DILLON CONSULTING

LaSalle Causeway Bascule Bridge Main Trunnion Rehabilitation

Strategic Transportation Analysis

April 2020 - 20-2306

April 3, 2020

Parsons
1223 Michael Street, Suite 100
Ottawa, ON
K1J 7T2

Attention: Mark Baker, P. Eng.
Manager, Transportation and Traffic

LaSalle Causeway Bascule Bridge Main Trunnion Rehabilitation – Strategic Transportation Analysis

This report documents the project background, approach, methodology, analysis, conclusions, and recommendations related to strategic transportation analysis of the rehabilitation of the main trunnions of the LaSalle Causeway Bascule Bridge in Kingston, ON. The report compares the performance of a range of alternatives to provide capacity across the causeway during the rehabilitation work and provides recommendations to minimize the impacts to the overall transportation network in the city.

I am available to discuss the contents of the report at your convenience and trust that the contents meet your needs to move forward with the larger project.

Sincerely,

DILLON CONSULTING LIMITED

Adam Lanigan, P. Eng.
Project Manager / Associate

AML:jes
Our file: 20-2306

Table of Contents

Figures

Tables

1.0 Introduction

The LaSalle Causeway separates Kingston's inner and outer harbours, while connecting the east side of the Cataraqui River to downtown Kingston via Highway 2. The causeway includes three bridges, the middle of which is a Strauss trunnion bascule bridge, which permits intermittent seasonal access to the inner harbour at specific times of day. Public Services and Procurement Canada (PSPC) has identified a need to rehabilitate the main trunnions of the Bascule Bridge which will require that operations on the bridge be limited for a 3- to 6-month period. The limitations will require partial or potential full closure of Highway 2 lanes during this period. Understanding the critical role of the Causeway during the peak summer season in facilitating and managing both roadway and river traffic, it is intended that the rehabilitation work occur during the off-peak season, November to May.

Parsons has been retained by PSPC to assess the impacts of the potential lane closure scenarios on the traffic operations and the broader city transportation system, for the purposes of identifying a traffic management plan during the closure, and has asked Dillon to provide expertise in the use of the City's strategic transportation planning model.

This report serves to document the approach, alternatives, analysis, and recommendations related to a range of options that could be taken with respect to providing mobility across the Cataraqui River during the maintenance work on the bridge.

2.0 Approach

The City of Kingston maintains a strategic transportation planning model. The transportation model was developed to assist in the assessment of transportation demand and roadway volumes for long term horizons for the purposes of their Transportation Master Plan Study and Study Updates. Dillon has undertaken recent technical work for the City to: migrate the city model to a state-of-the-art software (VISUM) and prepare the model for easy extraction of subarea operational models (VISSIM microsimulation). This technical work has allowed for the quick mobilization and assessment of both strategic and operational traffic issues.

These strategic and operational models can be used effectively to assess the following issues related to the temporary closure of the LaSalle Causeway:

- Quantify and assess the traffic diversion in the network resulting from closure scenarios;
- Quantify and assess the delay resulting from the closure scenarios; and
- Identify the effect of alternative capacity reductions on the local and system wide network performance.

For this effort, the strategic transportation model was applied to test a range of options for provision of mobility across the Cataraqui River. These alternatives were compared and contrasted across a range of Measures of Effectiveness (MOEs) to examine the effects and effectiveness of the options.

3.0 Study Area

Figure 1 shows the overall study area, as represented in the City of Kingston's travel demand forecasting model.

Figure 1 – Study Area Overview

It can be seen in the study area that there are currently only two major crossings of the Cataraqui River: the LaSalle Causeway in the south, and Highway 401 in the north. There is also a crossing further north of Highway 401 on Kingston Mills Road/Highway 21, but this is a small local road.

Note that the City of Kingston is working to construct a new crossing of the Cataraqui River – the Third Crossing – that is expected to open sometime in the window of 2022-2023. This facility will provide important extra capacity and redundancy in the transportation network across the river, especially for major incidents and prolonged construction on the crossings.

The corridors of concern for this analysis are also noted in the figure and provide important north/south and east/west access. These are:

- North / South
  - Sir John A MacDonald Boulevard
  - Division Street
  - Montreal Street
  - Highway 15
- East / West
  - LaSalle Causeway
  - Highway 401
  - Kingston Mills Road

On either side of the LaSalle Causeway, there are significant concentrations of residents and jobs (approximately 15,000 and 30,000 within the immediate vicinity, respectively). Many residents must travel across the causeway to access areas like Downtown Kingston or Queen's University on the west side, or the Royal Military College, CFB Kingston, or the many residential subdivisions on the east side. These residents will be directly affected by the rehabilitation work.

It is also important to note the potential effects the rehabilitation will have on access for emergency services across the river, as decreased capacity and/or increased congestion in the area could affect their ability to respond adequately.

4.0 Travel Demand Forecasting

4.1 Travel Demand Model Update

Prior to beginning the work on this effort, Dillon and the City of Kingston completed an update to the City's travel demand model. The update focused on two major changes:

- Inclusion of outputs from the 2016 Canadian Census regarding population and patterns of travel and mode choice

- Creation of forecasts for a new 2036 horizon year based on the latest available population and employment forecasts, as developed for the City of Kingston by Watson and Associates Economists Limited (March, 2019)

The model input data, parameters, and processes were updated as necessary to incorporate the new data and create the new 2036 forecast. This process also included a series of model recalibration steps to ensure that the model's outputs matched well to observed counts.

