City of Regina

REGINA DOWNTOWN TRANSPORTATION STUDY
PHASE 1

APPENDIX A: EXISTING CONDITIONS REPORT

MAY 2012

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1. INTRODUCTION

The scope of work for Phase 1 of the Downtown Transportation Study includes the assessment of traffic, transit, and active transportation modes on the 11th And 12th Avenue corridors under a variety of network alternatives for City Square Plaza. The network alternatives for the Plaza are for it to remain closed to traffic year round, or to open it to traffic, either one-way or two-way, for certain seasons or for certain times-of-day or days of the week.

1.1 Purpose of Report

In order to undertake the assessment of traffic and transit operations, a 'model toolkit' was developed consisting of a micro-simulation model supported by a travel demand model and a traffic operations model. The micro-simulation model, in the VISSIM software platform, is the primary tool for evaluation of traffic and transit conditions, and was developed and calibrated to current conditions. The City's EMME model was consulted for travel demand and routing under the various alternatives, and the City's Synchro model was used to assess intersection level-of-service, and compare results against the VISSIM analysis.

This report presents the data collection, model development, and calibration and validation tasks. Model development for Phase 1 of the City of Regina Downtown Transportation Study commenced in February 2012, based on traffic data collected throughout 2011.

The base model was selected to represent the PM peak hour, with 12th Avenue closed between Lorne Street and Scarth Street, which is the stretch adjacent to City Square Plaza. This decision reflected the state of current operations at 12th Avenue and collected traffic data. PM peak hour was observed to have the highest auto volumes in the study area and is critical in terms of congestion on 11th Avenue, Albert Street, and Broad Street.

1.2 Study Area

In Exhibit 1-1, the map of Downtown Regina is shown with three boundaries. The area enclosed in the red boundary represents the stretch of 12th Avenue that is closed under current operations, but is subject to alternative operations. The area enclosed in the dark blue boundary represents the study area for Phase 1 of the project. The area enclosed by the light blue boundary represents the study area for phase 2 of the project. This report represents the existing conditions analysis for Phase 1.

Exhibit 1-1: Regina Downtown Transportation Study Area
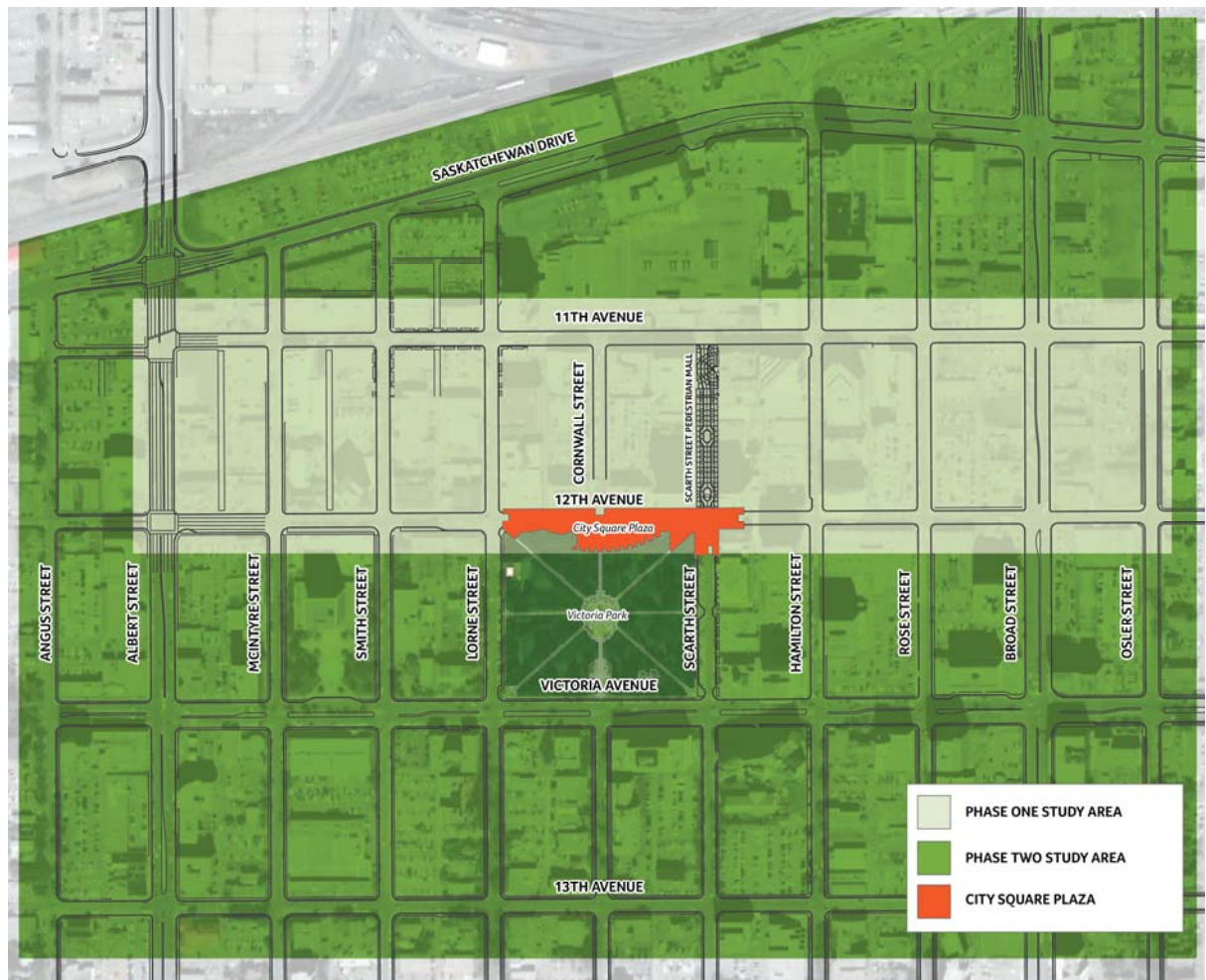
Phase 1 analysis includes signalized and unsignalized intersections bound by 11th Avenue to the north, Broad Street to the east, 12th Avenue to the south, and Albert Street to the west, all intersections on the boundaries inclusive.

Below is a list of signalized and unsignalized intersections included in all models (EMME, Synchro, VISSIM):

- 11th Avenue at Albert Street

- 11th Avenue at McIntyre Street

- 11th Avenue at Smith Street

- 11th Avenue at Lorne Street

- 11th Avenue at Cornwall Street

- 11th Avenue at Scarth Street

- 11th Avenue at Hamilton Street

- 11th Avenue at Rose Street

- 11th Avenue at Broad Street

- 12th Avenue at Albert Street

- 12th Avenue at McIntyre Street

- 12th Avenue at Smith Street

- 12th Avenue at Lorne Street (different operational schemes for various alternatives)

- 12th Avenue at Hamilton Street

- 12th Avenue at Rose Street

- 12th Avenue at Broad Street

- 12th Avenue at Cornwall Street

- 12th Avenue at Scarth Street

Below is a list of parkade entrances (unsignalized) included in all models:

- Parkade on east side of Cornwall Street, between 11th Avenue and 12th Avenue, with access to Cornwall Street

- Parkade on west side of Rose Street, between 11th Avenue and 12th Avenue, with access to Rose Street

Additionally, several parking lots were modelled in order to represent the various vehicle demand origins and destinations in the study area. Those parking lots were also used to balance network volumes.

1.3 Alternatives

Alternative evaluation is detailed under a separate report, while this report provides an overview of existing conditions and base model development and calibration. The base model was used to develop models of each of the four alternatives for the study, plus a refinement to the preferred alternative. The four major alternatives are:

1) PM peak hour, 12th Avenue closed at City Square Plaza (base model),

2) PM peak hour, 12th Avenue one-way eastbound at City Square Plaza,

3) PM peak hour, 12th Avenue one-way westbound at City Square Plaza, and

4) PM peak hour, 12th Avenue two-way at City Square Plaza.

For each alternative, there will be an EMME model, a Synchro model, and a VISSIM model, each with the correct representative network configurations and operations.

1.4 Data Collection

1.4.1 APPROACH COUNTS

The follow approach counts were obtained in the period between January 1st, 2012, and March 1st, 2012.

Exhibit 1-2: List of Approach Counts

E-W Road	N-S Road	Date From	Date To	Provider
11th Ave.	Cornwall St.	2011-10-17	2011-10-19	MetroCount
11th Ave.	Hamilton St.	2011-10-17	2011-10-26	MetroCount
11th Ave.	Lorne St.	2011-10-12	2011-10-17	MetroCount
11th Ave.	Rose St.	2011-10-17	2011-10-26	MetroCount
11th Ave.	Smith St.	2011-10-12	2011-10-17	MetroCount
12th Ave.	Albert St.	2011-11-03	2011-11-07	MetroCount
12th Ave.	Broad St.	2011-11-02	2011-11-07	MetroCount
12th Ave.	Lorne St.	2011-10-31	2011-11-03	MetroCount
12th Ave.	McIntyre St.	2011-10-31	2011-11-03	MetroCount
12th Ave.	Rose St.	2011-11-02	2011-11-07	MetroCount
12th Ave.	Smith St.	2011-10-31	2011-11-02	MetroCount
Saskatchewan Dr.	Lorne St.	2011-10-19	2011-10-24	MetroCount
Saskatchewan Dr.	Rose St.	2011-10-05	2011-10-12	MetroCount
Saskatchewan Dr.	Smith St.	2011-10-12	2011-10-17	MetroCount
Victoria Ave.	Hamilton St.	2011-10-19	2011-10-24	MetroCount
Victoria Ave.	Lorne St.	2011-10-24	2011-10-26	MetroCount
Victoria Ave.	McIntyre St.	2011-11-02	2011-11-07	MetroCount
Victoria Ave.	Rose St.	2011-10-19	2011-10-26	MetroCount
Victoria Ave.	Scarth St.	2011-10-24	2011-10-26	MetroCount
Victoria Ave.	Smith St.	2011-10-26	2011-10-28	MetroCount

1.4.2 TURNING MOVEMENT COUNTS

The following turning movement counts were received in the period between January 1st, 2012 and March 1st, 2012.

