadrant left project include a reduction in injury and property damage only (PDO) crashes.

USDOT-recommended values for monetizing reductions in injuries are based on the Maximum Abbreviated Injury Scale (MAIS), which categorizes injuries along a six-point scale from Minor to Not Survivable. However, the Department recognizes that accident data that are most readily available to applicants may not be reported as MAIS-based data. For example, law enforcement data is frequently reported using the KABCO scale, which is a measure of the observed severity of the victim's functional injury at the crash scene. In other cases, data may be further limited to the total number of accidents in the area affected by a particular project, perhaps also including a breakdown of those that involved an injury or fatality.

The anticipated injury and PDO crash reductions of the Aberdeen Boulevard & Cox Road quadrant left project are attributable to the reduction of conflicts between vehicles through the elimination of left-turning traffic. The Crash Modification Factors (CMF) Clearinghouse provides information on the expected impact of a given countermeasure on the safety performance of a location based on statistically significant data from peer reviewed research papers for sites that received that countermeasure. The CMF for a decrease in the signal spacing is 1.06. The CMF for restricting left-turn movements at an intersection is 0.85. The CMF for a right turn lane is 0.75, and the CMF for an adaptive signal control system is 0.68.

The average annual number of injuries was broken down by severity to better estimate the anticipated benefits. The cumulative number of average annual injuries is reported on TAB F of the

calculations along with the cumulative number of vehicles involved PDO crashes. The annual expected injuries avoided, and property damage avoided for each year of the analysis were calculated using the current annual averages and the CMF factors listed on page 4. The annual number of injuries avoided is reported and the annual reduction in vehicles involved in PDO crashes is reported in Tab F as well. Finally, a cost associated with each injury or vehicle in a PDO crash was derived using guidance from the RAISE Benefit-Cost Analysis Resource Guide on the value of injuries based on severity of the crash.

The resulting injury and PDO cost savings are $26,744,218.04 in total cost savings or $9,958,944.07 in present dollars for the Lineberger Connector project.

EMMISSIONS REDUCTION BENEFITS

The DOT supports projects that promote environmental sustainability through improved energy efficiency, reduced dependence on oil, and reduced greenhouse gas emissions. The quantitative sustainability measures of the Lineberger Connector project include air quality impacts, water quality impacts, and fuel consumption impacts.

The Lineberger Connector project is projected to lead to decreases in emissions of greenhouse gases and particulate matter, based on the decrease in daily VHT. Using guidance from the DOT, the emissions that were measured in this analysis include carbon dioxide (CO_2), volatile organic compounds (VOC), nitrogen oxides (NO_x), particulate matter (PM), and sulfur dioxide (SO_x). Air quality benefits were calculated as the value of emissions released per decrease in VHT. The decrease in VMT each year of the project life was previously described under the general and the emissions rate per VMT was found in the Environmental Protection Agency's "Average Annual Emissions and Fuel Consumption for Gasoline-Fueled Passenger Cars and Light Trucks" p.4, published in 2008.

The quadrant left intersection will not only improve overall operational efficiency of the corridor it will also work to reduce CO2 emissions at the intersection. Through the design of the quadrant intersection, start up and idling for trucks and cars will be reduced. Both of these activities are more impactful to emissions than a moving vehicle. The proposed design is configured to reduce the number of stops a vehicle must encounter as well as waiting for a movement, thereby reducing emissions and improving air quality. An idling emissions savings of $1,684,000 million is projected for passenger cars, and $588,000 for trucks for a combined savings of $2.2 million in idling savings.

OTHER ISSUES AND BENEFITS ESTIMATION

Work Zone Impacts

The proposed Lineberger Connector project will have minimal traffic disruptions to vehicles along Cox Road, Aberdeen Boulevard, and adjacent connecting streets during construction.

Noise Pollution

The proposed project is not anticipated to increase noise levels on the adjacent neighborhoods. The proposed intersection improvements will reduce the idling time for vehicles along Cox Road,

Aberdeen Boulevard and freight vehicles exiting the Lineberger Industrial park. As such, noise pollution from startup and idling will be significantly reduced.

Emergency Services

The project will not have an impact on emergency response times to CaroMont Regional Medical Center located off of Cox Road. Emergency Room access approaches from Court Drive will not be impacted during construction. Once completed, the emergency response times from Cox Road, particularly south of Aberdeen Boulevard will likely decrease with the reduction on travel time delay along the corridor.