The result is a functional, calibrated model based on the latest available data as to the current state of transportation in the City of Kingston and how it is expected grow and change to the year 2036. This provided a platform for testing the alternatives related to maintenance of the bridge on the LaSalle Causeway.

Note that the model represents the Weekday PM peak commuting hour.

4.2 Interim Year Demand Forecasting

The rehabilitation of the LaSalle Causeway Bridge, originally planned for 2020, but now likely to occur in 2021 dependent on funding availability and appropriate maintenance timelines. For the purposes of this work, the year of rehabilitation was assumed to be 2022, to examine the possible impacts of the implementation of the Third Crossing. There will not be a significant difference in overall volume and travel patterns between 2021 and 2022.

There were two possible approaches to the creation of the interim condition for 2022:

- Interpolation of population and employment levels between 2016 and 2036
- Interpolation of final assigned driving trips between 2016 and 2036

The first approach of interpolating population and employment would allow for a full model run through its various processes. This would allow residents of the city to move, change jobs, and change their lives according to the new reality for 2022 in response to the changes to access across the Cataraqui River. This was not deemed appropriate for this work, as the rehabilitation of the bridge is a temporary condition, despite the crossing's regional significance. It is not expected that a significant portion of residents would make this level of change due to short term maintenance on the bridge.

The second approach of interpolating the movement of vehicles between the two years was more appropriate, as this was more representative of a condition where travellers are expecting the vehicular capacity across the river, but need to temporarily find new routes or times to cross. In this approach, residents were not assumed to significantly change their need for or pattern of travel during the rehabilitation period.

Following the second approach, the final origin/destination matrix in the model, which defines the movement of vehicles through the city, was interpolated for the year 2022 between the 2016 existing model and the 2036 horizon model. This matrix represents the demand and pattern of travel by car for 2022.

4.3 Interim Year Base Network

For the purposes of this effort, the 2016 road network was assumed to be unchanged in 2022. No significant additions of capacity in the vicinity of the LaSalle Causeway were assumed for the base condition.

Note that the City of Kingston is working to construct a new crossing of the Cataraqui River – the Third Crossing – that is expected to open sometime in the window of 2022-2023. The base network assumed that this crossing would not yet be in operation.

4.4 2022 Forecasted Volume

Figure 2 shows the resulting car volumes and the resultant volume/capacity ratio on roadways in the vicinity of the LaSalle Causeway.

Figure 2 - 2022 Base Volume and V/C Ratio

It can be seen in the figure that there will be some existing capacity issues in the network prior to beginning rehabilitation of the bridge. Notably, sections of the north/south streets that provide access to and from Highway 401 are shown to be at or near capacity in 2022. These streets will be important to motorists looking to cross the Cataraqui River due to temporary reduced capacity or closure of the LaSalle Causeway.

The LaSalle Causeway itself was shown to operate at or near capacity in both directions during the 2022 PM peak hour, demonstrating its importance as a critical link across the river. Eastbound and westbound volumes across the causeway were 1286 and 1166, respectively. It is important to note the balance of volume in both directions, with westbound volumes being slightly higher in the PM peak hour. This is replicated in existing field observations of causeway crossing volumes.

Highway 401 provides important secondary crossing capacity of the Cataraqui River for residents of the city, while also being an important regional connection through the area. It was shown to be operating well within the available capacity in both directions during the PM peak hour with eastbound and westbound volumes of 2498 and 2846, respectively.

5.0 Alternatives Analysis

There are several possible options with respect to modifying the capacity across the bridge to accommodate the repair work. This section of the report discusses the options, the model outputs used to examine their effects, and provides analysis of the relative impacts.

5.1 Alternatives

There are four possible options to modify the capacity across the LaSalle Causeway to accommodate the rehabilitation work:

- **Closure of the eastbound lane** – Reducing capacity of the bridge to one lane and allowing only westbound vehicles to cross
- **Closure of the westbound lane** – Reducing capacity of the bridge to one lane and allowing only eastbound vehicles to cross
- **Full closure of the bridge** – This removes all access across the bridge
- **Alternating access** – Reducing capacity of the bridge to one lane and allowing westbound and eastbound vehicles to cross in an alternating fashion via temporary signals or flaggers

With respect to the capacity of the bridge in the various scenarios, in the directional closures, it was assumed that there would be no capacity change in the open direction. As observed in reality, each direction of the bridge can accommodate approximately 1200 vehicles during the peak hour.

For the Alternating Access alternative, where access is maintained in both directions via a single lane with alternating access, a capacity per direction of 500 vehicles was assumed for the PM peak hour. This assumes a base reduction to 50% of existing capacity (600 vehicles/hour) to allow for alternating use of one lane, plus some operational inefficiencies due to the required clearance times to allow vehicles to fully clear the single lane section. This assumption of 500 vehicles/hour also matches the findings of Parson's previous investigation that applied a Vissim microsimulation model to simulate alternating access operations, as documented in their technical memorandum to PSPC on January 13, 2020 titled: *"LaSalle Causeway (Bascule Bridge) – Alternating Lane Traffic Analysis"*.

In addition to the four alternative approaches to movement across the LaSalle Causeway, and as mentioned above, the City of Kingston is working to construct new bridge across the

Cataraqui River known as the Third Crossing. As shown in **Figure 3**, this new crossing creates a new east-west connection across the river at the approximate mid-point between the LaSalle Causeway in the south and Highway 401 in the north.