Exhibit 1-3: List of Turning Movement Counts

E-W Road	N-S Road	Date	Provider
11th Ave.	Broad St.	2011-09-01	MioVision
11th Ave.	Cornwall St.	2011-11-17	Miovision
11th Ave.	Hamilton St.	2011-10-18	manual
11th Ave.	Lorne St.	2011-11-16	manual
11th Ave.	Rose St.	2011-11-16	MioVision
12th Ave.	Broad St.	2011-11-01	manual
12th Ave.	Smith St.	2011-11-17	manual
Saskatchewan Dr.	Albert St.	2011-11-24	MioVision
Saskatchewan Dr.	Broad St.	2011-10-27	manual
Saskatchewan Dr.	Broad St.	2011-11-24	MioVision
Saskatchewan Dr.	Cornwall St.	2011-11-23	MioVision
Saskatchewan Dr.	Hamilton St.	2011-11-23	manual
Victoria Ave.	Broad St.	2011-11-10	MioVision

The turning movement counts on Saskatchewan Drive and Victoria Avenue are not used for the development of the base model in Phase 1, which focuses on 11th Avenue and 12th Avenue only. The intersections of 12th Avenue at Cornwall Street is within the closed plaza (as of 2011) and 12th Avenue at Scarth Street is a northbound right turn only and can be determined through volume balancing.

Out of the 17 modelled road intersections in Phase 1 base model, seven have corresponding turning movement counts. To fill the gaps in turning count data, two sources were used: first, the Synchro files provided included older turning movement counts (generally from 2010 and earlier) and the link counts (ATR counts) in 2011 as detailed above. To estimate turning movement counts at the missing locations for 2011, 2011 approach volumes (ATR counts) were distributed to left, through, and right turns at the intersection, based on the older 2010 and 2009 counts. Resulting movements were then checked for inconsistencies with the network or available 2011 turning movement counts and adjusted where necessary. Further volume balancing was conducted across the network.

Resulting base-year calibration volumes are provided below.

1.4.3 SIGNAL TIMING PLANS

The following signal timing plans were collected from the city:

Exhibit 1-4: List of Signal Timing Plans

E-W Road	N-S Road	Date	Provider
11th Ave.	Albert St.	2012-01-23	City of Regina
11th Ave.	Broad St.	2012-01-23	City of Regina
11th Ave.	Cornwall St.	2012-01-18	City of Regina
11th Ave.	Hamilton St.	2012-01-18	City of Regina
11th Ave.	Lorne St.	2012-01-18	City of Regina
11th Ave.	Rose St.	2012-01-18	City of Regina
11th Ave.	Scarth St.	2012-01-18	City of Regina
11th Ave.	Smith St.	2012-01-18	City of Regina
12th Ave.	Albert St.	2012-01-23	City of Regina
12th Ave.	Broad St.	2012-01-23	City of Regina
12th Ave.	Hamilton St.	2012-01-18	City of Regina
12th Ave.	Lorne St.	2012-01-23	City of Regina
12th Ave.	Rose St.	2012-01-23	City of Regina
12th Ave.	Scarth St.	2012-01-23	City of Regina
12th Ave.	Smith St.	2012-01-23	City of Regina
Saskatchewan Dr.	Albert St.	2012-01-23	City of Regina
Saskatchewan Dr.	Broad St.	2012-01-23	City of Regina
Saskatchewan Dr.	Hamilton St.	2012-01-23	City of Regina
Saskatchewan Dr.	Lorne St. / Cornwall St.	2012-01-23	City of Regina
Saskatchewan Dr.	Rose St.	2012-01-23	City of Regina
Victoria Ave.	Albert St.	2012-01-23	City of Regina
Victoria Ave.	Broad St.	2012-01-23	City of Regina
Victoria Ave.	Hamilton St.	2012-01-23	City of Regina
Victoria Ave.	Lorne St.	2012-01-23	City of Regina
Victoria Ave.	Rose St.	2012-01-23	City of Regina
Victoria Ave.	Scarth St.	2012-01-23	City of Regina
Victoria Ave.	Smith St.	2012-01-23	City of Regina

The above was sufficient for the modelling of signal timings across all signalized intersections for the base model in Phase 1.

1.4.4 PEDESTRIAN AND CYCLIST COUNTS

The following signal timing plans were received in the period between January 1st, 2012 and March 1st, 2012.

Exhibit 1-5: List of Pedestrian and Cyclist Counts

E-W Road	N-S Road	Date	Provider
11th Ave.	Albert St.	2011-06-15	City of Regina
11th Ave.	Broad St.	2011-06-28	City of Regina
11th Ave.	Cornwall St.	2011-11-17	MioVision
11th Ave.	Hamilton St.	2011-10-18	manual
11th Ave.	Rose St.	2011-11-16	MioVision
12th Ave.	Albert St.	2011-06-16	City of Regina
12th Ave.	Broad St.	2011-06-23	City of Regina

On each leg, pedestrians can cross both directions. Pedestrian signal timings follow those provided from the City of Regina. Pedestrian volumes were based on received City of Regina, MioVision, or manual counts where available. For intersections with no pedestrian volume data, a fixed number of 30 pedestrians per hour per direction per leg (total of 240 per intersection) was assumed.

1.4.5 AERIAL IMAGES AND DRAWINGS

A set of high-resolution aerial images was received in January 2012, on a DVD labelled "Downtown Transportation Study – Jan., 2012." A drawing filed named "Downtown Transportation Study.dwg" was also received in the same month.

The aerial images were combined into a single image file and edited appropriately to aid the Phase 1 model development. The drawing file was also simplified for model development purposes. Both files were imported into VISSIM as background files for network development.

1.4.6 SYNCHRO MODELS

Three Synchro models were collected in February 2012 – one for each time period (AM, off-peak, PM). All of them were based on 12th Avenue operating as a one-way eastbound street at City Square Plaza. These models were complete with turning movement volumes and signal timings at intersections. The turning movement volumes did not match the received in Section 1.3.2.

1.5 Lane Configuration

There were several inconsistencies between the sources (aerial images, CAD drawing, and the three reference Synchro models). To ensure the base VISSIM model represented true 2011 conditions (with the 12th Avenue Plaza closed), emails were exchanged with the City to agree on the details. The following were the key adjustments made based on the discussion with the city accurately reflect 2011 base-year conditions:

- Both 11th Avenue and 12th Avenue operate as a two-way road throughout the model with the exception of 12th Avenue from Lorne Street to Hamilton Street. 12th Avenue is closed from Lorne Street to Scarth Street, and it is one-way eastbound from Scarth Street to Hamilton Street;

- Both 11th Avenue and 12th Avenue have 2 lanes for each direction. Roadside parking and stopovers are allowed for select stretches, for the outside lane only. Outside lane is used as a bus-only lane for select stretches on 11th Avenue;

- Albert Street and Broad Street are considered 'major roads' compared to 11th Avenue and 12th Avenue, which are considered 'minor roads' in comparison (this has impact when determining priorities with conflict areas for select movements);

- Albert Street operates as a 6-lane, two-way (3 lanes each direction) road, with on-street parking available in small selected segments, and with storage lanes for left turn movements;

- Mcintyre Street operates as a 2-lane, one-way northbound road;

- Smith Street operates as a 4-lane, one-way southbound road, with on-street parking in lanes 1 and 4;

- Lorne Street operates as a 4-lane, one-way northbound road, with on-street parking in lanes 1 and 4;

- Cornwall Street operates as a 2-lane, two-way (1 lane each direction) road, and it connects 11th Avenue to the parkade east of Cornwall Street. For the base model, it does not connect with 12th Avenue;

- Scarth Street is closed to traffic at 11th Avenue, and operates as a 1-lane one-way northbound road that ends at 12th Avenue;

- Hamilton Street operates as a 4-lane, one-way southbound road, with on-street parking in lanes 1 and 4;

- Rose Street operates as a 2-lane, one-way northbound road;

- Broad Street operates as a 6-lane, two-way (3 lanes each direction) road, with on-street parking available in small selected segments, and with storage lanes for left turn movements; and

- Two-way pedestrian crossings exist on all legs of signalized intersections and also at the two unsignalized intersections on Mcintyre Street, but not at parkade entrances.

1.6 Volume Balancing

Due to the fact that approach volumes and turning movement counts were collected from different sources on different days, the following approach was taken to ensure that volumes were balanced across the network:

- All available vehicle volume data was tabulated together.

- Turning movement ratios were finalized for each intersection, based on given data. In cases where multiple resources were available for a single intersection, traffic movement counts (TMC) took precedent over turning movements from the reference Synchro files (from Section 1.3.6).

