Dewberry

Concept Development Report

Livingston Avenue Complete Streets

County of Middlesex

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County of Middlesex

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Executive Summary

The Livingston Avenue Complete Streets Study was initiated by Middlesex County and the City of New Brunswick with the goal to improve traffic safety for all users of the segment of Livingston Avenue between Elizabeth Street and New Street in New Brunswick, NJ. Middlesex County retained the services of Dewberry Engineers Inc. to prepare the "Complete Streets Concept Development Plan and Report along Livingston Avenue from New Street to the Centerline of Mile Run Bridge." This report evaluates alternatives for reconfiguring this portion of Livingston Avenue to improve the corridor for all roadway users by applying a complete streets approach.

Historically, roadways were designed with the primary purpose of moving vehicular traffic. As traffic volumes increased, roadways were widened to provide additional vehicular capacity, in many cases to the detriment of other roadway users, such as pedestrians and bicyclists. A complete streets approach accounts for all roadway users, providing balanced accommodations for pedestrians, bicyclists, cars, trucks, and buses. It ensures the roadway design is tailored to the community it serves. Since many roadways were previously designed to favor the vehicles, applying Complete Streets principles typically include reclaiming a portion of the roadway previously reserved for vehicles to provide enhanced accommodations for bicycles and pedestrians. This is commonly referred to as a Road Diet because the number of travel lanes on a roadway is reduced. The classic example converts a four lane, undivided roadway into a single through lane for each direction plus a center left turn lane (4 lanes to 3 lanes). However a road diet can also apply to any number of configurations in which the number of lanes on a roadway devoted to vehicular traffic is reduced. The space reclaimed from the reduction in lanes is then available to provide additional roadway features, such as bike lanes, shoulders, widened sidewalks or even parking; all while generally maintaining the existing right of way along the corridor.

The four alternatives developed for the corridor follow the Road Diet concept, reclaiming a portion of the road reserved for cars for other users. Alternative 1 (The Hybrid Road Diet) divides the corridor into two segments. The northern segment, from Morris Avenue to Sandford Avenue is reconfigured using a classic road diet approach, consisting of a single 15 foot through lane in each direction, a 12 foot center left turn lane and 9 foot parking lanes. Bicycles share the 15 foot through lanes with vehicles. South of Sandford Street, a single 11 foot through lane is provided in each direction, with left turns made from the through lane. A 5 foot wide bike lane is provided with a 5 foot striped buffer to separate bikes from vehicles. Curb extensions are provided at each intersection, to improve visibility of pedestrians and reduce pedestrian crossing distances, except where driveways and / or bus stops limit their installation.

Similar to Alternative 1, Alternative 2 (The Center Median) divides the corridor into two segments. The northern segment north of Sandford Street is reconfigured to provide a three lane section, consisting of a single 15 foot through lane in each direction, a 12 foot center left turn lane and 9 foot parking lanes. Bicycles share the 15 foot through lanes with vehicles. South of Sandford Street a 4 foot wide raised median with 11 foot through lanes is provided and left turns from Livingston Avenue to the various side

streets are prohibited. A 5 foot wide bike lane and a 3 foot striped buffer area is provided south of Sandford Street. Curb extensions are provided at each intersection, to improve visibility of pedestrians and reduce pedestrian crossing distances, except where driveways and / or bus stops limit their installation.

Alternative 3, (the Classic Road Diet) reconfigures the corridor to provide the proto-typical three lane roadway section with dedicated bike lanes for its entire length. A single 11 foot through lane is provided in each direction along with a 12 foot center left turn lane and 8 foot parking lane. A 5 foot wide bike lane is provided on each side of the roadway. Curb extensions are provided at each intersection, to improve visibility of pedestrians and reduce pedestrian crossing distances, except where driveways and / or bus stops limit their installation.

Alternative 4 (The Multi-Use Path) reconfigures the corridor to provide a three lane section along the entire corridor consisting of a single 11 foot through lane in each direction, a 12 foot center left turn lane and a 9 foot parking lane in each direction. The existing curb lines would be relocated to accommodate the narrower roadway cross section. Curb extensions are provided at each intersection to improve visibility of pedestrians and further reduce pedestrian crossing distances, except where driveways and / or bus stops limit their installation. Bicycles are accommodated by a new 10 foot wide multi-use path located outside the cart-way behind a new 5 foot wide grass buffer area accommodating the relocated utilities poles along the corridor.

The following evaluation matrix was developed to assist in the selection of a preferred alternative. The matrix ranks each of the alternatives with a score of 1 to 4, with a score of 1 representing best improvement in a given category and 4 representing the least improvement in a given category.

Alternative Evaluation Matrix					
Criteria	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Notes
Impact on Vehicular Flow	4	3	1	1	Scored based on relative increases in travel times along the corridor
Improvements to Safety	4	3	2	1	Scored based on relative decreases in predicted crash rates
Cost	1	3	2	4	Scored based on relative cost
Benefit / Cost Ratio	4	3	1	2	Scored based on relative benefit / cost ratio

Based on the results detailed in TABLE 1 above Alternatives 3 and 4 have the least overall impact to vehicular flow. Alternative 4 has the highest expected reduction in crashes and Alternative 1 has the lowest cost, but Alternative 3 has the best benefit / cost ratio.

In addition to the quantitative results identified above, qualitative considerations, such as public input, need to be considered as part of the selection of a preferred alternative. A public meeting is scheduled for August 18, 2015 to collect public input and this report will be revised to reflect the results of that meeting after it has occurred.

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Concept Development Report

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Livingston Avenue Complete Streets
Concept Development Report

Introduction

The Livingston Avenue Complete Streets Study was initiated by Middlesex County and the City of New Brunswick with the goal to improve traffic safety for all users of the segment of Livingston Avenue between Elizabeth Street and New Street in New Brunswick, NJ. It represents the first step towards addressing the traffic safety needs of the people who live, work, go to school in the area, as well as those who commute through the corridor. Middlesex County retained the services of Dewberry Engineers Inc. to prepare the "Complete Streets Concept Development Plan and Report along Livingston Avenue from New Street to the Centerline of Mile Run Bridge." This report evaluates alternatives for reconfiguring this portion of Livingston Avenue to improve the corridor for all roadway users by applying a complete streets approach.

Background

Livingston Avenue is a north-south minor urban arterial roadway with a 25 mph posted speed. Livingston Avenue is designated as Middlesex County Route 691 from Nassau Street to Suydam Street and New Jersey State Route 171 from Suydam Street to George Street. Livingston Avenue is under County jurisdiction from Nassau Street to New Street and is under City jurisdiction from New Street to George Street.

The roadway includes four travel lanes (two lanes in each direction) and parking lanes (where permitted). The wide cross-section hampers pedestrian crossings and the lack of shoulders makes bicycling along the corridor undesirable. From 2012-2014, there were 271 reported crashes along the study corridor, 11 involving a bicycle and 19 involving a pedestrian.

The study corridor begins just south of Elizabeth Street at the Mile Run Bridge centerline and continues north to the intersection of New Street. An area map of the study corridor is provided in FIGURE 1. Within the corridor there are 4 signalized and 22 unsignalized intersections. Sidewalks are provided on both sides of Livingston Avenue and multiple bus carriers including NJ Transit, Middlesex County Area Transit (MCAT), and the Somerset County Davidson Avenue Shuttle (DASH) operate along the corridor. Land uses along Livingston Avenue include three elementary schools, a rehabilitation center for the blind and visually impaired, a senior 62+ apartment building, multiple places of worship, a public library, as well as various other commercial and residential uses.

This corridor of Livingston Avenue has been the subject of multiple studies. The Rutgers University Center for Advanced Infrastructure & Transportation (CAIT) conducted an initial Road Safety Audit (RSA) and issued a report in May 2012. This report evaluated 8 intersections from Sandford Street to Suydam Street and identified existing safety issues and recommended short- and long-term countermeasures to improve safety along this segment of Livingston Avenue. The 2012 RSA report was followed by an update in 2014 in which the study area was expanded to include over 35 intersections along Livingston Avenue from

12th/Bergen Street in North Brunswick to George Street. In addition to the RSA reports, a "Cost and Benefits of a Road Diet for Livingston Avenue in New Brunswick, New Jersey" report was prepared for the City of New Brunswick. This report reviewed road diet alternatives along Livingston Avenue between New Street and Nassau Street, and performed a cost-benefit analysis to evaluate potential increases in travel time as compared to the benefits of crash reduction along the corridor. In addition to the previously prepared studies, the City of New Brunswick recently reviewed the American Community Survey and found that the mode share of people walking and/or biking to work in the City of New Brunswick was highest as compared to other select cities in New Jersey.

In 2014, a partial road diet was implemented along portions of Livingston Avenue by Middlesex County. The partial road diet included restriping the existing four lane travel section to provide a single wide center left-turn lane, a single travel lane in each the northbound and southbound directions, and parking lanes (where permitted). The restriped sections of Livingston Avenue are from south of Elizabeth Street to Loretto Street, Delavan Street to Baldwin Street, and Townsend Street to Morris Street. The sections between these areas remain as four lanes, with two travel lanes in each direction.

Public Input

On February 6, 2015 a stakeholder meeting was held at the County Engineering Building to brief agencies and businesses along the corridor of the project and to solicit comments and concerns. The first public meeting was held on February 11, 2015 at the AC Redshaw Elementary School to gain input from the community on perceived issues along the corridor and any special concerns of residents and business owners. Meeting materials were provided in both English and Spanish. An interpreter was available to ensure that project information was conveyed and questions answered for both English and Spanish speaking attendees. The four (4) primary concerns identified at the public meeting are noted In TABLE 1 below. The full issues matrix is provided in APPENDIX 1.