Property Value Increases/Quality of life

The properties in the immediate vicinity of the Lineberger Connector project are forecasted to see an increase in land value. A proxy for percentage increase in land value was found based on the average value per acre of industrial and the average value per acre of agricultural land. This ratio was then multiplied by the current land value of the properties that have been rezoned as a result of this project.

Travel Time Savings

NCDOT estimates that this project over a 10-year period will reduce travel times by 301,000 hours through eliminating delay and congestion at the intersection. The reduction in travel times saved through 2043 equates to $11,216,608 in savings for residents, business owners, and visitors to the area.

State of Good Repair

The configuration of the Lineberger Connector project and its reduction in the number of stops required at the intersection will also directly benefit the longevity of the pavement along both Cox Road and Aberdeen Boulevard. By providing additional green time on the approaches through the reduction of phases, the frequency of stops is also decreased. As such the potential for stopping vehicles at speed is also reduced. Pushing or shoving of pavement, especially with tractor trailer configurations is common at intersections with frequent stops. The design proposed will help to minimize the occurrence of this, thus extending the life of the pavement. Furthermore, the design will increase the foundational structure of the roadway to provide additional resiliency to pushing of pavement, especially in the summer months when asphalt temperatures can increase significantly.

Costs

Capital costs for the Lineberger Connector project are estimated at $31,318,535. The project, which is a critical connector between Gastonia and Lowell, is the genesis for continued economic growth for this region of Gaston County. The project sponsors seek approximately $18,110,358 in RAISE grant funding to complete the funding for project development and construction. As shown in **Table 1.0**, the remaining sources are anticipated from local, state, or private investment funding. The Cities of Gastonia and Lowell are committed to this project's development. Both communities understand the

necessity of this project to improve overall long-term mobility, community growth, and continued economic success within the Charlotte Metro region.

Table 1.0 – Funding Sources				
Type	Source	Amount	Percent of Total	Status
Federal	RAISE	$18,192,385	≈58%	Ongoing with this application
Local	City of Gastonia	$7,001,150	≈23%	-
Private	Property Owner/Developer	$6,125,000	≈19%	-

Table 2.0 shows the timing of expenditure of the various funding sources through the development years of the project. Committed local funds are more than enough to advance the project to construction. A detailed project budget is in the Project Readiness section of the narrative.

Table 2.0 - Expenditure by Year						
Funding Source	Amount	2022	2023	2024	2025	2026
Federal	$18,192,385	$250,000	$2,350,000	$1,000,000	$10,000,000	$4,592,385
Local	$7,001,150	$0	$3,000,000	$2,000,000	$1,000,000	$1,001,150
Private	$6,125,000	$0	$3,000,000	$2,000,000	$1,000,000	$125,000
Total	$31,318,535	$250,000	$8,350,000	$5,000,000	$12,000,000	$5,718,535

Specific project costs included initial costs of ROW, engineering and construction, utility relocation costs, and contingency. These costs are documented in the RAISE application.

Benefit Costs Analysis Summary

As shown in the table below, the project is expected to have a high benefit to cost ratio. The benefit mostly lies in the annual travel time savings by pulling jobs and industry to Gaston County.

Possible Societal Benefits for Consideration	Key Benefits Quantified	Total Benefits	Present Value (7% Discount Rate)	Tab
Economic Competitiveness				
Annual Travel Time Savings	Decreased travel time along the Cox Road corridor due to traffic signal efficiency benefits associated with proposed quadrant roadway.	$ 31,320,807.76	$ 11,216,608.08	D
Economic Output	Design and construction jobs created by the proposed project.	$ 26,311,417.36	$ 16,385,428.37	G
Safety				
Crash Cost Savings	Reduction in overall crash frequency due to the restriction of left-turn movements at the existing intersection of Cox Road with Aberdeen Boulevard. The installation of a new traffic signal will increase the frequency of rear-end crashes, but the net change in crash frequency is still negative.	$ 26,744,218.04	$ 9,958,944.07	F
Environmental Sustainability				
Annual Vehicle Idle Emissions Savings	Reduction in overall vehicle emissions due to decreases in stopped delay along the Cox Road corridor following the construction of the proposed quadrant roadway.	$ 2,273,054.67	$ 815,029.15	E
Costs & Residual Value				
Total Project Costs	Design and construction costs associated with the proposed project.	$ (31,318,535.00)	$ (21,657,270.03)	B
Residual Value	Residual value of assets at the end of the analysis period.	$ 7,081,150.00	$ 4,896,728.97	B
Maintenance Costs	Costs associated with resurfacing of existing roadways due to increases in VMT along the Cox Road corridor after the opening of industrial development tied to the proposed project.	$ (18,009,915.02)	$ (6,706,486.47)	C
	Total Benefits	$ 93,730,647.83	$ 43,272,738.65	
	Total Costs	$ 49,328,450.02	$ 28,363,756.51	
	Benefit/Cost Ratio	1.90	1.53	