- Where available, TMCs for intersection volumes were used as given for the appropriate hour. The peak hour was determined by picking the hour with the highest total volume, to 15-minute accuracy scale.

- Approach volumes were multiplied by turning movement ratios for intersections without TMCs. Where neither TMC nor approach counts were available, the reference Synchro volumes were used.

- It was found that for all locations, approach counts yielded higher volumes than TMCs. Volumes were then balanced across the network, using the TMC as lower-bound cap.

The final turning movements from this exercise, which also function as the 'target' volumes in the VISSIM model calibration, are included in Exhibit 2-3 (screenshot from Synchro) below.

2. EXISTING AUTO OPERATIONS

To model existing conditions a VISSIM base model of 11th Avenue and 12th Avenue was developed, calibrated, validated, and used to determine intersection, corridor, and network operations such as delay, travel times, and service levels. The VISSIM model was developed using collected network data (aerial images, etc), signal timing data, and volume data. VISSIM provides the ability to model vehicular routes, which was used to ensure that the travel paths of vehicles, and origins and destinations in the network, were logical. The routing was based on model assignments in the City's EMME network, manual balancing of volumes, and calibration to observed turning movements.

The following sub-sections provide an overview of the EMME model assignments, Synchro model, and VISSIM model development.

2.1 EMME Model

The City of Regina EMME model based on the model year of 2009 was used for studying traffic trends and path analysis for different scenarios.

Generally the City's EMME model is used for arterial planning and strategic network evaluations, not detailed operations studies on corridors such as 11th Avenue and 12th Avenue. As expected, on 11th Avenue and 12th Avenue, auto demand modelled in EMME did not closely match the demand observed in the traffic counts received. This is likely due to multiple factors, including but not limited to: the EMME model, based on 2009 demand, not including the closure of 12th Avenue, and simplifications in the EMME model (i.e. a single centroid connector representing an entire block with 3-6 access points in existing conditions). Still, the EMME model is useful for observing larger travel patterns and traffic loads on major roads, and in assessing at a high-level the diversion potential for network changes such as the re-opening of 12th Avenue, which will be detailed further in the Alternatives Evaluation Report.

Exhibit 2-1 provides an overview of model volumes and v/c ratios within downtown Regina, while Exhibit 2-2 provides a select-link analysis for 11th Avenue, west of Cornwall Street. The select link analysis provides the origins, destinations, and travel paths for all users of a link which can indicate the travel market served by a link and can be highly useful in building the route system in VISSIM.

Exhibit 2-1: Downtown Regina: Volume to Capacity Ratio and Auto Volumes
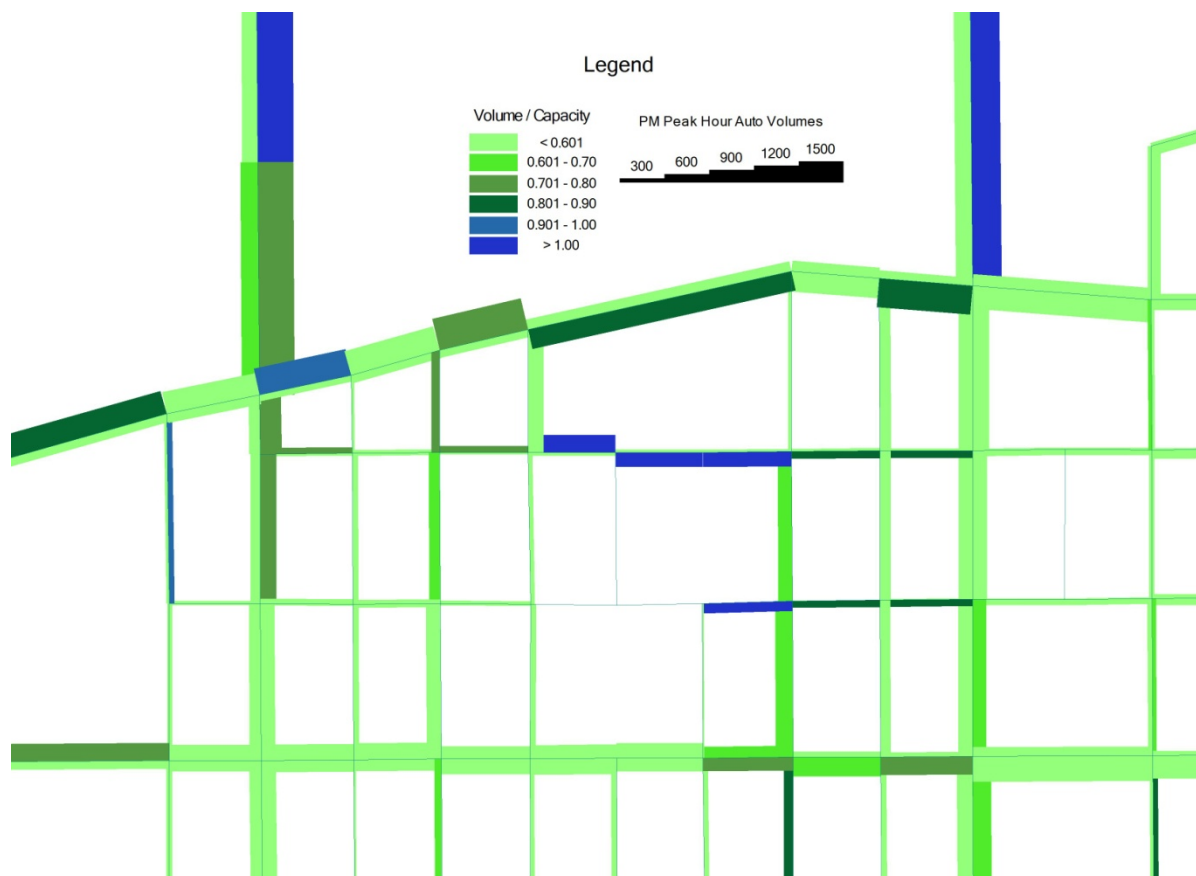
Based on Exhibit 2-1, northbound lanes on both Albert Street and Broad Street experience heavy volumes that push the streets over the nominal capacity. However, within the Phase 1 boundaries, all north-south streets remain within the nominal capacity. Westbound on 11th Avenue west of Cornwall Street and eastbound on 11th Avenue east of Cornwall street are both overcapacity, likely due to an overwhelming demand originating from the Cornwall Parkade These results are generally consistent with observed behaviour, although the macro model does not account for local operational problems such as the blocking observed at 11th Avenue and Hamilton Street and other micro-level behaviours.

Exhibit 2-2: Downtown Regina: Select Link Analysis, 11th Avenue West of Cornwall Street
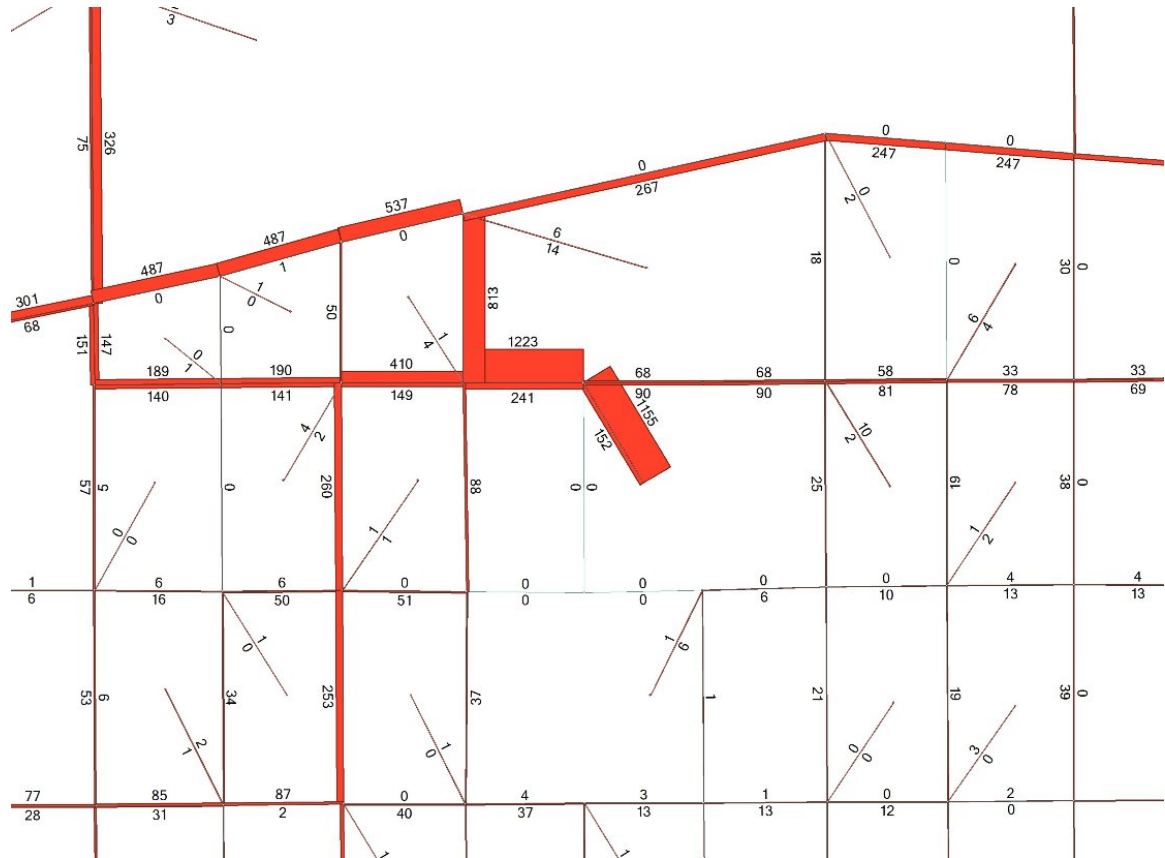
As it can be observed from Exhibit 2-2, there is a large volume exiting the centroid at Cornwall Parkade. Approximately 2/3 of the westbound traffic on 11th Avenue west of Cornwall Street take the right turn into Lorne Street northbound, then disperse into Saskatchewan Drive. The other 1/3 either continue westbound then exit to Albert Street northbound, or take Smith Street southbound. Compared to total volumes (not shown in the exhibit), the volumes originating from the Cornwall Parkade make up to 93% of the volumes on the immediately adjacent links on 11th Avenue, which means that there is very little through-traffic that use the 11th Avenue to connect from Albert Street to Broad Street. Although the model is slightly over-simplistic along 11th Avenue, the travel patterns indicate some of the key routes and ultimate destinations of traffic using 11th Avenue.