TABLE 1

Primary Concerns from Public Meeting

Ranking	Percent of Respondents	Concern
1	37.5%	Lack of Law Enforcement / need to issue tickets
2	29.2%	Cycling Safety / need for bike lanes
3	29.2%	Pedestrian Safety / need for easier crossings
4	25.0%	Speeding / need to slow vehicles down

The lack of law enforcement / need to issue tickets is an enforcement issue which is beyond the scope of engineering improvements and has been referred to the local police for action. However concerns

regarding the need for improved pedestrian crossings, bicycle accommodations and reducing speeds are elements which can be improved through design solutions under this project.

A second public meeting is scheduled for August 18, 2015. The meeting will present the alternatives discussed herewith to obtain public input. A summary of the commentary received at this public meeting will be added to the final report.

Why a Complete Streets Report

Vehicle speeds, pedestrian and vehicular crash history, and the wide variety of land uses along the corridor all contribute to the need to consider changes to the roadway configuration. While a classic road diet may appear to be the obvious solution along Livingston Avenue, Middlesex County and the City of New Brunswick initiated this concept development study to take a comprehensive look at the corridor, apply a complete streets approach and ensure all road users are adequately accommodated. The Concept Development Report summarizes the investigations and analysis performed along the corridor and is organized into three sections:

Section 1 - Existing Conditions

Section 2 - Alternatives Analysis

Section 3 - Recommendations

Historically, roadways were designed with the primary purpose of moving vehicular traffic. As traffic volumes increased, roadways were widened to provide additional vehicular capacity, in many cases to the detriment of other roadway users, such as pedestrians and bicyclists. A complete streets approach accounts for all roadway users, providing balanced accommodations for pedestrians, bicyclists, cars, trucks, and buses. It ensures the roadway design is tailored to the community it serves. Since many roadways were previously designed to favor the vehicles, applying Complete Streets principals typically includes reclaiming a portion of the roadway previously reserved for vehicles to provide enhanced accommodations for bicycles and pedestrians. This is commonly referred to as a Road Diet because the number of travel lanes on a roadway is reduced. The classic example converts a four lane, undivided roadway into a single through lane for each direction plus a center left turn lane (4 lanes to 3 lanes). However a road diet can also apply to any number of configurations in which the number of lanes on a roadway devoted to vehicular traffic is reduced. The space reclaimed from the reduction in lanes is then available to provide additional roadway features, such as bike lanes, shoulders, widened sidewalks or even parking; all while generally maintaining the existing right of way along the corridor.

Section 1.0 - Existing Conditions

The existing conditions along the corridor were evaluated and considered in the development of alternatives.

1.1 Roadway Features

1.1.1 Geometry

Livingston Avenue, as per the NJDOT straight line diagrams, is an urban minor arterial which connects US Route 1 in North Brunswick Township to George Street in the City of New Brunswick. The roadway has a general north-south orientation. Within the study limits between Elizabeth Street and New Street, Livingston Avenue (CR 691) is under Middlesex County jurisdiction. Within this one (1) mile section, the roadway is predominately two travel lanes in each direction with a 25 mph posted speed limit. Parking is provided on both sides of the roadway. At three locations, an interim road diet has been implemented where Livingston Avenue has been striped to provide a single travel lane in each direction plus a wide center turn lane. These include sections of roadway between Nassau Street and Loretto Street, Delavan Street and Baldwin Street, and Townsend and Morris Street. Cross streets are present at 200-300 foot intervals throughout the corridor. There are four signals located along the corridor at Sanford Street, Handy Street, Suydam Street and New Street. A signal is located just south of Elizabeth Street outside the study limits and is maintained by the NJDOT. FIGURE 2 shows an illustrative typical cross section of the existing corridor.

1.1.2 Lighting

Existing lighting was evaluated to identify areas where additional lighting may be needed. The majority of the existing luminaires on Livingston Avenue between Nassau Street and Delavan Street consist of 400-Watt Mercury Vapor (MV) luminaires mounted at 26 feet with 15 foot arms on existing utility poles as shown in PHOTO 1 below. Between Delavan Street and Welton Street the roadway is lit using aluminum lighting standards. A historic district begins at Hale Street and continues to the northerly study limits. Between Welton Street and George Street decorative luminaries mounted on decorative poles are used in addition to aluminum lighting standards as shown in PHOTO 2 below. Several of the decorative luminaires had high dirt accumulation. The decorative poles where generally spaced at approximately 50 feet.

Photo 1
Typical existing utility pole lighting
(wood poles and aluminum standards)

Photo 2
Decorative Lighting

The intersections are illuminated by the utility pole lighting mounted on either aluminum lighting standards or wood poles. The spacing between the light poles is not uniform. Trees located at various locations along the corridor adversely affect lighting levels along the roadway and sidewalks during times of the year when their leaves are abundant.

To determine the operability of the roadway lighting system, the corridor was driven after sunset. Twelve (12) luminaries on utility pole and/or aluminum lighting standards were observed to be not functioning. In addition, there were several decorative luminaires not functioning or had high dirt accumulation.

To determine the existing illumination levels, a lighting analysis of the existing street lights was performed using the Visual lighting software. The analysis assumes all lighting fixtures are operational. The lighting design criteria and results of the preliminary analysis of the existing lighting for the roadway, intersection, and sidewalk are shown in TABLE 2.

TABLE 2

Existing and Required Lighting Levels

	Roadway		Sidewalk	
	Existing **	NJDOT Design Criteria	Existing **	AASHTO Design Criteria
Average	1.78 fc	0.6 – 0.8 fc	1.23 fc	0.40 fc
Minimum	0.07 fc	0.20 fc	0.06 fc	-
Uniformity Ratio (Avg : Min)	25.4:1	4:1 or less	20.5:1	6:1 or less

** Results for existing conditions assume all luminaires present are working

The lighting analysis for the existing condition indicates the following:

- The uniformity, average and minimum illumination levels along the corridor do not meet the required values for both the roadway, intersection and the sidewalk areas.
- The side street crosswalks are poorly lit and creating dark areas for pedestrians.
- The sidewalk areas are not uniformly lit.

Existing lighting pole location and graphical results of existing lighting analysis shown on FIGURE 3.

1.1.3 Drainage

Livingston Avenue has a limited existing drainage system. The drainage area appears to flow to the south. A total of twelve (12) inlet structures exist within the study limits. An additional four (4) inlet structures exist just outside the study limits at Nassau Street in the vicinity of the Bridge over Mile Run tributary. Pairs of inlets exist at Lawrence Street, Handy Street and Welton Street which are roughly the one-thirds points of the corridor. The existing casting and mixed types, are not bicycle safe, and do not meet eco-friendly standards.

1.1.4 Utilities

Verification of existing utility facilities was not performed as part of the study, however, based on GIS information provided by the City of New Brunswick, existing water and sanitary sewer facilities exist along Livingston Avenue. Existing utility poles exist along the corridor and appear to carry electric, telephone and cable TV facilities.

1.1.5 Access

Land uses along Livingston Avenue vary from commercial to residential. Several properties have driveways connecting directly to Livingston Avenue.

1.1.6 Environmental

A historic district exists along Livingston Avenue between Hale Street and New Street. Decorative lighting appears to have been used in this area. A preliminary historic resource map is shown on FIGURE 4.

1.1.7 Pedestrian and Bicycle Facilities

Sidewalks are provided on both sides of Livingston Avenue. ADA ramps were recently upgraded at each intersection. At several locations along the corridor poor sidewalk conditions pose a tripping hazard. Detectable warning surfaces (DWS) exist at all intersections. Most DWS's are red in color however at several locations the DWS's are gray, possibly as a result of the historic district, making them less visible against the white/gray concrete sidewalk. Crosswalks generally exist at each intersection along the corridor but vary in width, style and condition. Pedestrian push buttons exist at each of the existing traffic signals. Bicycle lanes do not currently exist on Livingston Avenue or on the side streets except for Suydam Street where the bike lane transitions to a shared lane in the vicinity of the intersection with Livingston Avenue.

1.1.8 Bus Stops/Shelters

Ten (10) bus stops and four (4) bus shelters exist along the corridor. Based on a review of bus stop and bus shelter standards and guidelines obtained from New Jersey Transit (NJT) and field observations, only the Livingston Avenue northbound bus shelter at Elizabeth Street is ADA compliant. The other three (3) bus shelters do not provide a required ADA accessible route. Numerous existing bus stop signs do not appear to be properly oriented as per NJ Transit guidelines.

1.1.9 Street Furniture

Street furniture in varying forms exists along the corridor newspaper enclosures and garbage cans. Benches are also present at some bus stop locations.

1.1.10 Signage and Striping

Existing signs are faded, are not mounted on breakaway posts, and do not meet current MUTCD retro-reflectivity standards. Roadway striping is in relatively good condition, with crosswalks across and parallel to Livingston Avenue consisting of two 6" white lines spaced 6' apart.

1.1.11 Traffic Signals

There are four traffic signals along the corridor, at:

Livingston Avenue & New Street
Livingston Avenue & Suydam Street
Livingston Avenue & Handy Street
Livingston Avenue & Sandford Street

Each of these signals has pedestrian push buttons, walk / don't walk indications and ADA accessible ramps. The signals, however, do not reflect current MUTCD guidelines for ADA push button and countdown indications.

1.1.12 Right of Way

The existing Livingston Avenue ROW is 100 feet wide. Preliminary ROW and property lines were provided using GIS information provided by the County.