Figure 3 – Location of the Third Crossing

The potential for the opening of the Third Crossing within the timeframe of this rehabilitation provides some potentially impactful extra capacity for crossing the river. As the Third Crossing splits the distance between the LaSalle Causeway and Highway 401, it could provide a useful alternate route for those needing to cross the river when crossing capacity is reduced or eliminated on the LaSalle Causeway. With this in mind, the four alternatives for crossing the LaSalle Causeway were also tested with the Third Crossing in place to

provide insight into how the impacts may differ if the work proceeds before or after the opening of the crossing.

5.2 Measures of Effectiveness

Travel demand forecasting models produce a number of statistics that are useful in the analysis of traffic impacts as a result of re-construction of the LaSalle Causeway. The statistics applied in this analysis are described briefly below:

Vehicle Kilometres Travelled (VKT)
This statistic provides an aggregate estimate of the total distance (km) travelled by vehicles travelling in the model. Increases in VKT in this analysis versus the base condition indicate that drivers must travel extra distance to reach their destination, and vice versa for reductions.

Vehicle Hours of Travel (VHT)
Similar to the VKT, the VHT provides an aggregate estimate of the travel time (hours) for all vehicles in the model. Increases in VHT indicate the extra time taken for drivers to reach their destination (due to increased distance and/or congestion), and vice versa for reductions.

Average Travel Speed
This is the estimate of the average speed that vehicles will travel from origin to destination. This is calculated by dividing the VKT by the VHT.

Volume Capacity Ratio (V/C)
This statistic compares the volume assigned on the road segment or screenline to the available capacity. This is a representation of how "full" the road or screenline is, expressed as a decimal value. A value of 1.0 or greater indicates that the facility or screenline is forecasted to be at or above the available capacity. A value of 0.85 to 1.0 generally represents a range where operational issues will exist. And values below 0.85 indicate a facility or screenline that will generally operate well.

5.3 Scales of Analysis

The strategic analysis of the alternatives is presented at four scales from least to most detailed, as described briefly below:

- **City-wide** – Examination of the impacts that the project will have to the overall performance of the city-wide transportation network.
- **Study Area** – There is an area closer to the causeway that will be more directly impacted by changes to capacity across the river.

- **Screenline** – These are abstract lines drawn on a map to track movement of vehicles across important points on major facilities (e.g., two crossings of a river).
- **Key Facilities** – These are important roadways within the study area or those that makeup the screenlines.

The study area and screenlines applied in this analysis are shown in **Figure 4**. Both of these were designed to capture the major impacts of reduction of crossing capacity on the causeway.

Figure 4 – Study Area and Screenlines

5.4 Base Network Analysis

This section examines the outputs of the base network options, where the *Third Crossing has not been completed*. These apply the forecasted 2022 travel demands to the base 2016 road network with the appropriate changes made to capacity and access across the Cataraqui River for the individual alternatives.

Table 1 presents the results from the Base Network alternatives for the 2022 PM Peak Hour.

It can be seen in the table that, at the City-wide level, there will be some minor impacts. There are increases of 2% to 6% to the VKT and VHT totals, which do indicate some rerouting and increases in congestion. So, while the overall travel speed for the model stays essentially static, there are some increases in the distance and time that drivers will experience.

At the study area level - bounded by Division Street, Highway 401, Highway 15 and the southern waterfront – the effects of capacity reduction are far more significant. There will be reductions in average travel speed in the range of 13% to 27%, depending on the alternative, as drivers must travel along more congested roadways and for longer distances when capacity across the river is restricted.

The Alternating Access option performs the best of the available options with a decrease of 13% to the average travel speed and increases of approximately 8,000 vehicle kilometres and 400 vehicle hours of travel. The full lane closure scenario performs the worst, with a 27% reduction to average travel speed for all travellers in the study area and increases to VKT and VHT of approximately 15,400 and 900, respectively. The VHT increases much more sharply (66%) in the Full Closure versus the Alternating Access (28%) as options are more limited for crossing the river, so roadways naturally become more congested and vehicles crossing the river must travel further to access the Highway 401 crossing.

The Eastbound and Westbound closure scenarios showed results that fall in the middle between the Full Closure and Alternating Access scenarios. The Westbound Closure scenario performs slightly worse as the volume is slightly higher in the westbound direction than the eastbound direction, which causes more drivers to detour to the north to cross over the river on Highway 401.

At the screenline level, east/west movement across the river shows sufficient capacity overall for movement across the river. When capacity across the river is restricted or removed, volumes on Highway 401 and Kingston Mills Road (Highway 21) receive the bulk of the diverted traffic. This is logical, as they are the nearest points to the north to make the crossing. There is sufficient capacity on both facilities to accommodate the increased volume.

Table 1 – Screenline Analysis – 2020 PM Peak Hour – Base Network

V/C Ratio: 0.60 | 0.70 | 0.85 | 1.00 — Volume difference from base network: + | -

Summary Statistics		Base Network	Eastbound Closure			Westbound Closure			Full Closure			Alternating Access		
		Value	Value	Diff.	% Diff.	Value	Diff.	% Diff.	Value	Diff.	% Diff.	Value	Diff.	% Diff.
City-Wide	VKT	668,650	681,807	13,157	2%	691,318	22,669	3%	703,752	35,103	5%	684,269	15,619	2%
	VHT	19,039	19,618	579	3%	19,771	732	4%	20,242	1,203	6%	19,605	566	3%
	Avg Speed	35	34.8	-0.4	-1%	35.0	-0.2	0%	34.8	-0.4	-1%	34.9	-0.2	-1%
Study Area	VKT	70,247	78,386	8,138	12%	78,731	8,484	12%	85,682	15,434	22%	78,192	7,945	11%
	VHT	1,388	1,850	462	33%	1,925	537	39%	2,306	918	66%	1,774	387	28%
	Avg Speed	51	42.4	-8.2	-16%	40.9	-9.7	-19%	37.2	-13.5	-27%	44.1	-6.6	-13%