2.2 Synchro Model

The City of Regina Synchro model was updated as part of this Study, using the data received in Section 1.3, including all signal timing plans and aerial images. Balanced volumes (see Section 1.4) were used for intersections.

Exhibit 2-3: Downtown Regina: Synchro Model, PM Base Closed
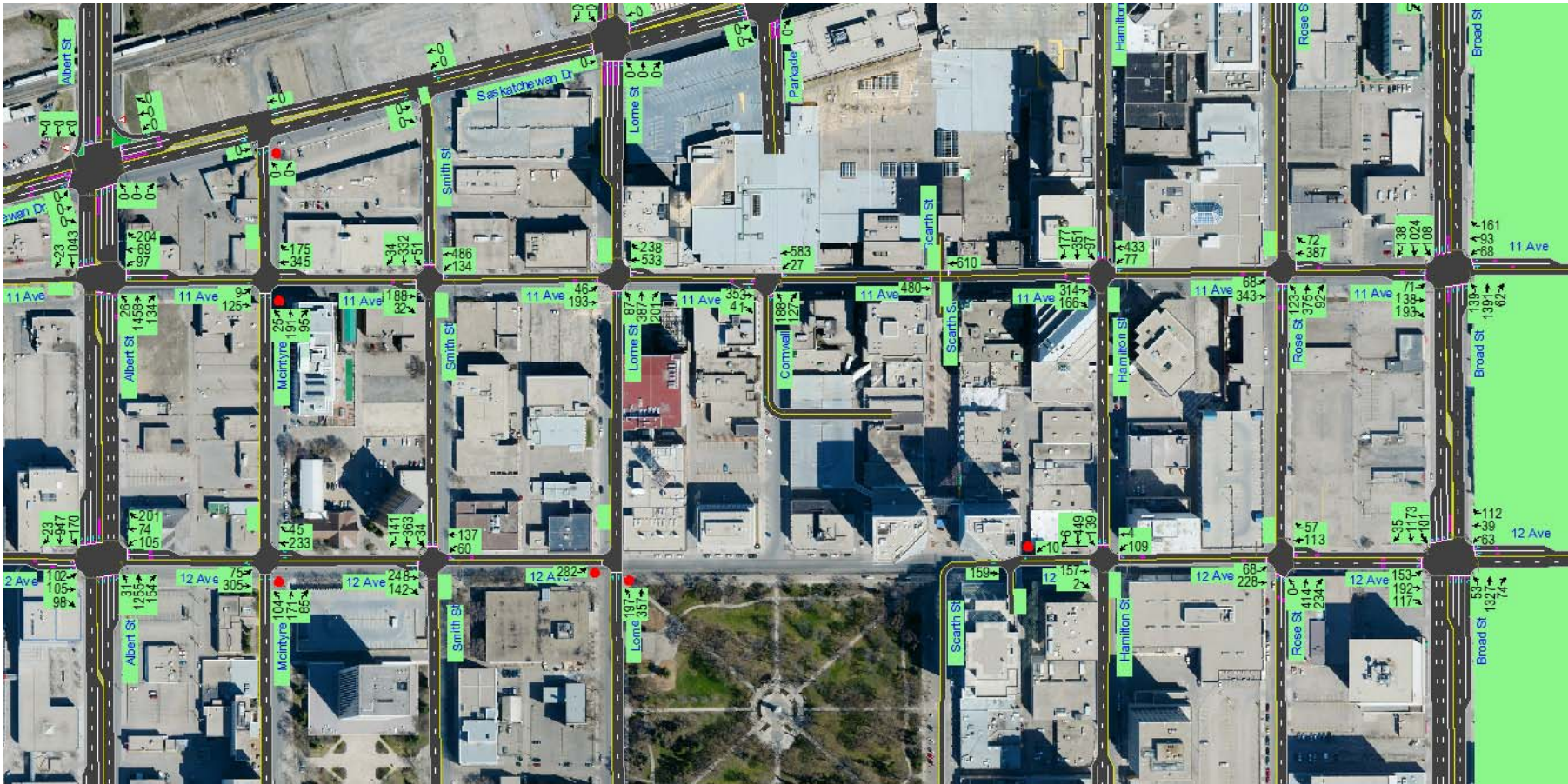
The Synchro model was built in accordance with the lane configurations outlined in Section 1.4 and the volumes balanced in Section 1.5. However, for simplification of links, parking lanes and bus-only lanes are not modelled in Synchro. Thus, 4-lane links with 2 parking lanes are modelled simply as 2-lane links, and 4-lane links with 2 bus-only lanes are modelled as 2-lane links as well.

Signal timings are identical to those provided in the signal timing data. All other Synchro default parameters are based on the "PM Downtown" reference Synchro file received.

Level-of-service results from Synchro, and a comparison to VISSIM, is provided in Section 2.4.

2.3 VISSIM Model

The VISSIM model for Phase 1 was built from the data received in Section 1.3, including all signal timings, aerial images, and the CAD drawing file. Lane configurations in Section 1.4 were followed as listed. Balanced volumes in Section 1.5 were used as the target volumes at the intersections. In addition to the modelled roads and intersections in the reference Synchro model, several parking lots were modelled to conserve the volumes between intersections.

The total simulation time was set to 75 minutes, with the first 15 minutes being 'seeding time' where no measurement are taken while the network is sufficiently populated with traffic. For the sake of coordinating transit schedules, the 75 minutes of simulated PM peak hour was defined to be from 3:45 PM to 5:00 PM.

Exhibit 2-4: Downtown Regina: VISSIM Model, PM Base Closed
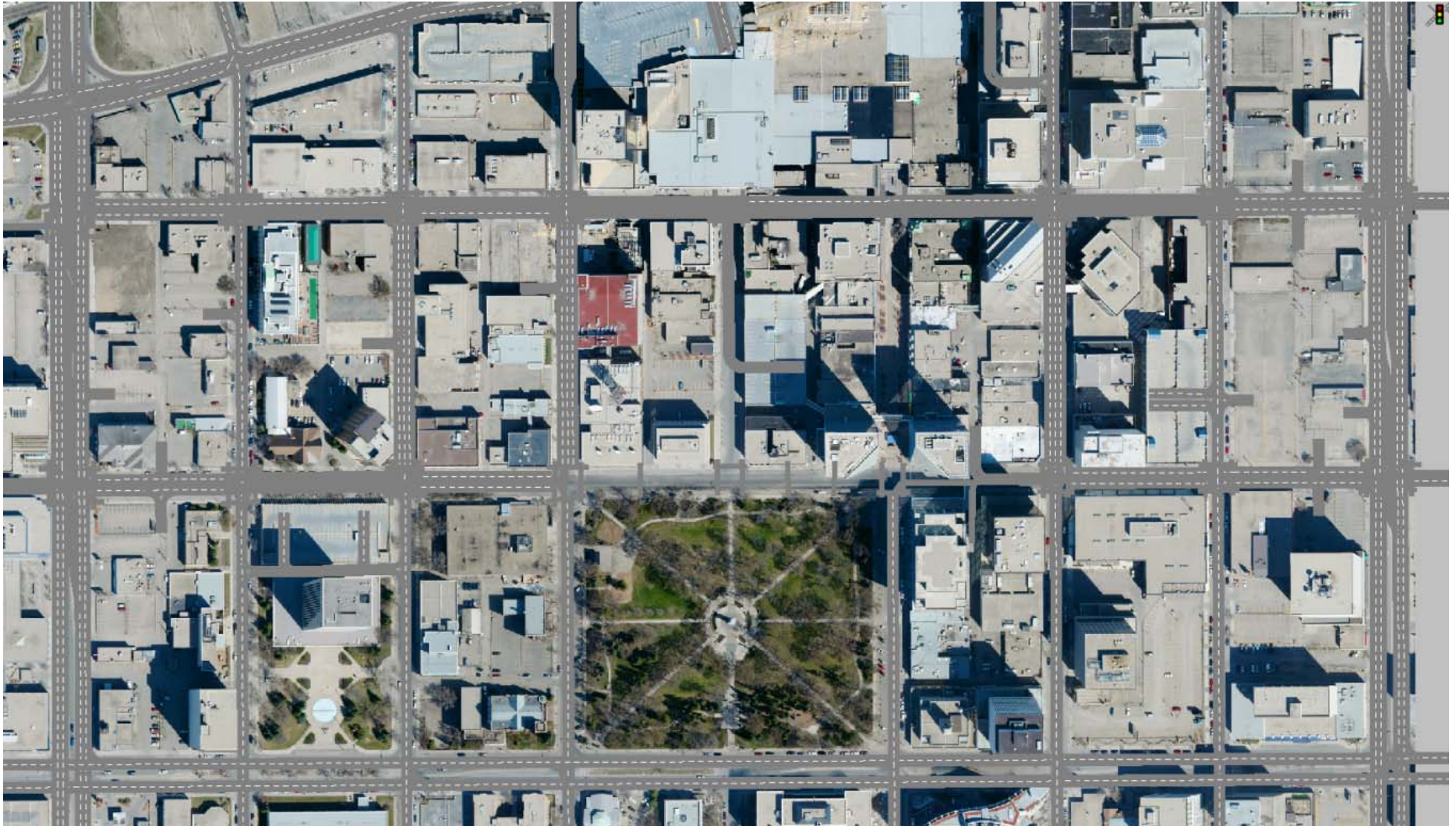
Vehicle speeds are controlled with desired speed decision points and reduced speed areas. The following desired speed categories are set for various movements in the model, in order to best reflect realistic driving behaviour.