1.2 Traffic Volumes

Current vehicular, pedestrian and bicycle volumes were obtained as part of Concept Development.

1.2.1 Vehicular Volumes

Vehicular volumes were obtained from intersection turning movement counts conducted at each intersection along the study corridor on Thursday, January 22nd, 2015 from 6:30 AM to 9:30 AM and 2:30 PM to 6:30 PM and on Saturday, January 24th 2015, from 11:00 AM to 2:00 PM and 6:00 PM to 9:00 PM. A common peak hour for the corridor was determined for each of the four peak hour count periods, specifically:

Weekday Morning:	7:30 AM to 8:30 AM
Weekday Evening:	4:30 PM to 5:30 PM
Saturday Mid-Day:	12:30 PM to 1:30 PM
Saturday Evening:	6:00 PM to 7:00 PM

Specifically, the following intersections were counted:

1- *Livingston Avenue & New Street
2- Livingston Avenue & Morris Street
3- Livingston Avenue & Welton Street
4- Livingston Avenue & Redmond Street
5- Livingston Avenue & Townsend Street
6- *Livingston Avenue & Suydam Street
7- Livingston Avenue & Seaman Street
8- *Livingston Avenue & Handy Street
9- Livingston Avenue & Baldwin Street
10- Livingston Avenue & Hale Street
11- Livingston Avenue & Comstock Street

12- Livingston Avenue & Delavan Street
13- *Livingston Avenue & Sandford Street
14- Livingston Avenue & Powers Street
15- Livingston Avenue & Stratford Place / Howard Street
16- Livingston Avenue & Lewell Place / Talmadge Street
17- Livingston Avenue & Edgewood Place / Ward Street
18- Livingston Avenue & Wellington Street / Lawrence Street
19- Livingston Avenue & Fulton Street
20- Livingston Avenue & Rutgers Street
21- Livingston Avenue & Ellen Street
22- Livingston Avenue & Juliet Street
23- Livingston Avenue & May Street
24- Livingston Avenue & Loretto Street
25- Livingston Avenue & Charles Street
26- Livingston Avenue & Elizabeth Street
27- Livingston Avenue & Woodnor Court
28- *Livingston Avenue & Nassau Street

* Denotes a signalized intersection.

The resulting peak hour volumes are illustrated on FIGURES 5-8. Individual traffic counts data is located in APPENDIX 2.

1.2.2 Automatic Traffic Recorders

Automatic traffic recorders (ATR's) were also installed on Livingston Avenue between Ellen Street and Rutgers Street and between Morris Street and Welton Street from Thursday, January 29th 2015 through Thursday, February 5th, 2015. The resulting AADT for the corridor based on this data is 14,772 vehicles. ATR counts are located in APPENDIX 3.

1.2.3 Pedestrian and Bicycle Volumes

Pedestrian and bicycle volumes were recorded in conjunction with the vehicular intersection counts. The resulting peak hour pedestrian and bicycle volumes for each time period studied are illustrated in FIGURES 9-12. Pedestrian and bicycle volumes are shown on the individual traffic count sheets located in APPENDIX 2.

1.2.4 Existing Peak Hour Levels of Service

Traffic Analysis Methodology

The 2010 Highway Capacity Manual (HCM) procedures as adopted and applied in Trafficware's Synchro 8 (Synchro) software program were used to generate the capacity analysis results. Capacity analysis is a

standard method used to estimate the traffic-carrying ability of roadway facilities over a range of defined operating conditions. Results are expressed by a resultant Level of Service (LOS).

LOS describes the delay experienced by the average vehicle at an intersection or a section of highway. There are six levels of service used, A through F, with Level of Service A (LOS A) reflects the best condition and LOS F reflects an over capacity or unstable condition. The LOS criteria is based upon average vehicle delay.

Delay at signalized intersections is referred to as “control delay”. It is the total delay experienced by an approaching vehicle as it passes through the intersection, including any time spent waiting for the traffic signal to turn green.

TABLE 3 presents the range of delay values that correspond with the letter designation of LOS for signalized intersections.

TABLE 3 Level of Service Criteria for Signalized Intersections	
Level of Service	Delay (sec)
A	≤ 10
B	>10-20
C	>20-35
D	>35-55
E	>55-80
F	>80

Delay at unsignalized intersections is essentially the delay experienced by vehicles turning left from the main street, or by vehicles approaching on the side (minor) street. Through vehicles on the major street experience no delay since they have the right-of-way over other approaching vehicles. The analysis of unsignalized intersections does not report overall intersection delay; rather it reports the worst average delay experienced by the minor street or left turning vehicles.

TABLE 4 presents the range of delay values that correspond with the letter designation of LOS for unsignalized intersections.

TABLE 4 Level of Service Criteria for Unsignalized Intersections	
Level of Service	Delay (sec)
A	≤ 10
B	>10-15
C	>15-25
D	>25-35
E	>35-50
F	>50

Using Synchro, the Level of Service and Delay for each study intersection and study time period was calculated. A summary of this analysis is provided in TABLE 5. Detailed LOS printouts, which indicate the individual levels of service, delays, and queues for each intersection are located in APPENDIX 4.

TABLE 5 Existing Peak Hour Level of Service Summary								
Intersection	AM		PM		SAT MID		SAT PM	
	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay
Livingston Ave & New Street	C	27.0	D	41.0	D	49.4	C	27.0
Livingston Ave & Welton Street [1]	B	13.1	C	31.4	A	3.8	A	3.1
Livingston Ave & Redmond Street [1]	B	13.6	B	13.3	A	2.7	A	3.0
Livingston Ave & Townsend Street	A	5.7	E	36.8	A	3.7	A	3.9
Livingston Ave & Suydam Street	C	21.9	E	66.4	B	19.0	B	16.0
Livingston Ave & Seaman Street	A	1.1	F	72.4	A	2.4	A	4.1
Livingston Ave & Handy Street	B	17.0	D	44.2	B	16.1	B	15.0
Livingston Ave & Baldwin Street	A	6.1	D	25.9	A	3.8	A	5.9
Livingston Ave & Hale Street	A	7.8	C	24.4	A	3.4	A	2.4
Livingston Ave & Comstock Street [1]	D	47.5	B	14.2	A	2.0	A	1.5
Livingston Ave & Delavan Street [1]	A	4.0	A	3.0	A	0.8	A	1.0
Livingston Ave & Sandford Street	B	19.6	C	21.9	B	17.5	B	13.8
Livingston Ave & Powers Street	A	3.3	A	4.7	A	2.1	A	2.9
Livingston Ave & Stratford Place/Howard Street	A	2.2	A	2.4	A	1.0	A	1.6
Livingston Ave & Llewellyn Place/Talmadge Street	A	0.5	A	0.3	A	1.4	A	1.8
Livingston Ave & Ward Street	A	3.6	A	2.6	A	2.9	A	1.3
Livingston Ave & Wellington Place/Lawrence Street	A	2.4	A	3.7	A	2.4	A	2.3
Livingston Ave & Fulton Street	A	1.0	A	0.9	A	1.0	A	0.7
Livingston Ave & Rutgers Street	A	1.6	A	1.9	A	1.6	A	1.2
Livingston Ave & Ellen Street	A	1.6	A	0.8	A	0.6	A	0.5
Livingston Ave & Juliet Street	A	0.9	A	0.7	A	0.8	A	0.9
Livingston Ave & May Street	A	1.9	A	1.4	A	1.4	A	1.6
Livingston Ave & Loretto Street	A	3.9	A	2.3	A	2.1	A	2.1
Livingston Ave & Charles Street	A	3.6	A	1.0	A	1.0	A	0.6

[1] - School Crossing Guard

* - Delay Exceeds 600 Seconds

1.2.5 Travel Time Delay Study

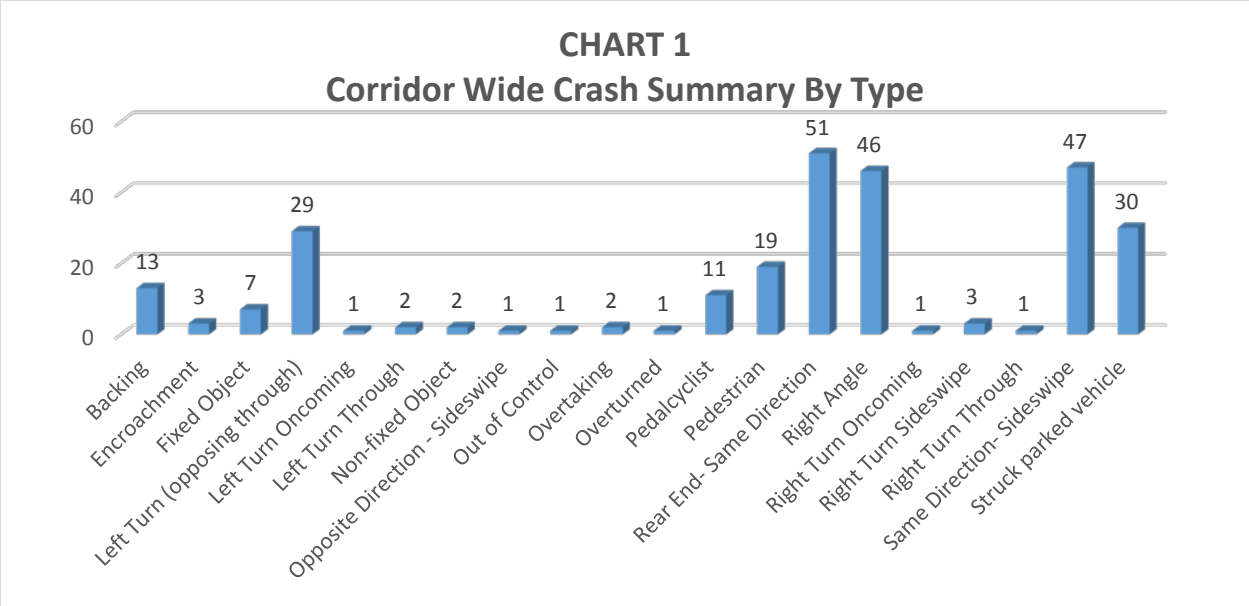
A travel time delay study was performed along the corridor. These provided data on how long it takes to traverse the corridor in a vehicle during each of the four study peak hours. TABLE 6 below provides a summary of the each of the travel time runs for each time period, including a comparison of the measured travel time to the modeled travel time using Synchro. Individual travel time runs are included in APPENDIX 5.