Screenline Assessment		Base Network				Eastbound Closure			Westbound Closure			Full Closure			Alternating Access		
		# Lanes	Cap.	Vol.	V/C	Vol.	Vol. Diff.	V/C	Vol.	Vol. Diff.	V/C	Vol.	Vol. Diff.	V/C	Vol.	Vol. Diff.	V/C
1. Cataraqui River Crossing																	
EB	S Frontenac Road 12	1	1,100	63	0.06	105	42	0.10	63	0	0.06	107	44	0.10	64	1	0.06
	Kingston Mills	1	1,100	228	0.21	588	360	0.53	270	42	0.25	589	361	0.54	444	216	0.40
	Highway 401	3	5,400	2,498	0.46	3,280	782	0.61	2,571	73	0.48	3,261	763	0.60	2,959	461	0.55
	Third Crossing	1	0	0	0.00	0	0	0.00	0	0	0.00	0	0	0.00	0	0	0.00
	LaSalle Causeway	1	900	1,188	**1.32**	0	-1,188	0.00	1,059	-129	**1.18**	0	-1,188	0.00	507	-681	**1.13**
	Total	**7**	**8,500**	**3,977**	**0.47**	**3,973**	**-4**	**0.52**	**3,963**	**-14**	**0.47**	**3,957**	**-20**	**0.52**	**3,974**	**-3**	**0.49**
WB	S Frontenac Road 12	1	1,100	10	0.01	11	1	0.01	47	37	0.04	47	37	0.04	36	26	0.03
	Kingston Mills	1	1,100	381	0.35	414	33	0.38	713	332	0.65	714	333	0.65	613	232	0.56
	Highway 401	3	5,400	2,846	0.53	2,862	16	0.53	3,741	895	0.69	3,741	895	0.69	3,347	501	0.62
	Third Crossing	1	0	0	0.00	0	0	0.00	0	0	0.00	0	0	0.00	0	0	0.00
	LaSalle Causeway	1	900	1,266	**1.41**	1,217	-49	**1.35**	0	-1,266	0.00	0	-1,266	0.00	506	-760	**1.12**
	Total	**7**	**8,500**	**4,503**	**0.53**	**4,504**	**1**	**0.53**	**4,501**	**-2**	**0.59**	**4,502**	**-1**	**0.59**	**4,502**	**-1**	**0.56**
2. South of Hwy 401																	
NB	Sir John A. MacDonald Blvd	2	2,000	1,892	0.95	2,154	262	**1.08**	1,867	-25	0.93	2,116	224	**1.06**	2,036	144	**1.02**
	Division Street	3	2,400	1,894	0.79	2,181	287	0.91	1,909	15	0.80	2,158	264	0.90	2,012	118	0.84
	Montreal Street	1	900	720	0.80	867	147	0.96	747	27	0.83	818	98	0.91	800	80	0.89
	Highway 15	1	1,000	1,161	**1.16**	1,182	21	**1.18**	1,555	394	**1.56**	1,529	368	**1.53**	1,402	241	**1.40**
	Total	**7**	**6,300**	**5,667**	**0.90**	**6,384**	**717**	**1.01**	**6,078**	**411**	**0.96**	**6,621**	**954**	**1.05**	**6,250**	**583**	**0.99**
SB	Sir John A. MacDonald Blvd	3	3,000	1,755	0.59	1,712	-43	0.57	1,958	203	0.65	1,917	162	0.64	1,874	119	0.62
	Division Street	2	1,600	967	0.60	927	-40	0.58	1,489	522	0.93	1,433	466	0.90	1,189	222	0.74
	Montreal Street	1	900	818	0.91	831	13	0.92	1,010	192	**1.12**	981	163	**1.09**	917	99	**1.02**
	Highway 15	1	1,000	810	0.81	1,405	595	**1.41**	721	-89	0.72	1,405	595	**1.41**	1,143	333	**1.14**
	Total	**7**	**6,500**	**4,350**	**0.67**	**4,875**	**525**	**0.75**	**5,178**	**828**	**0.80**	**5,736**	**1,386**	**0.88**	**5,123**	**773**	**0.79**
3. South of John Counter Boulevard																	
NB	Sir John A. MacDonald Blvd	4	3,600	1,613	0.45	1,788	175	0.50	1,622	9	0.45	1,800	187	0.50	1,709	96	0.47
	Division Street	2	1,600	1,446	0.90	1,664	218	**1.04**	1,459	13	0.91	1,609	163	**1.01**	1,531	85	0.96
	Wellington Street	1	0	0	0.00	0	0	0.00	0	0	0.00	0	0	0.00	0	0	0.00
	Montreal Street	2	1,600	1,089	0.68	1,164	75	0.73	1,069	-20	0.67	1,140	51	0.71	1,102	13	0.69
	Highway 15	2	1,800	1,295	0.72	1,086	-209	0.60	1,533	238	0.85	1,253	-42	0.70	1,194	-101	0.66
	Total	**11**	**8,600**	**5,443**	**0.63**	**5,702**	**259**	**0.66**	**5,683**	**240**	**0.66**	**5,802**	**359**	**0.67**	**5,536**	**93**	**0.64**
SB	Sir John A. MacDonald Blvd	3	2,700	1,332	0.49	1,323	-9	0.49	1,565	233	0.58	1,579	1,346	0.58	1,485	153	0.55
	Division Street	1	800	750	0.94	750	0	0.94	930	180	**1.16**	927	747	**1.16**	863	113	**1.08**
	Wellington Street	1	0	0	0.00	0	0	0.00	0	0	0.00	0	0	0.00	0	0	0.00
	Montreal Street	1	800	432	0.54	402	-30	0.50	601	169	0.75	593	424	0.74	479	47	0.60
	Highway 15	2	1,800	626	0.35	991	365	0.55	382	-244	0.21	811	1,055	0.45	616	-10	0.34
	Total	**8**	**6,100**	**3,140**	**0.51**	**3,466**	**326**	**0.57**	**3,478**	**338**	**0.57**	**3,910**	**3,572**	**0.64**	**3,443**	**303**	**0.56**
4. North of LaSalle Causeway																	
NB	Sir John A. MacDonald Blvd	4	3,200	1,699	0.53	1,794	95	0.56	1,773	74	0.55	1,850	151	0.58	1,777	78	0.56
	Palace Road	1	500	407	0.81	484	77	0.97	348	-59	0.70	424	17	0.85	381	-26	0.76
	Princess Street	3	2,400	1,292	0.54	1,352	60	0.56	1,262	-30	0.53	1,299	7	0.54	1,276	-16	0.53
	Victoria Street	1	500	235	0.47	281	46	0.56	231	-4	0.46	297	62	0.59	249	14	0.50
	Alfred Street	1	500	538	**1.08**	554	16	**1.11**	527	-11	**1.05**	535	-3	**1.07**	533	-5	**1.07**
	Division Street	1	800	916	**1.15**	932	16	**1.17**	914	-2	**1.14**	929	13	**1.16**	919	3	**1.15**
	Montreal Street	1	600	589	0.98	613	24	**1.02**	590	1	0.98	612	23	**1.02**	595	6	0.99
	Rideau Street	1	800	672	0.84	725	53	0.91	650	-22	0.81	687	15	0.86	673	1	0.84
	Highway 15	2	1,800	745	0.41	355	-390	0.20	911	166	0.51	437	-308	0.24	528	-217	0.29
	Total	**15**	**11,100**	**7,093**	**0.64**	**7,090**	**-3**	**0.64**	**7,206**	**113**	**0.65**	**7,070**	**-23**	**0.64**	**6,931**	**-162**	**0.62**
SB	Sir John A. MacDonald Blvd	2	1,600	819	0.51	757	-62	0.47	957	956	0.60	926	107	0.58	858	39	0.54
	Palace Road	1	500	73	0.15	70	-3	0.18	95	95	0.19	93	20	0.19	78	5	0.16
	Princess Street	2	1,600	1,025	0.64	962	-63	0.60	1,105	1,104	0.69	1,015	-10	0.63	1,000	-25	0.63
	Victoria Street	1	500	259	0.52	274	15	0.55	249	248	0.50	257	-2	0.51	235	-24	0.47
	Alfred Street	1	500	269	0.54	252	-17	0.50	426	425	0.85	363	94	0.73	312	43	0.62
	Division Street	1	800	636	0.80	583	-53	0.73	733	732	0.92	703	67	0.88	631	-5	0.79
	Montreal Street	1	600	556	0.93	543	-13	0.91	609	608	**1.02**	614	58	**1.02**	574	18	0.96
	Rideau Street	1	800	166	0.21	153	-13	0.19	208	208	0.26	175	9	0.22	163	-3	0.20
	Highway 15	2	1,800	458	0.25	522	64	0.29	158	158	0.09	252	-206	0.14	268	-190	0.15
	Total	**12**	**8,700**	**4,261**	**0.49**	**4,116**	**-145**	**0.48**	**4,540**	**4,535**	**0.52**	**4,398**	**137**	**0.51**	**4,119**	**-142**	**0.47**