SPOT ID:	H191177	TIP No.	N/A	County:	Gaston	Division:	12
Route No.:	Aberdeen Boulevard		Cross Street/Limits:	SR 2200 (Cox Road)			

Base Year	2018	28,150 trips/day
Future Year	2028	37,850 trips/day
Area Type	Urban	
Terrain	Rolling	

AADT Source
A - NCDOT AADT Map at Intersection
B - NCDOT AADT Map - Adjacent Segment
C - Based on Traffic Count Proportions
D - Based on Engineering Judgment
E - Other - See Notes

SR 2200 (Cox Road)

4Arterial

Daily Savings Conv. Factor	1.5

	V/C Ratio	Over/Under Capacity		
1	0.70	Under	0.74	0
2	0.19	Under	0.20	0
3	0.76	Under	0.80	0
4	0.45	Under	0.48	0

Node ID:	1
2018 AADT:	22,100
Source:	C
PM Peak Dir:	INBOUND
No. of Lanes	4
Facility Type	Arterial
Classification	Arterial
Growth Source	NCSTM
Annual Growth %	3.2%
Change in Turn %	No
2028 AADT:	30,300

K = 0.09
D (AM) = 0.4
D (PM) = 0.60

2018	2028	2018	2028	2018	2028	
12.5%	12.5%	83.7%	83.7%	3.8%	3.8%	PM
10.9%	10.9%	85.4%	85.4%	3.7%	3.7%	AM

Aberdeen Boulevard

Node ID:	4
2018 AADT:	7,200
Source:	C
PM Peak Dir:	INBOUND
No. of Lanes	2
Facility Type	Arterial
Classification	Local
Growth Source	VMT
Annual Growth %	2.0%
Change in Turn %	No
2028 AADT:	8,800

	AM	PM
2028	29.0%	31.2%
2018	29.0%	31.2%
2028	9.7%	5.3%
2018	9.7%	5.3%
2028	61.4%	63.5%
2018	61.4%	63.5%

K = 0.1
D (AM) = 0.4
D (PM) = 0.60

2018 AM Peak Travel Time Saving	-8
2018 PM Peak Travel Time Saving	17
Daily Savings Conv. Factor	1.5
2018 Daily Travel Time Savings	14.2
2028 AM Peak Travel Time Saving	16
2028 PM Peak Travel Time Saving	129
2028 Daily Travel Time Savings	217.1
Days per Year	260
Travel Time Savings Duration	10 Years

10-year Travel Time Savings
301,000 hours
Travel Time Savings Per Vehicle

2018	2 sec/veh	2028	21 sec/veh

AM	PM	
13.2%	19.9%	2028
13.2%	19.9%	2018
16.4%	27.9%	2028
16.4%	27.9%	2018
70.4%	52.2%	2028
70.4%	52.2%	2018

K = 0.09
D (AM) = 0.25
D (PM) = 0.75

Node ID:	2
2018 AADT:	3,000
Source:	C
PM Peak Dir:	INBOUND
No. of Lanes	2
Facility Type	Arterial
Classification	Local
Growth Source	VMT
Annual Growth %	2.0%
Change in Turns	No
2028 AADT:	3,700

Aberdeen Boulevard

2018	2028	2018	2028	2018	2028	
16.2%	16.2%	81.1%	81.1%	2.7%	2.7%	PM
16.3%	16.3%	78.1%	78.1%	5.6%	5.6%	AM

K = 0.09
D (AM) = 0.65
D (PM) = 0.35

Node ID:	3
2018 AADT:	24,000
Source:	B
PM Peak Dir:	OUTBOUND
No. of Lanes	4
Facility Type	Arterial
Classification	Arterial
Growth Source	NCSTM
Annual Growth %	3.2%
Change in Turn %	No
2028 AADT:	32,900