TABLE 6 Travel Time Delay Summary				
	Northbound		Southbound	
Peak Hour	Field Measured	Per Synchro Model	Field Measured	Per Synchro Model
Weekday Morning	422	415	302	294
Weekday Evening	360	375	339	349
Saturday Mid-day	394	377	317	289
Saturday Evening	336	329	283	279

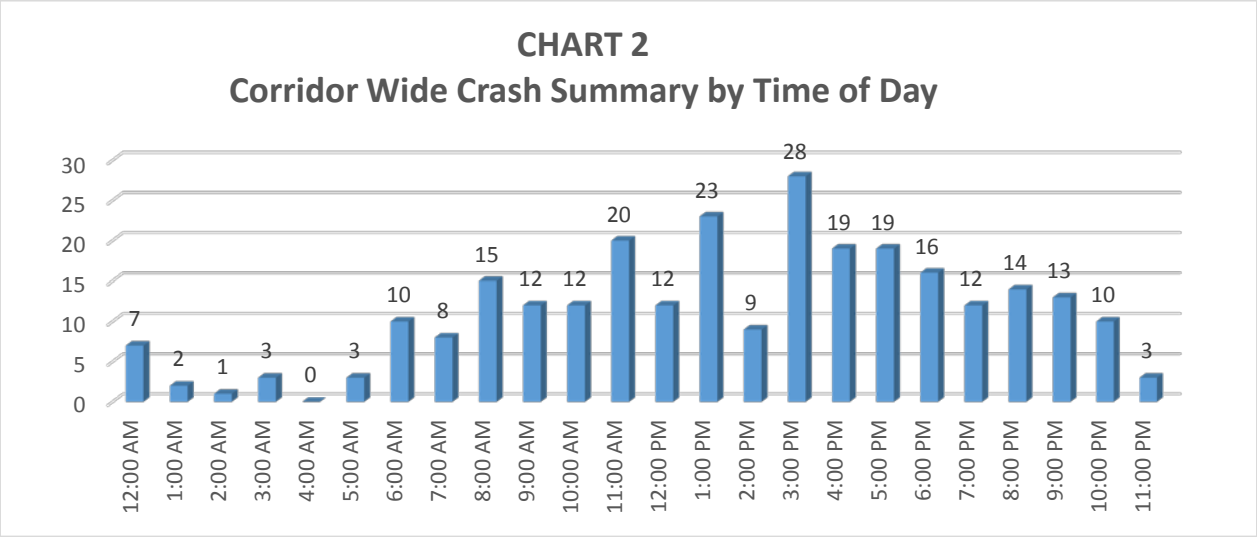
1.3 Safety Analysis

1.3.1 Crash History

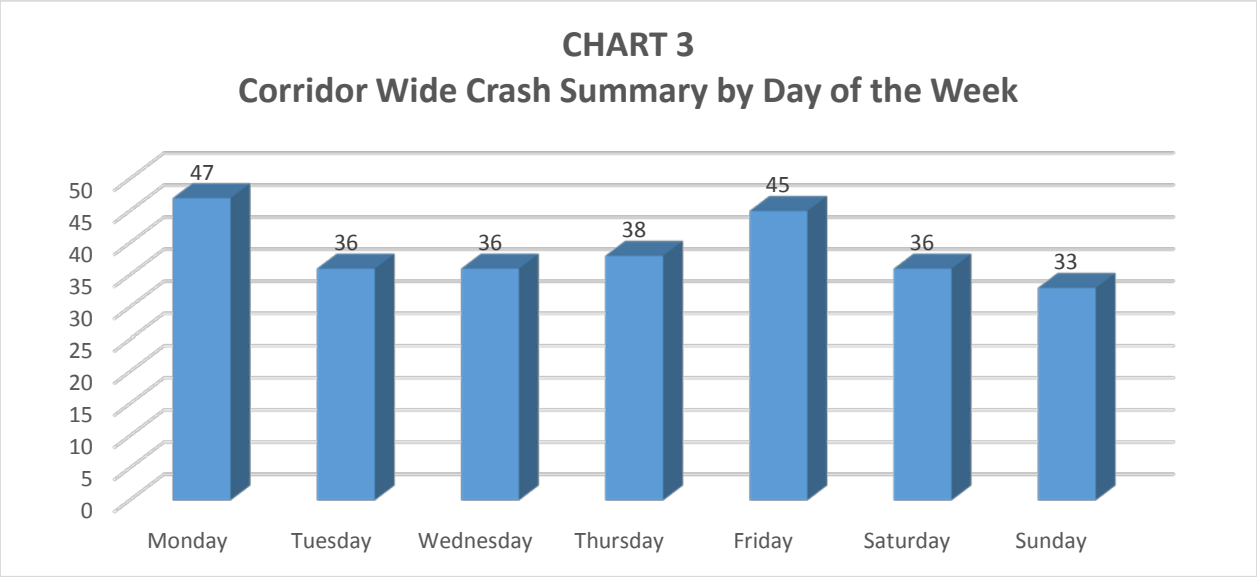
When considering a roadway reconfiguration, a review of the crash history allows for identification of locations with high / repetitive crashes so that appropriate design elements can be considered and incorporated to mitigate the crashes in the future. Crash reports were obtained for the corridor from the City of New Brunswick Police Department for the three year period from January 1, 2012 to December 31, 2014. Each crash report was reviewed and plotted on a series of collision diagrams to identify crash patterns that warranted further investigation. A summary of the results of the crash analysis is provided in CHARTS 1-5 below. Crash diagrams for the corridor are provided in APPENDIX 6.



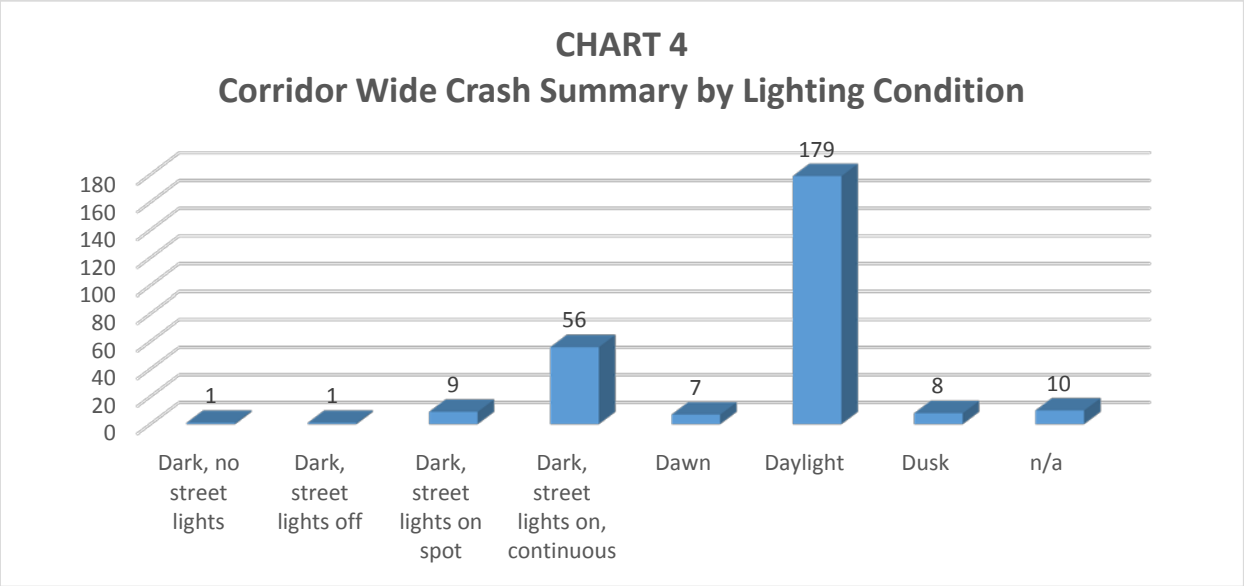
As indicated in Chart 1 above, "Same Direction- Rear End Crashes" are the most prevalent crash type along the corridor, followed closely behind by "Same Direction - Sideswipe" and "Right Angle" crashes. High instances of same direction rear end crashes are typical along congested corridors. High numbers of sideswipe crashes typically indicate a geometric issue and a high numbers of right angle crashes typically indicate an operational issue at an intersection.