The north/south screenlines (2-4) show general degradation of performance in line with the overall study area impacts, as is logical. Screenline 2, just south of Highway 401, is the only one to show significant capacity issues across all tested alternatives, in the northbound direction in particular. In the base condition, this screenline was already shown to operate at a v/c ratio of 0.9, which indicates that there will be operational issues. The changes to capacity on the LaSalle Causeway exacerbate the issue across all alternatives, pushing Screenline 2 up to and over its capacity. Similarly, the southbound direction of Screenline 2 was shown to increase in volume in all scenarios, though the overall screenline still has sufficient capacity.

Some key facilities will see significant changes to their performance as a result of the construction, most notably Highway 15. As the only major north-south corridor on the east side of the city, any volume that is diverted in either direction across the river will need to travel along Highway 15. Abbey Dawn Road lies a further 6 kilometres to the east, so while it does provide additional north-south capacity, the extra distance keeps it from being an attractive alternative. Performance on Highway 15 was shown to degrade significantly in all tested alternatives, though notably, the facility was shown to operate at 16% over capacity in the base model. This rises significantly in the northbound direction in the three scenarios that restrict or prohibit westbound movement across the bridge, bringing the facility to 40-53% over capacity. This indicates that there will be significant daily congestion on Highway 15 near Highway 401 during construction. The southbound direction on Highway 15 at Highway 401 shows a similar pattern for southbound volume where eastbound movement is restricted or prohibited. Significant congestion can be expected in this direction as well.