Exhibit 2-5: Model Desired Speeds

Link	Desired Speed Category	Speed Distribution
12th Avenue at City Square Plaza	20 km/h	20.0 km/h – 25.0 km/h
All left turn movements	15 km/h	15.0 km/h – 20.0 km/h
All right turn movements	12 km/h	12.0 km/h – 15.0 km/h
Everywhere else	50 km/h	48.0 km/h – 58.0 km/h

Priority Rules and conflict areas were defined in various places of the network to achieve the following objectives:

- Prevent cars from blocking the intersection;

- Prioritize pedestrian movement above all else, given that the pedestrian movement is allowed for that phase;

- Force cars (and trucks) making a permitted left turn to check for clearances in all of: opposite direction through traffic, crossing pedestrians, and downstream lane availability; and

- Force cars (and trucks) making a permitted right turn to check for crossing pedestrians and downstream lane availability.

Right Turn on Red (RTOR) was permitted for all right-turning movements on the following intersections: 11th Avenue & Albert Street, 12th Avenue & Albert Street, 11th & Broad Street, 12th Avenue & Broad Street, 11th Avenue & Lorne Street, and 11th Avenue & Cornwall Street.

On-street parking was made available for select stretches along 11th Avenue, 12th Avenue, Albert Street, Broad Street, Smith Street, Lorne Street, and Hamilton Street.

For each alternative and time period, ten simulation runs of one simulated hour were completed to provide a statistical average. The simulation included a 15 minute seeding period, in which the network was populated with appropriate flow of vehicles. Data measurements were taken after the seeding period, for 60 minutes of simulation time, making the total simulation time 75 minutes per iteration. This approach ensured that the network was sufficiently loaded with vehicles prior to collecting measures of performance.

The VISSIM model is also capable of producing 3D videos of the simulation runs.

Exhibit 2-6: VISSIM 3D Model, at 11th Avenue and Cornwall Street
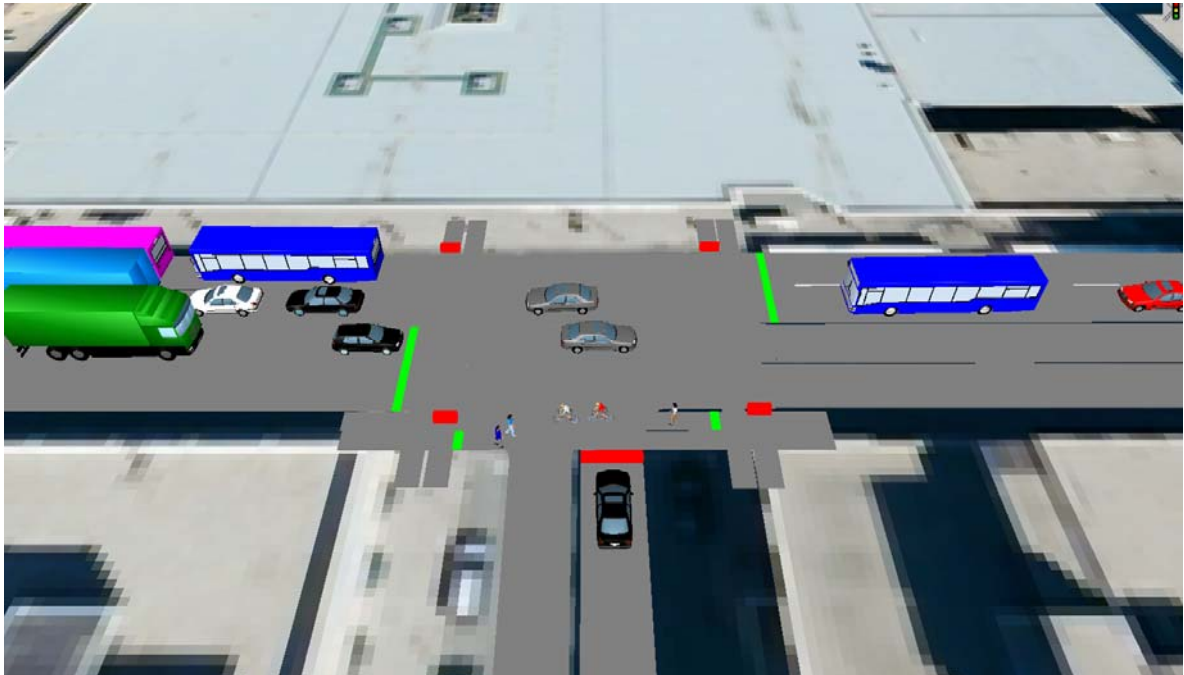
2.4 VISSIM Model Validation

As originally proposed, three levels of calibration were conducted on the VISSIM base model. The overall goal of the calibration process was to validate the model for its ability to reflect the realistic conditions to the best within its limits. All three calibration levels were performed after the transit network was fully coded and checked for proper operations. Thus, all buses are accounted for in the following calibrations. See section 3.1 for details on transit coding.

2.4.1 OBSERVATIONAL CALIBRATION

During the VISSIM simulations, the model was visually observed with the following goals:

- Check for network coding errors which may result in undesirable behaviour. Examples of undesirable behaviours are insufficient left turning priority zone resulting in vehicle-vehicle or vehicle-pedestrian crashes, improperly placed decision routing points resulting in certain vehicles looping around the network endlessly, miscoded conflict area rules resulting in cars being prioritized over pedestrians, and missing speed decision points resulting in high speeds in low speed zones (such as the City Square Plaza).

- Check the number of vehicles in the network at all times to make sure that during the simulation hour (900 seconds to 4500 seconds), the volume of vehicles present in the network is not unreasonably low (below 300) or unreasonably high (above 700). It was observed that once car volumes peaked over 700, the network experienced circular jams and soon became completely locked, essentially breaking the simulation.

Potential hotspots were identified from preliminary Synchro results and marked movements were observed with extra attention.

When the stop command is selected for the simulation, all simulated objects are immediately emptied from the network as VISSIM reverts back to editor mode. Thus, when errors were detected, the simulation was immediately paused (which keeps the objects in place) to detect the problem and its source. Upon sufficient observation, problem-solving steps were noted and the simulation was fully stopped. After appropriate steps were taken, simulation and observation took place again with attention to the previously erroneous sections. This process was repeated until all unintended problems were eliminated.

2.4.2 VOLUMETRIC CALIBRATION

VISSIM is able to collect and report various measures and counts for each defined nodes (intersections). Using the node evaluation feature, the following data was collected for each turning movement of signalized and unsignalized intersections on 11th Avenue and 12th Avenue:

- Total vehicle count for the simulation hour

- Average delay for the simulation hour, in seconds

- Average queue for the simulation hour, in meters

In VISSIM, each simulation can be assigned a different seed to release vehicles into the network at various rates (but for the same total volume). To eliminate seed-based bias, ten iterations were performed on the network with different seeds, then the results were averaged. All ten iterations were individually observed for potential problems (see section 2.4.12.4.1 above). The average volume was calibrated against reference volumes determined from section 1.6. Both the numerical differences and the percentage differences between the simulated volumes and reference volumes for each movement were calculated.