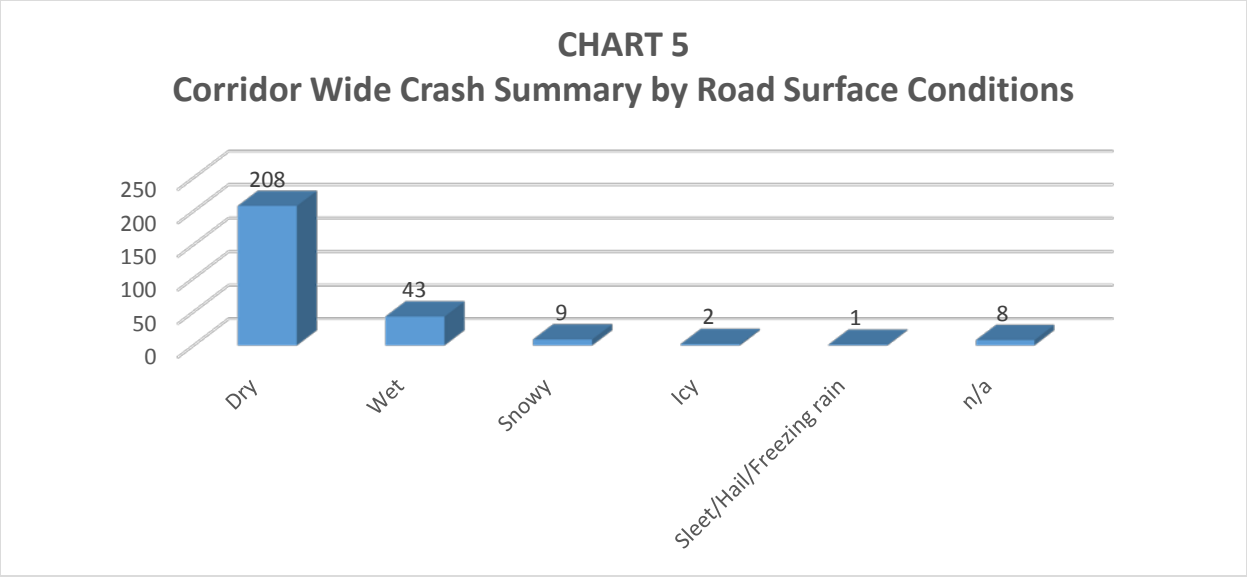
Typically, crashes throughout the course of the day mirror traffic volumes, with noted peaks in crashes during the morning and evening peak hours, however, as indicated in CHART 2 above, the highest number of crashes occur during the mid-day hours, corresponding with school activity along the corridor.



As indicated by Chart 3 above, the highest concentration of crashes along the corridor occurs on Mondays and Fridays.



As indicated by Chart 4 above, the majority of crashes occur during daylight hours which is typical for most arterial corridors.



As indicated in CHART 5 above, the majority of crashes occur during dry conditions which is typical for most arterial corridors.

FIGURE 13 illustrates the number of crashes by intersection along the corridor for the three year period. The signalized intersections of New Street, Suydam Street, and Handy Street have the most crashes along the corridor. It is worth noting that while the highest vehicular crashes occurred are at the signalized intersections, pedestrian and bicycle crashes are scattered along the entire corridor.

1.2.6 Highway Safety Manual Analysis

The Highway Safety Manual (HSM) utilizes data on the volumes, lane geometry, signal phasing (if applicable) and other roadway features to establish a predicted number of crashes for a given roadway facility. This analysis is analogous to the Highway Capacity Manual (HCM), which uses similar data to calculate vehicular delay. Whereas the HCM compares delays based on different alternatives, the HSM can be used to evaluate the anticipated crash rates for various alternatives. Once crash rates are determined for both the existing and proposed configurations, an economic analysis can be performed to determine the benefit to cost ratio for an alternative based on safety.

Model Crash Rates under Existing Conditions

Using the HSM prediction spreadsheet for urban and suburban arterials, the Livingston Avenue corridor was evaluated to determine the HSM model existing crash rates. In total, 26 roadway segments and 27 intersections were analyzed as part of the existing conditions crash modeling. The results of the HSM analysis for existing conditions is shown in TABLE 7 below. The model results include crash rates for Property Damage Only (PDO) and Fatal & Injury (F&I) crashes.

It is worth noting that the HSM analysis provides predicted crash rates, which in many cases differ from actual crash rates since the model cannot account for all possible factors inherent in a crash. Since the crash rate calculation will be used to compare each alternative having its own geometric configurations

against the existing condition, the predicted crash rates, in lieu of actual crash rates, is the most appropriate to use so an “apples to apples” comparison is maintained.

TABLE 7 Predicted Average Crash Frequency Crashes / Year (Existing Conditions)			
Crash Type	PDO Crashes/ Yr	F&I Crashes / Yr	Total Crashes / Yr
Mid-Block, Multiple Vehicle Non-Driveway	3.657	1.654	5.311
Mid-Block, Single Vehicle	1.044	0.359	1.402
Mid-Block, Multiple Vehicle – Driveway Related	1.830	0.951	2.781
Intersection, Multiple Vehicle	27.777	15.510	43.287
Intersection, Single Vehicle	5.185	1.666	3.519
Total	**37.826**	**20.140**	**57.966**

SECTION 2.0 - Alternatives Analysis

Alternative were developed to address the issues identified along the corridor using a complete streets approach. The four alternatives developed, are described below with conceptual plans included with this report. These alternatives were developed by building on the recommended designs from the Federal Highway Administration's Nine Proven Crash Countermeasures which includes the "road diet". FHWA statistics indicate road diets can achieve a crash reduction of 19 to 47 percent. Each of the alternatives utilized the classic road diet methodology as a base with modifications for specific for needs along segments of Livingston Avenue.

Preliminary alternative development included consideration of roundabouts along the corridor. While a roundabout can typically improve operation, the roundabout option was not considered feasible due to the minimum geometry required and associated right of way impacts.

In general traffic volumes on the northern section of the corridor are such that a three lane section, one lane in each direction with a center left turn lane is required to maintain vehicular flow without introducing excessive delays along Livingston Avenue. The southern portion of the corridor, however, has lower volumes, which allows more variations to be considered which balancing traffic operation with pedestrian and bicycle concerns. Illustrative typical cross sections for each alternative are provided in FIGURES 14-17. Concept plans for each alternative are shown in FIGURES 18-21.

2.1 Intersection Improvements

2.1.1 Livingston Avenue and New Street

To improve operations and safety at the intersection of Livingston Avenue and New Street, revisions to the lane configurations are proposed including the addition of a dedicated left turn lanes along Livingston Avenue northbound and southbound. Livingston Avenue northbound will also include a dedicated right turn lane. The locations of the crosswalks are also proposed to be modified to shorten the pedestrian crossing distances. Signal modifications include the addition of a westbound lead left turn phase with a northbound right turn overlap and a dedicated pedestrian phase.

2.1.2 Livingston Avenue and Suydam Street

To improve operations and safety at the intersection of Livingston Avenue and Suydam Street, re-striping at the intersection is recommended to eliminate the offset of the opposing left turn lanes. The left turn lanes would be realigned so they are 'head to head' resulting in improved visibility for left turning vehicles.

2.1.3 Traffic Signal Warrant Analyses

Each of the stop controlled intersections along the corridor was investigated for Manual on Uniform Traffic Control Devices (MUTCD) traffic signal warrants. Based on the results of the evaluation, none of the intersections investigated warrant signalization. Additional information on the individual warrant analyses is provided in APPENDIX 7.

2.2 Parking Impacts

The proposed guidelines for accessibility for Public Rights of Way, known as PROWAG, includes provisions for handicap accessible parking spaces based on the perimeter length of marked and / or metered parking spaces on a given roadway block. Since portion of Livingston Avenue between Welton Street and New Street and their surrounding blocks include striped and / or metered parking therefore handicap accessible parking spaces will need to be provided as part of the improvements. The improvements require four accessible spaces be included as part of the project. The final location of these spaces will be determined during final design, and can be located anywhere along the affected perimeter block, not necessarily on Livingston Avenue.

2.3 Corridor Improvements

2.3.1 Alternative 1 – "The Hybrid Road Diet"

Alternative 1 divides the corridor into two segments. The northern segment, from Morris Avenue to Sandford Avenue is reconfigured using a classic road diet approach, consisting of a single 15 foot through lane in each direction, a 12 foot center left turn lane and 9 foot parking lanes. Bicycles share the 15 foot through lanes with vehicles. South of Sandford Street, a single 11 foot through lane in each direction is provided in each direction, with left turns made from the through lane. A 5 foot wide bike lane is provided with a 5 foot striped buffer to separate bikes from vehicles. The existing 60 foot wide roadway cross-section is maintained. In areas where Livingston Avenue is 58 feet wide curb to curb, the parking lanes is reduced to 8 feet to maintain the existing roadway width. Curb extensions are provided at each intersection, to improve visibility of pedestrians and reduce pedestrian crossing distances, except where driveways and / or bus stops limit their installation.

A variation on Alternative 1 maintains the 60 foot roadway cross section and 11 foot lanes for the southern portion of the corridor maintains the 11 through lanes but locates the bike lane and bike buffer along the existing curb where they are separated from the travel lanes by the parking lane.

Alternative 1 has an estimated cost of $3,487,087.

2.3.2 Alternative 2 – "The Center Median"

Similar to Alternative 1, Alternative 2 divides the corridor into two segments. The northern segment north of Sandford Street is reconfigured to provide a three lane section, consisting of a single 15 foot through lane in each direction, a 12 foot center left turn lane and 9 foot parking lanes. Bicycles share the 15 foot through lanes with vehicles. South of Sandford Street a 4 foot wide raised median with 11 foot through lanes is provided and left turns from Livingston Avenue to the various side streets are prohibited. These turning movements would be made by vehicles making right turns off Livingston Avenue at either the previous or following intersection and utilizing the grid street network and a series of right turn maneuvers to cross Livingston Avenue. A 5 foot wide bike lane and a 3 foot striped buffer area is provided south of Sandford Street. Curb extensions are provided at each intersection, to improve visibility of pedestrians and reduce pedestrian crossing distances, except where driveways and / or bus stops limit their installation.