Division Street, Montreal Street, and Sir John A MacDonald Boulevard are also key corridors for north-south movement related to rehabilitation of the causeway. These facilities provide the necessary access to and from Highway 401 so that drivers can cross the river when capacity is removed or reduced on the causeway. These three facilities receive the bulk of displaced volume in the alternatives, which did show some situations where the volume was forecasted to exceed the available capacity. In particular, the screenline south of Highway 401 shows that there will likely be operational issues on these three facilities in both directions. There will likely be significant congestion at intersections daily during the PM peak hour along each of the corridors.

Overall, the Alternating Closure alternative was shown to have the best performance. It allows for the most drivers to maintain their current routing, thereby reducing the overall distance and time related to diversions for drivers in the study area. This places less pressure on the key north/south corridors (Montreal, Division, and John A MacDonald) as fewer drivers need to travel on these already congested corridors. V/C ratios are overall lower for all screenlines and key facilities in the study area in this scenario, which indicates that there will be less daily congestion during the PM peak hour.

5.5 Third Crossing Network Analysis

As described above, the same alternatives for the causeway rehabilitation were also tested in a network that includes the addition of the Third Crossing across the Cataraqui River. This provides significant additional capacity across the river and an important mid-city crossing halfway between Highway 401 and the LaSalle Causeway.

Table 2 shows the results of the screenline analysis for the 2022 PM peak hour.

The performance between the alternatives follows the same trends observed in analysis of the Base Network scenarios. The Alternating Closure alternative provided the best performance overall, as it diverted the least number of trips to longer routes along already congested corridors. Overall average speed was reduced by only 3% in the study area from 52 km/h to 50 km/h. There are an additional 130 vehicle-hours of travel due to diversion and increased congestion, which is 33% less delay to drivers than the directional closure alternatives, and 50% less than the Full Closure alternative.

Performance of the key facilities in the study area also follows similar trends to the Base Network Analysis. Notably, the Third Crossing, which was shown to already operate near capacity in the base condition, accepts between 120 to 300 additional vehicles during the various scenarios in either direction in response to the alternatives. In the directional closure alternatives and the Full Closure alternative, the Third Crossing was shown to operate at 20 to 32% over capacity. This indicates that there will be significant congestion on the Third Crossing and likely at the intersections and along the corridors that connect to it. In the Alternating Access alternative, this surcharge on the Third Crossing is reduced, as more cross-river capacity is maintained.

As in the Base Network alternatives, the Alternating Access alternative was shown to perform overall better than the other options.

Table 2 – Screenline Analysis – 2020 PM Peak Hour – Base Network with Third Crossing

V/C Ratio: 0.60 | 0.70 | 0.85 | **1.00**

Volume difference from base network: **+** | **-**

Summary Statistics		Base Network With Third Crossing	Eastbound Closure			Westbound Closure			Full Closure			Alternating Access		
		Value	Value	Diff.	% Diff.	Value	Diff.	% Diff.	Value	Diff.	% Diff.	Value	Diff.	% Diff.
City-Wide	VKT	658,256	663,732	5,477	1%	664,537	6,282	1%	669,191	10,935	2%	662,637	4,381	1%
	VHT	18,722	18,923	201	1%	18,864	142	1%	19,058	336	2%	18,853	131	1%
	Avg Speed	35	35.1	-0.1	0%	35.2	0.1	0%	35.1	0.0	0%	35.1	0.0	0%
Study Area	VKT	65,695	70,703	5,008	8%	70,914	5,219	8%	76,116	10,421	16%	70,081	4,386	7%
	VHT	1,270	1,457	187	15%	1,467	197	15%	1,648	378	30%	1,401	131	10%
	Avg Speed	52	48.5	-3.2	-6%	48.4	-3.4	-7%	46.2	-5.5	-11%	50.0	-1.7	-3%