Exhibit 2-7: Volumetric Calibration Table, Base Model, 11th Avenue

a) Target volumes based on volume balancing and routing analysis

Target	101	102	103	104	105	106	107	108	109
EBL		9	0	46	0	0	0	68	71
EBT		125	188	193	353	480	314	343	138
EBR		0	32	0	41	0	166	0	193
WBL	97	0	134	0	27	0	77	0	68
WBT	69	345	486	533	583	610	433	387	93
WBR	204	175	0	238	0	0	0	72	161
NBL	26	25		87	188			123	139
NBT	1458	191		387	0			375	1391
NBR	134	95		201	127			92	62
SBL	0		51				97		108
SBT	1043		332				351		1024
SBR	23		34				177		138

b) VISSIM simulated volumes, 10-iteration average

Simulation	101	102	103	104	105	106	107	108	109
EBL		9		47				67	71
EBT		129	192	196	366	491	327	357	131
EBR			31		36		164		197
WBL	92		145		26		73		70
WBT	71	334	478	536	586	613	432	390	93
WBR	195	179		234				66	159
NBL	28	23		87	187			121	147
NBT	1462	201		364				361	1383
NBR	138	93		206	124			85	65
SBL			51				99		108
SBT	1050		322				357		1027
SBR	24		35				183		149

c) Numerical differences, simulated vs. target

Sim - Target	101	102	103	104	105	106	107	108	109
EBL	0	-1	0	1	0	0	0	-1	0
EBT	0	4	4	3	13	11	13	14	-7
EBR	0	0	-1	0	-5	0	-2	0	4
WBL	-5	0	11	0	-1	0	-4	0	2
WBT	2	-11	-8	3	3	3	-1	3	0
WBR	-9	4	0	-4	0	0	0	-6	-2
NBL	2	-2	0	0	-2	0	0	-2	8
NBT	4	10	0	-23	0	0	0	-14	-8
NBR	4	-2	0	5	-3	0	0	3	3
SBL	0	0	0	0	0	0	2	0	0
SBT	7	0	-10	0	0	0	7	0	3
SBR	1	0	1	0	0	0	6	0	11

d) Percentage simulated vs. target

Sim%	101	102	103	104	105	106	107	108	109
EBL		94%		102%				99%	100%
EBT		103%	102%	102%	104%	102%	104%	104%	95%
EBR			97%		88%		99%		102%
WBL	95%		108%		96%		95%		102%
WBT	102%	97%	98%	101%	100%	100%	100%	101%	100%
WBR	96%	102%		98%				92%	99%
NBL	108%	92%		100%	99%			98%	106%
NBT	100%	105%		94%				96%	99%
NBR	103%	98%		103%	98%			103%	104%
SBL			101%				102%		100%
SBT	101%		97%				102%		100%
SBR	103%		103%				104%		108%

Exhibit 2-8: Volumetric Calibration Table, Base Model, 12th Avenue

a) Target volumes based on volume balancing and routing analysis

Reference	201	202	203	204	205	206	207	208	209
EBL	102	75	0	282	0	0	0	68	153
EBT	105	305	248	0	0	0	157	228	192
EBR	98	0	142	0	0	0	2	0	117
WBL	105	0	60	0	0	0	109	0	63
WBT	74	233	137	0	0	0	4	113	39
WBR	201	45	0	0	0	0	0	57	112
NBL	31	104		197		0		0	53
NBT	1255	171		377		0		414	1327
NBR	154	85		0		159		234	74
SBL	170		34		0		139		101
SBT	947		353		0		449		1173
SBR	23		141		0		6		35

b) VISSIM simulated volumes, 10-iteration average

Simulation	201	202	203	204	205	206	207	208	209
EBL	99	73		294				64	163
EBT	107	306	258				162	238	195
EBR	97		133				2		119
WBL	104		60				111		70
WBT	69	234	140				4	116	34
WBR	203	49						58	114
NBL	31	102		200				0	57
NBT	1267	175		359				411	1335
NBR	163	86				163		231	76
SBL	154		34				141		97
SBT	964		353				443		1178
SBR	23		144				5		37

c) Numerical differences, simulated vs. target

Sim - Ref	201	202	203	204	205	206	207	208	209
EBL	-3	-2	0	12	0	0	0	-4	10
EBT	2	1	10	0	0	0	5	10	3
EBR	-1	0	-9	0	0	0	0	0	2
WBL	-1	0	0	0	0	0	2	0	7
WBT	-5	1	3	0	0	0	0	3	-5
WBR	2	4	0	0	0	0	0	1	2
NBL	0	-2	0	3	0	0	0	0	4
NBT	12	4	0	-18	0	0	0	-3	8
NBR	9	1	0	0	0	4	0	-3	2
SBL	-16	0	0	0	0	0	2	0	-4
SBT	17	0	0	0	0	0	-6	0	5
SBR	0	0	3	0	0	0	0	0	2

d) Percentage simulated vs. target

Sim%	201	202	203	204	205	206	207	208	209
EBL	97%	98%		104%				94%	106%
EBT	102%	100%	104%				103%	104%	101%
EBR	99%		94%				90%		102%
WBL	99%		100%				102%		110%
WBT	93%	100%	102%				95%	102%	88%
WBR	101%	108%						101%	101%
NBL	100%	98%		102%					108%
NBT	101%	102%		95%				99%	101%
NBR	106%	101%				103%		99%	103%
SBL	90%		100%				101%		96%
SBT	102%		100%				99%		100%
SBR	98%		102%				98%		105%

The goals of the volumetric calibration were to meet the following criteria:

- Non-minor movements (with turning movement volume of at least 60) within +/- 20% of the target reference volumes;

- Major movements (with turning movement volume of at least 300) within +/- 15% of the target reference volumes; and

- The total simulated turning movement count for the entire network within 2.5% of the total reference turning movement count.

If any of the above criteria were not met, routing decisions and entry volumes were edited in VISSIM to close out the gap. Only when all of the above criteria were met, the calibration process was complete.

2.4.3 COMPARISONS WITH SYNCHRO MODEL

The level of service results of corresponding movements from VISSIM and Synchro base models were compared for consistencies and potential disparities. See section 2.5 below for results and details.

2.5 Intersection Level of Service

Intersection capacity analyses were undertaken using the Highway Capacity Manual (HCM) methodology. The level of service (LOS) and corresponding delay per vehicle in seconds is provided in the following tables:

Signalized Intersection LOS

LOS	Control Delay Per Vehicle
A	≤10
B	>10 and ≤20
C	>20 and ≤35
D	>35 and ≤55
E	>55 and ≤80
F	>80

Unsignalized Intersection LOS

LOS	Control Delay Per Vehicle
A	≤10
B	>10 and ≤15
C	>15 and ≤25
D	>25 and ≤35
E	>35 and ≤50
F	>50

Exhibit 2-9: PM Base Model Level of Service Comparison, Synchro vs. VISSIM

East-West Street	North-South Street	LOS		Average Delay (s)	
		Synchro	VISSIM	Synchro	VISSIM
11th Avenue	Albert Street	C	B	34	14
	Mcintyre Street	A	A	6	7
	Smith Street	B	B	18	12
	Lorne Street	B	C	19	22
	Cornwall Street	B	D	16	37
	Scarth Street	B	C	17	29
	Hamilton Street	B	C	19	30
	Rose Street	B	C	20	29
	Broad Street	C	C	32	23
12th Avenue	Albert Street	C	C	34	21
	Mcintyre Street	B	A	11	7
	Smith Street	B	B	13	14
	Lorne Street	B	B	13	17
	Hamilton Street	B	B	13	14
	Rose Street	B	B	16	17
	Broad Street	B	C	17	20

The comparison of level-of-service between Synchro and VISSIM acts as an additional check on model validation. Any severe operational problems in VISSIM could be a result of model error. The exhibit indicates relatively close compliance between the two models. Synchro and VISSIM results in large agree with each other. For all intersections except 11th Avenue & Cornwall Street, the level of service differs by one rank at the most. Largest differences are found in 11[h] Avenue & Albert Street (Synchro = 34s, VISSIM = 14s) and 12th Avenue & Albert Street (Synchro = 34s, VISSIM = 21s). In both cases, Synchro estimates the single lane left combined left and through movement to operate in LOS E or F, whereas VISSIM estimates the same movements to operate in LOS D or E. The left turns in VISSIM may be slightly more aggressive than the ones calculated in Synchro, resulting in slightly better level of service. At 11th Avenue & Cornwall Street, vehicles in VISSIM have a tough time making the NBR or NBL movements due to queue spillbacks from downstream intersections and heavy pedestrian volumes.

Overall, all intersections operate relatively well across the network in the PM base model with 12th Avenue closed between Lorne Street and Scarth Street. The average delay for the intersections do not exceed 34 seconds (LOS C). Across the network, a number of individual movements were identified as being near or over capacity. Exhibit 2-10 provides the 'hotspot' analysis of movements

over capacity. Detailed level-of-service output is provided in Appendix A-2 for Synchro results, and Appendix A-3 for VISSIM results.