A variation on Alternative 2 for the southern portion of the corridor maintains the center median and 11 through lanes but locates the bike lane and bike buffer along the existing curb where they are separated from the travel lanes by the parking lane.

Alternative 2 has an estimated cost of $3,599,958.

2.3.3 Alternative 3 – The Classic Road Diet

Alternative 3 reconfigures the corridor to provide the proto-typical three lane roadway section with dedicated bike lanes for its entire length. A single 11 foot through lane is provided in each direction along with a 12 foot center left turn lane and 8 foot parking lane. A 5 foot wide bike lane is provided on each side but no bike buffer is provided. The existing 60 foot wide roadway cross-section is maintained. In areas where Livingston Avenue is 58 feet wide curb to curb, two (2) feet of roadway widening is required to maintain the 60 foot cart-way. Curb extensions are provided at each intersection, to improve visibility of pedestrians and reduce pedestrian crossing distances, except where driveways and / or bus stops limit their installation.

A variation on Alternative 3 maintains the existing roadway width but locates the bike lane along the existing curb where it is separated from the travel lanes by the parking lane.

Alternative 3 has an estimated cost of $3,508,921.

2.3.4 Alternative 4 – “The Multi-Use Path”

Alternative 4 reconfigures the corridor to provide a three lane section along the entire corridor consisting of a single 11 foot through lane in each direction, a 12 foot center left turn lane and a 9 foot parking lane in each direction. The existing cart-way is reduced from 60 to 52 feet. The existing curb lines would be relocated to accommodate the narrower roadway cross section. Curb extensions are provided at each intersection to improve visibility of pedestrians and further reduce pedestrian crossing distances, except where driveways and / or bus stops limit their installation. Bicycles are accommodated by a new 10 foot wide multi-use path located outside the cart-way behind a new 5 foot wide grass buffer area accommodating the relocated utilities poles along the corridor.

Alternative 4 has an estimated cost of $4,202,165.

2.4 Traffic Analysis of Alternatives

Similar to the analysis prepared for existing conditions, each of the four alternatives was analyzed using Synchro for each of the four peak hour time periods to determine how each alternative would operate from a level of service and delay perspective. TABLE 8 detail the overall levels of service for each intersection for each of the four alternatives. TABLE 9 below provides a summary of the anticipated travel time delay runs for each alternative and time period. Level of Service details for each of the alternatives are provided in APPENDIX 8.

TABLE 8 Alternative 1 Peak Hour Level of Service Summary								
Intersection	AM		PM		SAT MID		SAT PM	
	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay
Livingston Ave & New Street	B	16.1	F	101.1	E	61.4	D	45.5
Livingston Ave & Welton Street [1]	B	13.1	C	31.4	A	3.8	A	3.1
Livingston Ave & Redmond Street [1]	B	13.6	B	13.3	A	2.7	A	3.0
Livingston Ave & Townsend Street	A	6.3	F	51.0	A	4.2	A	4.1
Livingston Ave & Suydam Street	C	27.0	F	90.9	C	21.0	B	13.6
Livingston Ave & Seaman Street	A	0.7	F	89.7	A	2.6	A	4.5
Livingston Ave & Handy Street	E	57.3	F	155.4	C	20.9	B	19.4
Livingston Ave & Baldwin Street	A	8.1	D	26.9	A	4.7	A	6.3
Livingston Ave & Hale Street	A	7.8	C	24.4	A	3.4	A	2.4
Livingston Ave & Comstock Street [1]	B	18.3	B	14.2	A	2.0	A	1.5
Livingston Ave & Delavan Street [1]	A	9.1	A	5.1	A	0.8	A	1.0
Livingston Ave & Sandford Street	D	47.3	D	38.1	C	24.7	B	17.0
Livingston Ave & Powers Street	A	4.1	A	6.6	A	2.4	A	3.6
Livingston Ave & Stratford Place/Howard Street	A	2.5	A	2.8	A	1.1	A	1.7
Livingston Ave & Llewellyn Place/Talmadge Street	A	0.7	A	0.3	A	1.6	A	2.1
Livingston Ave & Ward Street	A	4.4	A	3.0	A	3.7	A	1.6
Livingston Ave & Wellington Place/Lawrence Street	A	3.0	A	4.9	A	3.0	A	2.7
Livingston Ave & Fulton Street	A	0.9	A	0.9	A	1.0	A	0.7
Livingston Ave & Rutgers Street	A	2.0	A	2.2	A	2.0	A	1.5
Livingston Ave & Ellen Street	A	2.1	A	1.3	A	0.7	A	0.7
Livingston Ave & Juliet Street	A	1.1	A	0.8	A	0.8	A	0.9
Livingston Ave & May Street	A	2.8	A	2.2	A	1.8	A	2.2
Livingston Ave & Loretto Street	A	6.2	A	3.1	A	2.9	A	2.5
Livingston Ave & Charles Street	A	2.0	A	0.9	A	0.9	A	0.6

[1] - School Crossing Guard
* - Delay Exceeds 600 Seconds

TABLE 8 (Continued) Alternative 2 Peak Hour Level of Service Summary								
Intersection	AM		PM		SAT MID		SAT PM	
	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay
Livingston Ave & New Street	B	16.1	F	101.1	E	61.4	D	45.5
Livingston Ave & Welton Street [1]	B	13.1	C	31.4	A	3.8	A	3.1
Livingston Ave & Redmond Street [1]	B	13.6	B	13.3	A	2.7	A	3.0
Livingston Ave & Townsend Street	A	6.3	F	51.0	A	4.2	A	4.1
Livingston Ave & Suydam Street	C	27.0	F	90.9	C	21.0	B	13.6
Livingston Ave & Seaman Street	A	0.7	F	89.7	A	2.6	A	4.5
Livingston Ave & Handy Street	E	56.9	F	157.4	C	20.9	B	19.4
Livingston Ave & Baldwin Street	A	8.1	D	26.9	A	4.7	A	6.3
Livingston Ave & Hale Street	A	7.8	C	24.4	A	3.4	A	2.4
Livingston Ave & Comstock Street [1]	B	18.3	B	14.2	A	2.0	A	1.5
Livingston Ave & Delavan Street [1]	A	9.1	A	5.1	A	0.8	A	1.0
Livingston Ave & Sandford Street	E	58.5	D	38.7	C	26.1	B	17.6
Livingston Ave & Powers Street	C	18.4	A	9.0	A	4.1	A	4.2
Livingston Ave & Stratford Place/Howard Street	A	6.1	A	9.0	A	1.9	A	2.6
Livingston Ave & Llewellyn Place/Talmadge Street	A	1.9	A	0.5	A	2.9	A	2.9
Livingston Ave & Ward Street	C	19.4	A	4.6	A	5.4	A	1.7
Livingston Ave & Wellington Place/Lawrence Street	A	5.4	B	13.6	A	4.9	A	4.1
Livingston Ave & Fulton Street	A	2.5	A	0.8	A	1.0	A	1.3
Livingston Ave & Rutgers Street	A	6.1	D	32.1	A	4.8	A	2.7
Livingston Ave & Ellen Street	A	2.4	A	1.8	A	1.3	A	1.1
Livingston Ave & Juliet Street	A	1.3	A	0.8	A	0.9	A	1.1
Livingston Ave & May Street	A	4.8	A	3.1	A	2.4	A	2.6
Livingston Ave & Loretto Street	B	10.3	A	5.2	A	3.1	A	7.7
Livingston Ave & Charles Street	A	2.1	A	0.9	A	0.9	A	0.6

[1] - School Crossing Guard

* - Delay Exceeds 600 Seconds

TABLE 8 (Continued) Alternatives 3 and 4 Peak Hour Level of Service Summary								
Intersection	AM		PM		SAT MID		SAT PM	
	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay
Livingston Ave & New Street	D	46.1	F	132.2	F	132.2	D	45.6
Livingston Ave & Welton Street [1]	B	13.1	C	31.4	A	3.8	A	3.1
Livingston Ave & Redmond Street [1]	B	13.6	B	13.3	A	2.7	A	3.0
Livingston Ave & Townsend Street	A	6.3	F	51.0	A	4.2	A	4.1
Livingston Ave & Suydam Street	C	27.0	F	80.9	C	21.0	B	13.6
Livingston Ave & Seaman Street	A	0.7	F	89.7	A	2.6	A	4.5
Livingston Ave & Handy Street	E	56.7	F	155.4	C	20.9	B	19.4
Livingston Ave & Baldwin Street	A	8.1	D	26.9	A	4.7	A	6.3
Livingston Ave & Hale Street	A	7.8	C	24.4	A	3.4	A	2.4
Livingston Ave & Comstock Street [1]	B	18.1	B	14.2	A	2.0	A	1.5
Livingston Ave & Delavan Street [1]	A	9.0	A	5.1	A	0.8	A	1.0
Livingston Ave & Sandford Street	D	47.3	D	38.1	C	24.7	B	17.0
Livingston Ave & Powers Street	A	3.9	A	6.0	A	2.4	A	3.5
Livingston Ave & Stratford Place/Howard Street	A	2.4	A	2.7	A	1.1	A	1.7
Livingston Ave & Llewellyn Place/Talmadge Street	A	0.7	A	0.3	A	1.1	A	2.1
Livingston Ave & Ward Street	A	4.1	A	2.9	A	3.6	A	1.2
Livingston Ave & Wellington Place/Lawrence Street	A	2.9	A	4.7	A	3.0	A	2.6
Livingston Ave & Fulton Street	A	0.9	A	0.9	A	1.0	A	0.7
Livingston Ave & Rutgers Street	A	1.9	A	2.2	A	2.0	A	1.5
Livingston Ave & Ellen Street	A	2.0	A	1.3	A	0.7	A	0.7
Livingston Ave & Juliet Street	A	1.1	A	0.8	A	0.8	A	0.9
Livingston Ave & May Street	A	2.7	A	2.2	A	1.8	A	2.2
Livingston Ave & Loretto Street	A	5.9	A	3.0	A	2.9	A	2.4
Livingston Ave & Charles Street	A	2.0	A	1.0	A	1.0	A	0.6