Screenline Assessment		e NetworkWith Third Crossi				Eastbound Closure			Westbound Closure			Full Closure			Alternating Access		
		# Lanes	Cap.	Vol.	V/C	Vol.	Vol. Diff.	V/C	Vol.	Vol. Diff.	V/C	Vol.	Vol. Diff.	V/C	Vol.	Vol. Diff.	V/C
1. Cataraqui River Crossing																	
EB	S Frontenac Road 12	1	1,100	63	0.06	63	0	0.06	63	0	0.06	63	0	0.06	63	0	0.06
	Kingston Mills	1	1,100	50	0.05	171	121	0.16	50	0	0.05	171	121	0.16	53	3	0.05
	Highway 401	3	5,400	1,885	0.35	2,421	536	0.45	1,966	81	0.36	2,427	542	0.45	2,248	363	0.42
	Third Crossing	1	1,100	915	0.83	1,318	403	**1.20**	905	-10	0.82	1,311	396	**1.19**	1,107	192	**1.01**
	LaSalle Causeway	1	900	1,068	**1.19**	0	-1,068	0.00	994	-74	**1.10**	0	-1,068	0.00	503	-565	**1.12**
	Total	**7**	**9,600**	**3,981**	**0.41**	**3,973**	**-8**	**0.46**	**3,978**	**-3**	**0.41**	**3,972**	**-9**	**0.46**	**3,974**	**-7**	**0.43**
WB	S Frontenac Road 12	1	1,100	10	0.01	10	0	0.01	10	0	0.01	10	0	0.01	10	0	0.01
	Kingston Mills	1	1,100	139	0.13	144	5	0.13	291	152	0.26	291	152	0.26	224	85	0.20
	Highway 401	3	5,400	2,355	0.44	2,364	9	0.44	2,747	392	0.51	2,754	399	0.51	2,586	231	0.48
	Third Crossing	1	1,100	1,065	0.97	1,030	-35	0.94	1,455	390	**1.32**	1,449	384	**1.32**	1,182	117	**1.07**
	LaSalle Causeway	1	900	1,015	**1.13**	969	-46	**1.08**	0	-1,015	0.00	0	-1,015	0.00	501	-514	**1.11**
	Total	**7**	**9,600**	**4,584**	**0.48**	**4,517**	**-67**	**0.47**	**4,503**	**-81**	**0.52**	**4,504**	**-80**	**0.52**	**4,503**	**-81**	**0.49**
2. South of Hwy 401																	
NB	Sir John A. MacDonald Blvd	2	2,000	1,789	0.89	1,918	129	0.96	1,742	-47	0.87	1,884	95	0.94	1,856	67	0.93
	Division Street	3	2,400	2,074	0.86	2,288	214	0.95	2,022	-52	0.84	2,237	163	0.93	2,197	123	0.92
	Montreal Street	1	900	578	0.64	608	30	0.68	555	-23	0.62	558	-20	0.62	585	7	0.65
	Highway 15	1	1,000	829	0.83	699	-130	0.70	1,026	197	**1.03**	1,008	179	**1.01**	818	-11	0.82
	Total	**7**	**6,300**	**5,270**	**0.84**	**5,513**	**243**	**0.88**	**5,345**	**75**	**0.85**	**5,687**	**417**	**0.90**	**5,456**	**186**	**0.87**
SB	Sir John A. MacDonald Blvd	3	3,000	1,657	0.55	1,574	-83	0.52	1,737	80	0.58	1,673	16	0.56	1,672	15	0.56
	Division Street	2	1,600	1,132	0.71	1,158	26	0.72	1,330	198	0.83	1,361	229	0.85	1,275	143	0.80
	Montreal Street	1	900	645	0.72	642	-3	0.71	662	17	0.74	653	8	0.73	738	93	0.82
	Highway 15	1	1,000	264	0.26	468	204	0.47	230	-34	0.23	437	173	0.44	280	16	0.28
	Total	**7**	**6,500**	**3,698**	**0.57**	**3,842**	**144**	**0.59**	**3,959**	**261**	**0.61**	**4,124**	**426**	**0.63**	**3,965**	**267**	**0.61**
3. South of J.C.B.																	
NB	Sir John A. MacDonald Blvd	4	3,600	1,603	0.45	1,726	123	0.48	1,625	22	0.45	1,727	124	0.48	1,664	61	0.46
	Division Street	2	1,600	1,114	0.70	1,288	174	0.81	1,156	42	0.72	1,287	173	0.80	1,226	112	0.77
	Wellington Street	1	800	630	0.79	733	103	0.92	633	3	0.79	744	114	0.93	683	53	0.85
	Montreal Street	2	1,600	973	0.61	1,121	148	0.70	1,001	28	0.63	1,152	179	0.72	1,063	90	0.66
	Highway 15	2	1,800	1,401	0.78	1,137	-264	0.63	1,996	595	**1.11**	1,880	479	**1.04**	1,396	-5	0.78
	Total	**11**	**9,400**	**5,721**	**0.61**	**6,005**	**284**	**0.64**	**6,411**	**690**	**0.68**	**6,790**	**1,069**	**0.72**	**6,032**	**311**	**0.64**
SB	Sir John A. MacDonald Blvd	3	2,700	1,321	0.49	1,331	10	0.49	1,479	158	0.55	1,507	1,349	0.56	1,389	68	0.51
	Division Street	1	800	743	0.93	727	-16	0.91	848	105	**1.06**	845	740	**1.06**	794	51	0.99
	Wellington Street	1	800	160	0.20	267	107	0.33	163	3	0.20	239	236	0.30	189	29	0.24
	Montreal Street	1	800	352	0.44	358	6	0.45	727	375	0.91	731	356	0.91	574	222	0.72
	Highway 15	2	1,800	434	0.24	839	405	0.47	326	-108	0.18	740	848	0.41	438	4	0.24
	Total	**8**	**6,900**	**3,010**	**0.44**	**3,522**	**512**	**0.51**	**3,543**	**533**	**0.51**	**4,062**	**3,529**	**0.59**	**3,384**	**374**	**0.49**
4. North of LaSalle Causeway																	
NB	Sir John A. MacDonald Blvd	4	3,200	1,719	0.54	1,760	41	0.55	1,763	44	0.55	1,811	92	0.57	1,760	41	0.55
	Palace Road	1	500	350	0.70	438	88	0.88	334	-16	0.67	393	43	0.79	369	19	0.74
	Princess Street	3	2,400	1,197	0.50	1,264	67	0.53	1,184	-13	0.49	1,265	68	0.53	1,222	25	0.51
	Victoria Street	1	500	197	0.39	254	57	0.51	244	47	0.49	253	56	0.51	214	17	0.43
	Alfred Street	1	500	512	**1.02**	539	27	**1.08**	501	-11	**1.00**	531	19	**1.06**	523	11	**1.05**
	Division Street	1	800	878	**1.10**	914	36	**1.14**	867	-11	**1.08**	906	28	**1.13**	895	17	**1.12**
	Montreal Street	1	600	607	**1.01**	633	26	**1.06**	609	2	**1.02**	636	29	**1.06**	623	16	**1.04**
	Rideau Street	1	800	773	0.97	842	69	**1.05**	761	-12	0.95	837	64	**1.05**	819	46	**1.02**
	Highway 15	2	1,800	884	0.49	503	-381	0.28	982	98	0.55	755	-129	0.42	630	-254	0.35
	Total	**15**	**11,100**	**7,117**	**0.64**	**7,147**	**30**	**0.64**	**7,245**	**128**	**0.65**	**7,387**	**270**	**0.67**	**7,055**	**-62**	**0.64**
SB	Sir John A. MacDonald Blvd	2	1,600	822	0.51	788	-34	0.49	899	898	0.56	876	54	0.55	840	18	0.53
	Palace Road	1	500	86	0.17	88	2	0.22	143	143	0.29	148	62	0.30	92	6	0.18
	Princess Street	2	1,600	994	0.62	974	-20	0.61	1,032	1,031	0.65	1,012	18	0.63	984	-10	0.62
	Victoria Street	1	500	198	0.40	251	53	0.50	229	229	0.46	233	35	0.47	214	16	0.43
	Alfred Street	1	500	342	0.68	291	-51	0.58	411	410	0.82	391	49	0.78	352	10	0.70
	Division Street	1	800	531	0.66	515	-16	0.64	716	715	0.90	706	175	0.88	639	108	0.80
	Montreal Street	1	600	516	0.86	508	-8	0.85	605	604	**1.01**	607	91	**1.01**	561	45	0.94
	Rideau Street	1	800	143	0.18	142	-1	0.18	221	221	0.28	198	55	0.25	171	28	0.21
	Highway 15	2	1,800	333	0.19	597	264	0.33	156	156	0.09	434	101	0.24	271	-62	0.15
	Total	**12**	**8,700**	**3,965**	**0.46**	**4,154**	**189**	**0.48**	**4,412**	**4,408**	**0.51**	**4,605**	**640**	**0.53**	**4,124**	**159**	**0.47**