Exhibit 2-10: Intersection Analysis, Synchro Base Model
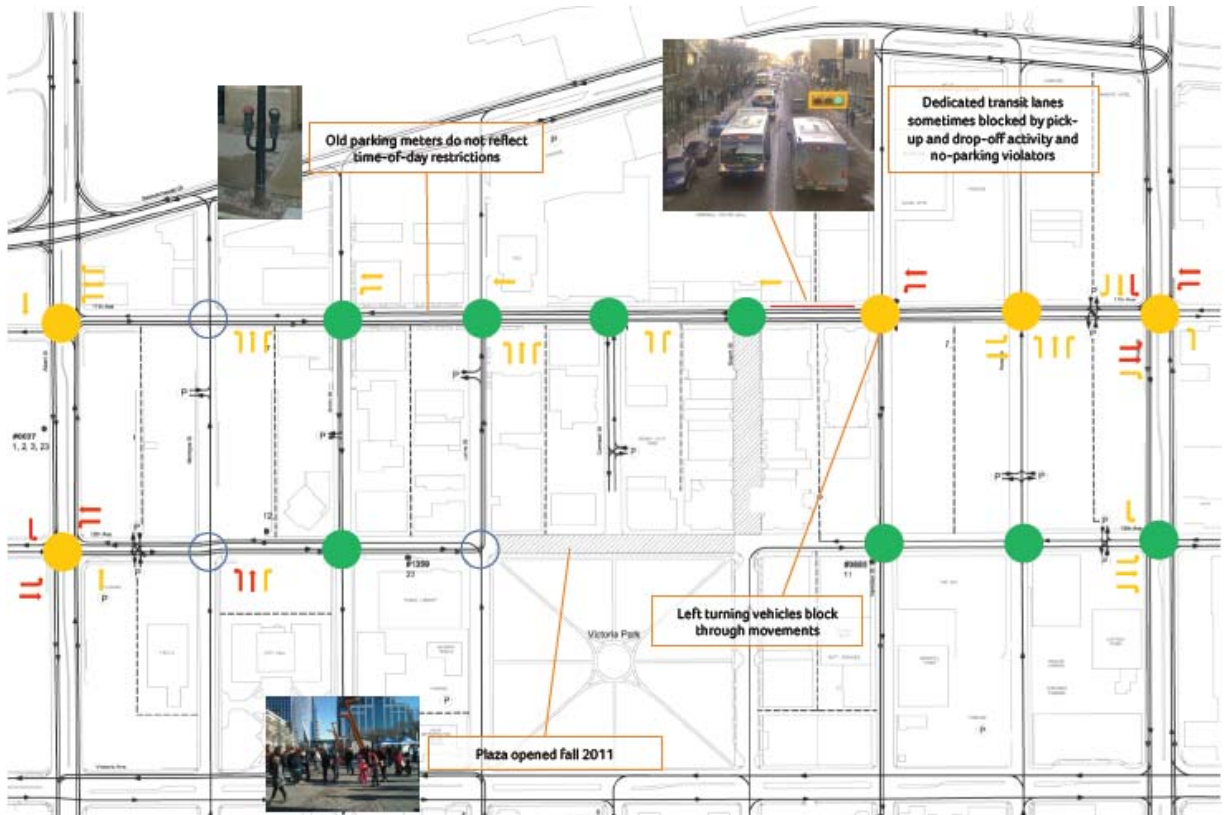
2.6 Critical Movements in VISSIM

There were several critical movements identified in the base model. Movements with LOS D or worse were identified in the base model.

Exhibit 2-11: Critical Intersection Turning Movements

Location			Delay
East-West Street	North-South Street	Movement	
11th Avenue	Cornwall Street	NBL	67
		NBR	59
11th Avenue	Hamilton Street	SBR	70
11th Avenue	Broad Street	EBL	83
		EBT	77
		WBL	61
		WBT	60
12th Avenue	Albert Street	WBL	69
		WBT	64
12th Avenue	Broad Street	SBL	58

- On 11th Avenue and Cornwall Street, cars exiting the parkade and trying to join 11th Avenue experience high delays due to heavy pedestrian volumes and downstream queue problems.

- On 11th Avenue and Hamilton Street, the southbound right movement experiences high delays due to the heavy traffic downstream on 11th Avenue westbound. Due to there being little to no room downstream, vehicles trying to make SBR are forced to wait a few seconds until it clears. In some cases, the SBR vehicles must wait an entire cycle or two before they can make the turn.

- On 11th Avenue and Broad Street, the heavy volumes forced into a single eastbound through and left shared lane causes high delays. Due to left turn movement having no protected phasing, the entire single lane queue must sometimes wait for the leading left turn vehicle while it waits for sufficient gap to make the permitted turn.

- Similar problems are found in 12th Avenue and Albert Street, where WBL and WBT share a single lane, and WBL does not have a protected phase.

2.7 Auto Travel Times

Travel time measurement segments were set up across the entire network. Each segment started at the beginning of a link (just past the intersection) and ended at the downstream end of the intersection. In Exhibit 2-12, red vertical markers are the starts of travel time measurement Sections, green vertical markers are the ends of travel time measurement Sections, and the yellow arrow represents one travel segment.

Exhibit 2-12: Example of a VISSIM Travel Time Segment
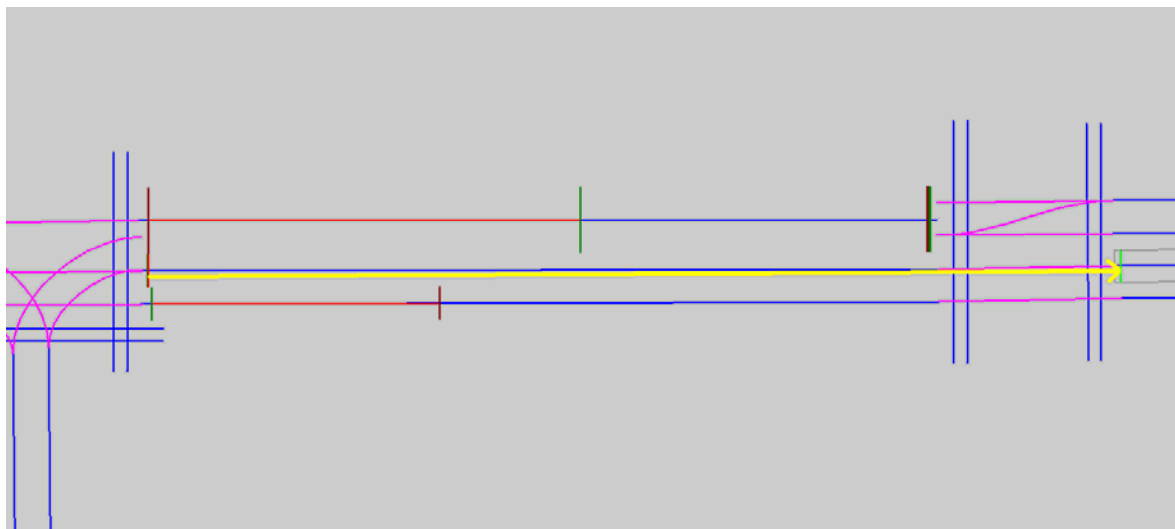
To calculate the total travel time between two observation points, appropriate travel time measurements from individual segments are added together.

Exhibit 2-13: PM Base Closed Model Travel Time Measurements

On	From	To	Direction	Travel Time (s)
11th Avenue	Albert Street	Cornwall Street	EB	74
11th Avenue	Cornwall Street	Broad Street	EB	150
11th Avenue	Broad Street	Cornwall Street	WB	193
11th Avenue	Cornwall Street	Albert Street	WB	109
12th Avenue	Albert Street	Lorne Street	EB	58
12th Avenue	Hamilton Street	Broad Street	EB	60
12th Avenue	Broad Street	Hamilton Street	WB	37
12th Avenue	Lorne Street	Albert Street	WB	108

On 11th Avenue, the east half of the avenue (from Cornwall Street to Broad Street) is busier than the west half of the avenue, in both directions. In terms of volume, a significant portion of westbound volume is relieved at Lorne Street (via right turn), which explains the lower travel time in the westbound direction in the west half of the avenue. The eastbound left and eastbound through movements share a single lane at 11th Avenue & Broad Street. Due to high delays of two movements in a single lane, amplified by the fact that left turn does not have a protected phase, causes high delays and thus high travel times eastbound.

In total, from west end to east end on 11th Avenue, it takes 224 seconds (3.7 minutes). From east end to west end on 11th Avenue, it takes 302 seconds (5.0 minutes).

On 12th Avenue, traffic is noticeably lighter than 11th Avenue and the travel times reflect that. It should also be noted that since 12th Avenue is closed between Lorne Street and Scarth Street, a true through-corridor travel time cannot be measured in either direction. Unlike 11th Avenue, the west half is heavier in traffic than east half. Similar to 11th Avenue & Broad Street, the sharing of a

single lane between left and through movement at 12th Avenue & Albert Street causes high delays and thus high travel times.

3. EXISTING TRANSIT OPERATIONS

Transit routes were coded in VISSIM to match reality as closely as possible. Routes were coded individually with scheduled time adherence at stops on 12th Avenue between McIntyre Street and Lorne Street. At other stops, bus dwell times were adjusted to match observed times.

The existing transit operations were extracted from the VISSIM model for level of service and delay information.

3.1 Transit Coding

The full list of bus lines and schedules were obtained from the transit Section of City of Regina official website, at http://regina.ca/residents/transit-services/regina-transit. All listed routes, from 1 – Dieppe – Broad North to 23 – University – Rochdale, were included in the model if any portion of their route is present inside or on the Phase 1 boundary. Any transit lines that do not have any portion of their route present inside or on the Phase 1 boundary were not included in the model.

TransitLive is an automatic vehicle location pilot project from Canadian Research Logistics (CRL), a Regina-based company. In addition to the schedules obtained from City of Regina's official website, TransitLive was used to verify routes and stop locations. TransitLive is accessible to the public, and can be found online at http://transitlive.com.