[1] - School Crossing Guard
* - Delay Exceeds 600 Seconds

TABLE 9 Travel Time Delay Runs by Alternative and Time Period (in seconds)										
	Existing Conditions (Per Synchro)		Alternative 1		Alternative 2		Alternative 3		Alternative 4	
Peak Hour	NB	SB	NB	SB	NB	SB	NB	SB	NB	SB
Weekday Morning	415	294	473	328	471	307	369	309	369	309
Weekday Evening	375	349	404	482	391	521	382	437	382	437
Saturday Mid-day	377	289	365	317	387	312	385	308	385	308
Saturday Evening	329	279	335	304	350	301	345	301	345	301

As TABLE 9 indicates, all four of the identified alternatives increase travel times along the Livingston Avenue corridor above existing conditions. The changes in travel times, however, are all relatively modest with the exception of the weekday evening peak hour, which experiences a substantial increase in travel times during each alternative. This is consistent with the observed traffic volumes since the southbound evening flow is the highest of the peak hours and favors the existing four lane section. Alternatives 3 and 4 (which have the same travel times since the number of vehicular travel lanes is the same) provide the shortest overall travel times of the four alternatives.

2.5 Crash Analysis of Alternatives

Similar to the existing conditions, a Highway Safety Manual analysis was performed for each of the four alternatives. TABLE 10 below provides a summary of the anticipated crash frequencies for each of the alternatives compared to existing conditions. As TABLE 10 below shows, the four alternatives can be expected to reduce overall crash frequency along the corridor over existing conditions, with Alternative 4 having the greatest overall crash reduction. Detailed outputs from the HSM analysis for each alternative are provided in APPENDIX 9.

TABLE 10

Anticipated Crash Frequency (crashes / year)

	Existing Conditions			Alternative 1			Alternative 2			Alternative 3			Alternative 4		
Crash Type	PDO	F&I	ALL	PDO	F&I	ALL	PDO	F&I	ALL	PDO	F&I	ALL	PDO	F&I	ALL
Mid-Block, Multiple Vehicle Non-Driveway	3.657	1.654	5.311	4.185	1.591	5.776	3.522	1.302	4.824	4.648	1.773	6.422	4.730	1.681	6.411
Mid-Block, Single Vehicle	1.044	0.359	1.402	1.215	0.371	1.586	0.827	0.250	1.077	1.464	0.493	1.957	0.910	0.352	1.261
Mid-Block, Multiple Vehicle – Driveway Related	1.830	0.951	2.781	1.600	0.625	2.225	0.994	0.327	1.321	1.599	0.628	2.227	1.431	0.473	1.904
Intersection, Multiple Vehicle	27.777	15.510	43.287	23.721	13.260	36.982	23.436	13.091	36.527	19.158	10.567	29.724	19.076	10.577	29.653
Intersection, Single Vehicle	5.185	1.666	3.519	3.042	1.452	4.495	3.000	1.432	4.432	2.329	1.084	3.412	2.342	1.091	3.433
Total	**37.826**	**20.140**	**57.966**	**33.765**	**17.299**	**51.064**	**31.779**	**16.403**	**48.182**	**29.198**	**14.545**	**43.743**	**28.489**	**14.174**	**42.663**

2.6 Economic Analysis and Benefit to Cost Ratio (B/C) of Alternatives

The document, "Societal Crash Costs by Severity," FHWA-HRT-05-051, dated October, 2005 provides cost estimates in 2001 dollars for the societal costs for crashes in the United States. This data allows crash rates to be assigned a dollar value and permits a benefit / cost analysis to be performed for roadway improvement projects. Using the Consumer Price Index Calculator, these crash costs can be adjusted to present day values. The 2001 crash values adjusted for inflation to 2015 are detailed in Table 11 below:

TABLE 11 Estimated Crash Costs by Severity (as of July 27, 2015)	
Crash Type	2015 Cost
Fatal and/or Injury	$213,170.70
Property Damage Only	$9,971.32

Using predicted existing and future crash rates, along with timeline and traffic growth parameters, a comparison of the change in equivalent crash costs due to each alternative was determined. TABLE 12 below provides a summary of the Benefit / Cost Analysis for each alternative. Details of the Benefit Cost Analysis are provided in APPENDIX 10.

TABLE 12 Benefit/Cost Analysis				
	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Estimated Cost (2015 Dollars)	$3,487,087	$3,599,958	$3,508,921	$4,202,165
Anticipated Benefit (2015 Dollars)	$10,905,804	$14,463,993	$21,583,734	$23,042,517
Benefit / Cost Ratio	3.13	4.02	6.15	5.48

As TABLE 12 above indicates, Alternative 3 has the best Benefit to Cost Ratio. This is due to the lower cost of the alternative relative to the improvements provided. The center turn lane along the entire corridor improves safety, making the Benefit / Cost ratio for the alternative the highest when compared to the other alternatives.

SECTION 3 – Recommendations

3.1 Design Considerations

The selected alternative should address existing deficiencies where possible. Recommended improvements along the corridor are detailed below:

3.1.1 Lighting

As indicated in Section 1.1.2, a number of the existing lighting fixtures along the corridor were noted to be malfunctioning. Public Service Electric & Gas (PSE&G), who is responsible for maintaining this lighting, should be contacted to perform maintenance on the nonfunctioning lights along the corridor.

Based on evaluations and the results of preliminary lighting analysis, mainline crosswalks were lit with a minimum lighting levels of 0.20 fc or better and do not require additional lighting. Additional lighting at the intersections, however, should be considered to improve the visibility of the side street crosswalks. This could potentially be accomplished by adding lighting units to the existing utility pole or aluminum lighting standards. A detailed lighting design utilizing survey and topographic mapping would be required in final design to evaluate existing light pole locations, determine the need for new light poles and determine required lighting levels. The final design lighting design will include evaluation of pedestrian scale lighting.

3.1.2 Drainage

As indicated in Section 1.1.3, many of the existing drainage castings lack bicycle safe grates. Consistent with the goal of providing improved bicycle accommodations along the corridor, any deficient castings should be converted to bicycle safe grates. Eco-Friendly curb pieces should be provided to reduce the amount of trash which could be transferred to the drainage system.

Each of the alternatives includes intersection curb extensions along the corridor to reduce pedestrian crossing distance and times. Offset curb extensions, similar to those shown in PHOTO 3 below, can be used to ensure existing gutter flow is maintained without the need to install drainage inlets along the entire corridor. Where the bike lane is located along the curb line, the offset curb extension allows for a continuous bike lane through the corridor as well as a means to maintain the existing drainage system. Topographic mapping and an evaluation of the existing drainage system will need to be performed during final design to ensure any additional required drainage modifications are incorporated.

PHOTO 3
Offset Curb Extension

The project is not expected to create more than 0.25 acres of new impervious area. Therefore, compliance with the NJDEP water quality rules should not be required. The 1-acre threshold for land disturbance may be exceeded, depending on the alternative advanced to final design therefore compliance with the NJDEP water quantity and recharge rules may be needed. If required, it is anticipated compliance can be demonstrated by ensuring no net change in the project's impervious area, avoiding the need for the construction of detention/retention basins.

3.1.3 Utilities

Impacts to existing underground utilities would be expected to be minor based on the anticipated work. Impacts would typically be limited to resetting of manhole casting and valves associated with paving operations on Livingston Avenue and side streets. Alternative 4 impacts above ground utilities due to the relocation of the utility poles along both sides of the corridor. Underground risers would need to be relocated. Test pits may be required for new traffic signal equipment. Impacts to these facilities as a result of pavement widening and new traffic signal equipment would also need to be evaluated. Utility verification and potential impacts to existing facilities would be performed during final design. Since the utility companies are not reimbursed for their relocations the cost for this work would not be reflected in the project cost.

3.1.4 Access

During final design, curb extensions will be designed to ensure all existing driveways and aprons are maintained or identified for reconstruction if necessary.

3.1.5 Environmental

Since the project includes a designated historic area, coordination with the State Historic Preservation Office (SHPO) may be required during final design. Typically historic coordination results in the need to incorporate select materials into the improvements for sidewalk, decorative traffic signal and / or lighting poles.

3.1.6 Pedestrian and Bicycle Facilities

Throughout the corridor, sections of the existing sidewalk are in poor condition and may not meet ADA requirements. Final design will include replacement of curb on both sides of Livingston Avenue along the corridor. This may require coordination with SHPO for the portion of the corridor within the historic district.

Mid-block crosswalks were briefly considered along the corridor but dismissed due to the relatively short blocks along the corridor (200'-250' between intersections). Since legal crosswalks are present at each intersection, a pedestrian would be required to walk no more than 125 feet to access a crosswalk at an intersection. Mid-block crosswalks are typically considered when adjacent intersections are over 300 feet apart, which is not the case here along Livingston Avenue.