5.6 Comparison of Base Network and Third Crossing Network

Comparison of the performance between the Third Crossing and Base network alternatives provides important insight into the significance of the new crossing to network performance in the study area and along key facilities. As it was shown to perform the best overall of the tested alternatives with and without the Third Crossing, this section compares performance of the Alternating Access alternative between those two conditions.

The Third Crossing was shown to significantly reduce overall delays in the study area from an increase of 387 vehicle-hours (or 28%) in the Base Network to an increase of 113 vehicle-hours (or 10%) when the Third Crossing is operational. This is a 70% reduction (or 255 hours) in the expected delay for drivers in the study area when compared between the two scenarios. It is important to note that this additional delay will occur daily throughout the rehabilitation and will likely create similar delays during the AM peak hour as well.

The increase in VKT is also significantly lower with the Third Crossing in operation for the Alternating Access alternative. The increase in distance travelled is 45% less with the Third Crossing in place than without (4386 vehicle-kilometers vs. 7935 vehicle-kilometers). Due to its mid-point positioning between Highway 401 and the causeway, the Third Crossing allows for shorter detours for drivers who can no longer (or choose not to) make the crossing at the LaSalle Causeway.

At an overall reduction in average speed of 3% from the base network condition, the Alternating Access alternative with the Third Crossing in place shows that overall study area performance will not be significantly impacted. Compare this to a reduction of 13% to overall study area speed when the Third Crossing is not in place. A difference of 3% in overall travel speed is not likely perceptible to the average motorist, though they may encounter some spot congestion issues along key corridors and at key intersections (e.g., John Counter Boulevard / Montreal Street at the Third Crossing).

These trends are also evident in the performance of the screenlines and individual facilities where the Third Crossing provides improvements to the north-south screenlines, particularly to the screenline to the south of Highway 401, where capacity issues were more prevalent in the Base Network analysis.

The impacts of the capacity restrictions across the LaSalle Causeway were shown to be significantly reduced when the Third Crossing is operational versus the Base Network condition.

6.0 Conclusions

Of the four tested options for modifying the capacity of the LaSalle Causeway during its rehabilitation, the Alternating Access alternative, where the causeway is reduced to one lane that provides alternating access across the bridge via signals or flaggers, provides the best overall performance. It maintains more capacity across the Cataraqui River and results in fewer diverted vehicles. This reduces the increases in delay (i.e., VHT) and distance (i.e., VKT) that drivers will experience during the course of construction when compared to other options, though these are not fully eliminated.

The Third Crossing of the Cataraqui River, currently scheduled for an opening of 2022/2023, provides an important alternate route and additional capacity across the river. Located at the midpoint between Highway 401 and the LaSalle Causeway, the Third Crossing shortens the diversion distance for drivers and provides additional capacity across the river. These two aspects contribute to significantly lower impacts to delay and distance travelled for drivers crossing the river in either direction during the PM peak hour.

The Alternating Access alternative with the Third Crossing in place provides the best overall performance of any of the tested alternatives and performs significantly better than the same alternative without the Third Crossing. Delay and diversion distance are significantly reduced in the study area for this same alternative with the new facility in place than without it.

7.0 Recommendations

With respect to performance of the transportation network, it is recommended that the Alternating Access alternative be pursued, if it can be operated safely and efficiently throughout the construction period. To minimise the impacts to daily performance of the transportation network in the City of Kingston it is also recommended that the rehabilitation of the LaSalle Causeway Bascule Bridge occur after the opening of the Third Crossing.

This document presents the results of strategic "planning-level" analysis of the impacts. Additional analysis could be undertaken to examine the operational impacts in more detail through the use of an operational transportation model, such as microsimulation. This would provide information related to queuing and delays at key intersections and provide localized assessment of the projected operations for the client's preferred alternative. The appropriate scale of the operational model will depend on the preferred alternative. For an alternating access approach, the model could include the Highway 2 corridor between Princess Street and Highway 15. For the full or directional closure options, the model would likely need to cover a substantially larger area to adequately assess the impacts.