SR 2200 (Cox Road)

2018

AM Peak O-D Matrix

	1	2	3	4	Total
1		29	680	86	*795*
2	9		48	11	*68*
3	1097	78		229	*1404*
4	83	28	177		*288*
Total	*1189*	*135*	*905*	*326*	**2555**

PM Peak O-D Matrix

	1	2	3	4	Total
1		46	998	149	*1193*
2	40		106	56	*202*
3	613	20		122	*755*
4	135	23	274		*432*
Total	*788*	*89*	*1378*	*327*	**2582**

2028

AM Peak O-D Matrix

	1	2	3	4	Total
1		40	932	118	*1090*
2	11		59	14	*84*
3	1504	107		313	*1924*
4	102	34	216		*352*
Total	*1617*	*181*	*1207*	*445*	**3450**

PM Peak O-D Matrix

	1	2	3	4	Total
1		63	1369	205	*1637*
2	50		130	70	*250*
3	841	28		168	*1037*
4	165	28	335		*528*
Total	*1056*	*119*	*1834*	*443*	**3452**

2018 No-Build

AM Peak

Vehicle Hours Traveled (VHT)	RS = 5	RS = 10	RS = 15	RS = 20	RS = 25	RS = 30	RS = 35	RS = 40	RS = 45	RS = 50	Average
Queued Trips	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total VHT	52.2	52.0	52.2	52.0	52.0	52.8	51.8	52.2	51.9	52.3	**52.1**

PM Peak

Vehicle Hours Traveled (VHT)	RS = 5	RS = 10	RS = 15	RS = 20	RS = 25	RS = 30	RS = 35	RS = 40	RS = 45	RS = 50	Average
Queued Trips	0.0	0.2	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total VHT	80.8	84.9	80.6	88.9	80.1	73.1	90.2	83.5	77.7	71.7	**81.1**

2028 No-Build

AM Peak

Vehicle Hours Traveled (VHT)	RS = 5	RS = 10	RS = 15	RS = 20	RS = 25	RS = 30	RS = 35	RS = 40	RS = 45	RS = 50	Average
Queued Trips	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
Total VHT	94.1	148.6	97.5	94.6	110.4	85.5	84.1	93.8	95.2	102.3	**100.6**

PM Peak

Vehicle Hours Traveled (VHT)	RS = 5	RS = 10	RS = 15	RS = 20	RS = 25	RS = 30	RS = 35	RS = 40	RS = 45	RS = 50	Average
Queued Trips	93.8	80.5	76.7	94.1	85.1	84.4	88.6	92.0	73.7	78.0	84.7
Total VHT	227.9	219.1	206.2	224.3	217.5	221.7	233.1	224.0	206.6	212.2	**219.3**

2018 Build

AM Peak

Vehicle Hours Traveled (VHT)	RS = 5	RS = 10	RS = 15	RS = 20	RS = 25	RS = 30	RS = 35	RS = 40	RS = 45	RS = 50	Average
Queued Trips	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total VHT	60.1	60.6	59.7	60.3	60.0	59.4	59.9	59.9	60.1	60.7	**60.1**

PM Peak

Vehicle Hours Traveled (VHT)	RS = 5	RS = 10	RS = 15	RS = 20	RS = 25	RS = 30	RS = 35	RS = 40	RS = 45	RS = 50	Average
Queued Trips	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total VHT	63.3	63.7	63.7	63.7	64.1	64.3	63.4	63.6	64.3	63.7	**63.8**

2028 Build

AM Peak

Vehicle Hours Traveled (VHT)	RS = 5	RS = 10	RS = 15	RS = 20	RS = 25	RS = 30	RS = 35	RS = 40	RS = 45	RS = 50	Average
Queued Trips	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total VHT	85.4	84.7	85.4	85.1	85.6	84.5	84.6	84.9	84.9	84.0	**84.9**

PM Peak

Vehicle Hours Traveled (VHT)	RS = 5	RS = 10	RS = 15	RS = 20	RS = 25	RS = 30	RS = 35	RS = 40	RS = 45	RS = 50	Average
Queued Trips	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total VHT	90.2	90.2	91.1	90.3	89.1	90.5	90.0	90.0	90.3	90.3	**90.2**

Existing Configuration

Proposed Build Design