Proposed bicycle facilities along Livingston Avenue vary between alternatives and are addressed in Section 2.0.

3.1.7 Bus Stops / Shelters

For each of the alternatives, placement of curb extensions was minimized in the vicinity of bus stops/shelters to maintain bus access. A meeting with NJT and other bus carriers will be held during final design to obtain input on bus stop improvements. Bus stop will be evaluated to ensure compliance with current ADA guidelines and ensure modifications do not compromise pedestrian circulation.

3.1.8 Street Furniture

Relocation of street furniture will be required. Each alternative includes a three to five foot grass strip to accommodate this need. Placement of features will be further evaluated in final design to minimize effect to sight distance and pedestrian circulation.

3.1.9 Signs / Striping

Existing signs will be located and evaluated during final design to ensure they meet current MUTCD requirements for retro-reflectivity and are mounted on breakaway posts. Additional signing required for new left turn lanes, bike lanes, and wayfinding signs, as appropriate, will be incorporated in final design. Since pedestrian safety is a primary goal of the project, high visibility "ladder type" crosswalks are recommended for the entire corridor, particularly for the crossings across Livingston Avenue.

3.1.10 Traffic Signals

Each of the four traffic signals along the corridor will be evaluated for operational and functional improvements as part of final design. These improvements are expected to include the addition of pedestrian countdown timers, audible pedestrian push buttons, and revised pedestrian crossing times. All of the improvements will be consistent with MUTCD guidelines and recommendations.

3.1.11 Right of Way

ROW and/or easement acquisition is not anticipated for any of the alternatives. The setting of existing ROW and property lines may be required during final design as the scope of the preferred improvements is finalized.

3.1.12 Permits

The south end of the project lies within the regulated floodplain for Mile Run. Therefore, an NJDEP Flood Hazard Area (FHA) will be required. Since the proposed work in this area is limited to replacement of the existing sidewalk, authorization can be issued via the FHA Permit-By-Rule (PBR) described at N.J.A.C. 7:13-7.2(a)2, which requires the submission of a letter notification to the NJDEP at least 14 days prior to the start of construction. No formal permit application is necessary.

The project corridor is located in an urban setting. No wetlands are shown on the NJDEP's GeoWeb database, therefore, the need for a NJDEP wetland permit is not anticipated.

Since all of the alternatives will disturb over 5,000 square feet of land, a Soil Erosion and Sediment Control Certification from the Freehold Soil Conservation District will be required.

3.2 Recommendation of a Preferred Alternative

The following evaluation matrix was developed to assist in the selection of a preferred alternative. The matrix ranks each of the alternatives with a score of 1 to 4, with a score of 1 representing best improvement in a given category and 4 representing the least improvement in a given category.

TABLE 13 Alternative Evaluation Matrix					
Criteria	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Notes
Impact on Vehicular Flow	4	3	1	1	Scored based on relative increases in travel times along the corridor
Improvements to Safety	4	3	2	1	Scored based on relative decreases in predicted crash rates
Cost	1	3	2	4	Scored based on relative cost
Benefit / Cost Ratio	4	3	1	2	Scored based on relative benefit / cost ratio

Based on the results detailed in TABLE 13 above Alternatives 3 and 4 have the least overall impact of vehicular flow. Alternative 4 has the highest reduction in crashes and Alternative 1 has the lowest cost, but Alternative 3 has the best benefit / cost ratio.

3.3 Next Steps

Following the public meeting scheduled for August 18th, 2015, a preferred alternative is expected to be selected, which will then be advanced to preliminary engineering. The selection of the preferred alternative should consider the technical aspects detailed above, input from the public involvement process, as well as other interested stakeholders such as emergency services and NJ Transit.

Figures

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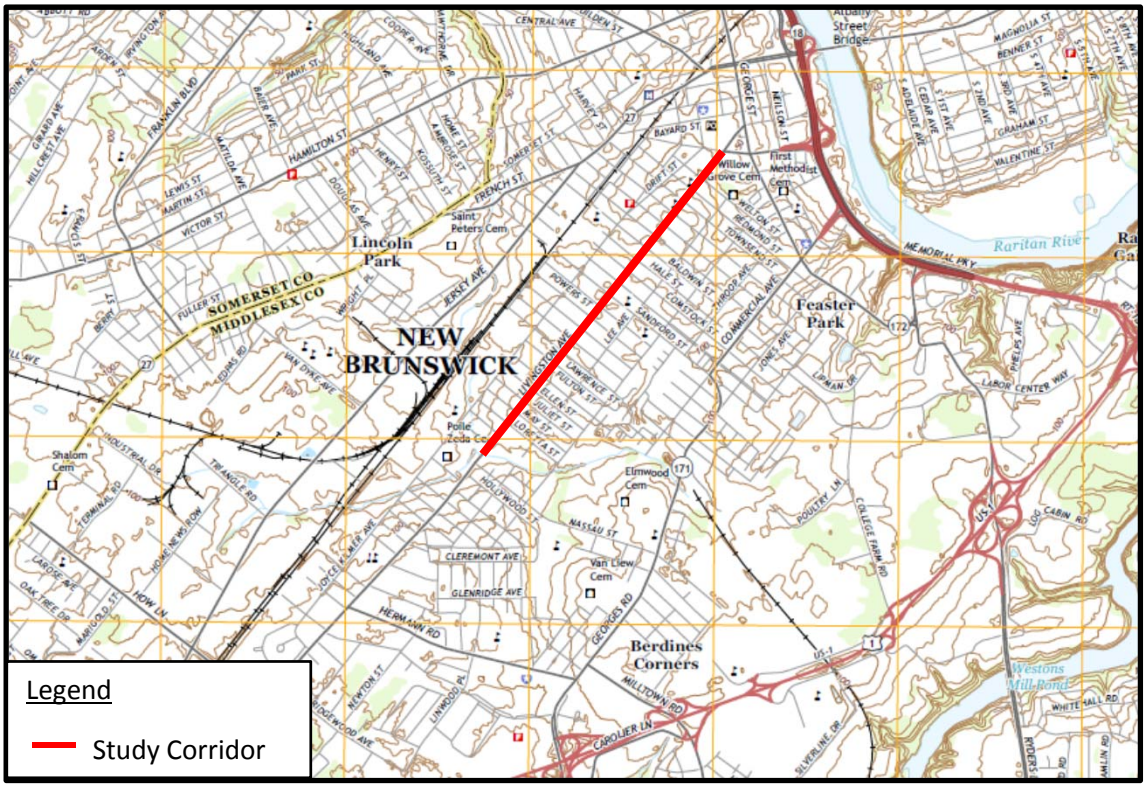
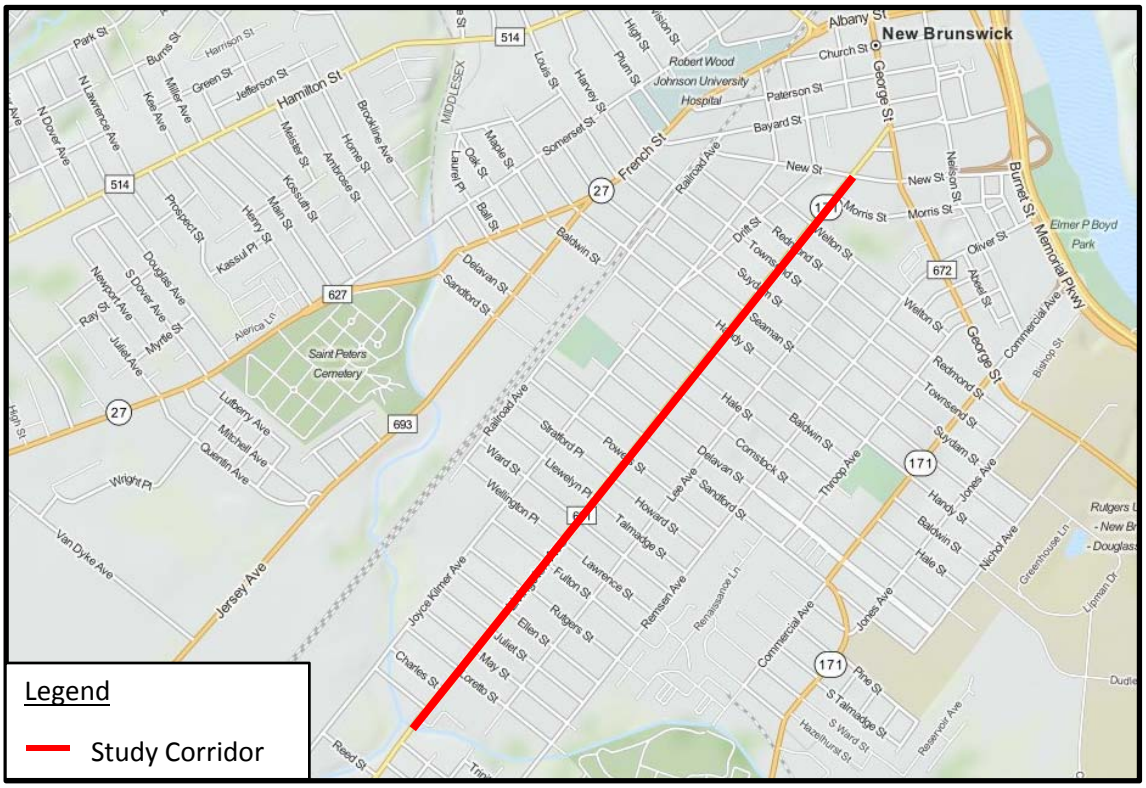


Project Location



Study Corridor