Exhibit 3-1: TransitLive, Showing Route 1 Stops and Buses
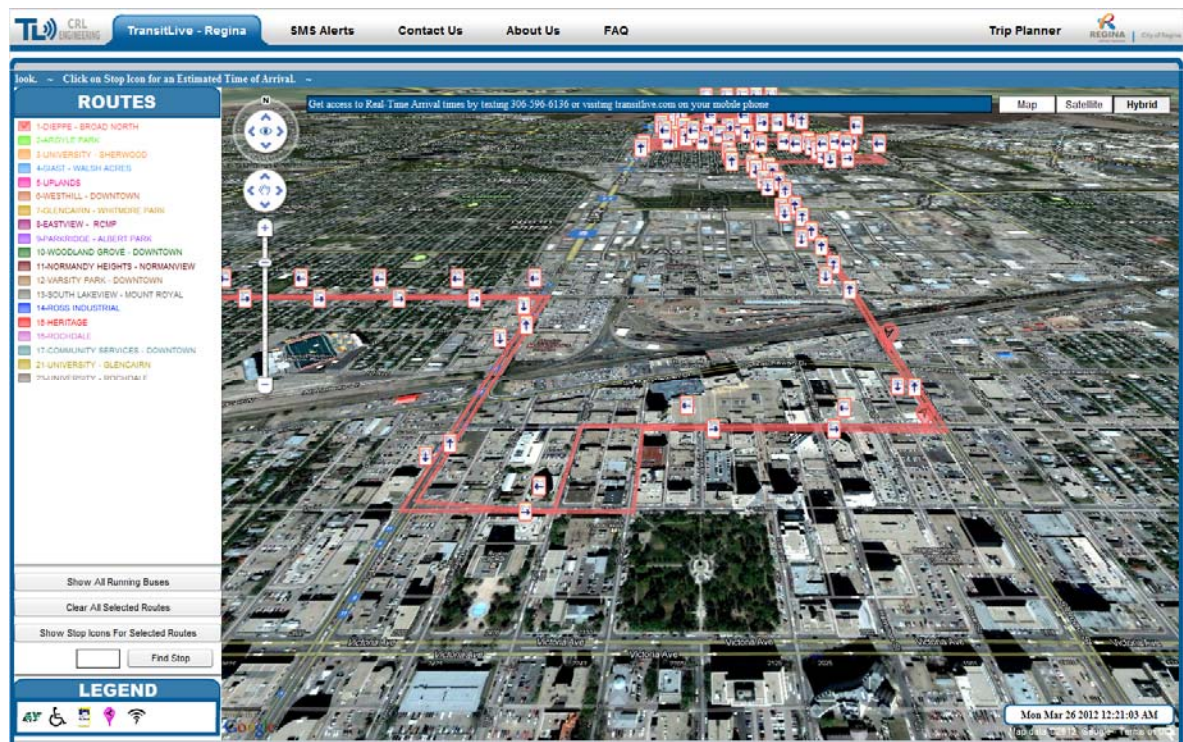
One of the key drivers of bus operations on 11th Avenue and 12th Avenue is the dwell time of buses at stops. Field observations were used to verify bus dwell times in the study area. Bus dwell times at bus stations were given static distributions in the VISSIM model. Dwell time distributions range from short (normal, 15 +/- 5 seconds) to long (empirical, 30 to 240 seconds), depending on the observed significance of the stop. In Exhibit 3-2: Bus Dwell Time List by Stop ID the list of dwell times are listed with the following code: N for normal distribution, with (average time, max/min range), and E for empirical distribution, with (min-max), all in seconds.

Exhibit 3-2: Bus Dwell Time List by Stop ID

Stop ID	Description	Dwell Time
0037	11th & Albert SB	N (25, 5)
0038	City Hall, EB	E (30-240)
0041	11th & Broad, NB	N (25, 5)
0112	11th & Saskatchewan, SB	N (25, 5)
0114	11th & Hamilton, WB	N (25, 5)
0115	11th & Cornwall (farside), WB	E (30-240)
0180	11th & Cornwall (nearside), WB	E (30-240)
0360	12th & Albert, SB	N (25, 5)
0690	11th & Broad, WB	N (25, 5)
0885	12th & Hamilton, SB	N (25, 5)
1271	11th & Saskatchewan, NB	N (25, 5)
1354	11th & Cornwall, EB	N (25, 5)
1355	11th & Hamilton, EB	N (25, 5)
1356	City Hall, WB	N (45, 15)
1357	11th & Mcintyre, EB	N (25, 5)
1360	11th & Albert, NB	N (25, 5)
1362	12th & Broad, SB	N (25, 5)

Exhibit 3-3: Dwell Time Distribution: Empirical, 30-240
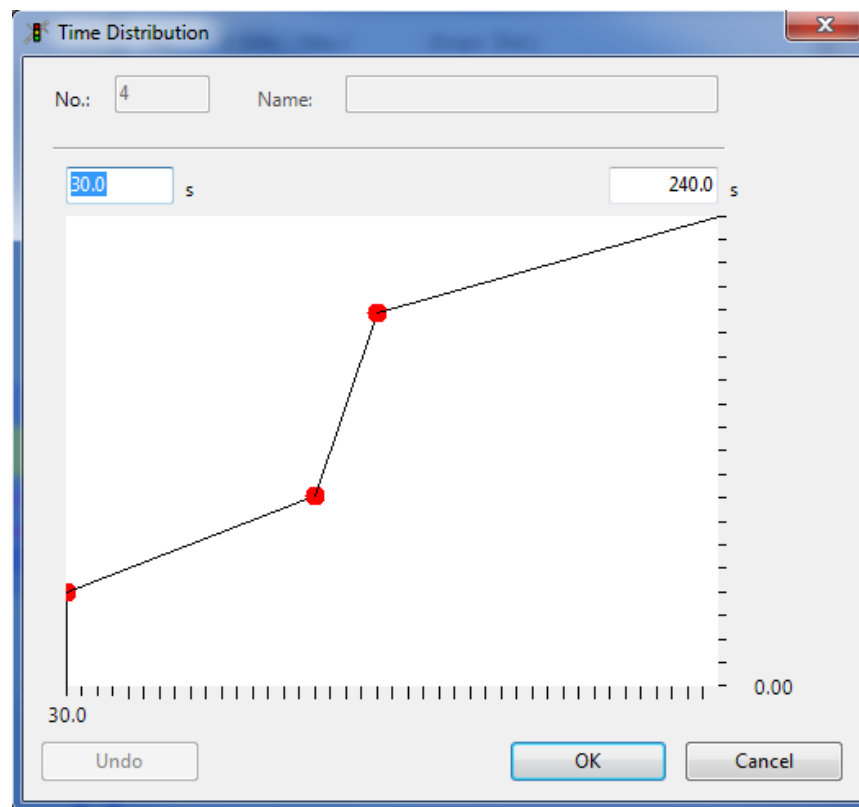
As stated above, all bus routes were modelled individually. Bus routes start and end where they cross the VISSIM model boundary (different from Phase 1 boundary). The routes do not share a common time and headway. The individual routes' starting times were coordinated to best match the first scheduled departure time at the City Hall stop within the model's time frame. For routes that do not use the City Hall stop, the nearest station was used as the point of reference.

Bus-only lanes were modelled at appropriate segments along 11th Avenue and 12th Avenue. Lane violations by automobiles were modelled as well: at 11th Avenue and Scarth Street, a small static chance was coded into the routing decisions to have westbound automobiles make a short stop (dwell time is based on a static normal distribution), which disrupt and/or delay the buses trying to make a stop or pass through.

For major stops used by several bus lines (such as the City Hall eastbound stop or the Cornwall Plaza westbound stop), bus stops were elongated to accommodate for up to 4 buses to dwell simultaneously. In the case for Cornwall Plaza westbound stop, the stop was split into nearside and farside stops – each with capacity for 3 buses to dwell simultaneously – and the bus lines that use the stop were assigned to either one of the stops according to the information from TransitLive.

3.2 Transit Level of Service

Buses travelling in mixed traffic experience the same level of service as the vehicles.

Select segments were modelled as bus-only routes in the model. This was accomplished either by placing restrictions the outside lane of a 2-lane link for vehicles, or modelling the road as two separate 1-lane links.

Exhibit 3-4: Transit Movements Level of Service

East-West Street	North-South Street	Movement	Average Delay (s)	LOS
11th Avenue	Albert Street	NBT	16	B
		NBR	16	B
		SBT	10	A
	Mcintyre Street	EBT	5	A
	Smith Street	EBT	24	C
		WBL	13	B
	Lorne Street	EBT	7	A
		WBT	32	C
	Cornwall Street	EBT	12	B
		WBT	36	D
	Scarth Street	EBT	25	C
		WBT	29	C
	Hamilton Street	EBT	12	B
		EBR	8	A
		WBT	26	C
	Rose Street	EBT	22	C
		WBT	24	C
	Broad Street	EBL	83	F
		EBR	16	B
		SBR	22	C
12th Avenue	Albert Street	WBR	20	B
		NBR	14	B
		SBL	33	C
	Mcintyre Street	EBT	2	A
		WBT	6	A
	Smith Street	EBT	16	B
		SBR	17	B
	Lorne Street	EBL	20	B
	Broad Street	WBR	32	C
		NBT	15	B
		SBT	14	B

The delays on transit-only movements are similar to those of mixed traffic. Generally, with delays less than 30 seconds, buses are usually able to proceed through the intersection within one signal cycle.

3.3 Transit Travel Times

In Exhibit 2-12, the travel time measurement segments for buses start at the downstream end of a bus stop and end at the upstream end of a bus stop. This ensures that dwell times at bus stops have no effect on the travel times. Unlike regular traffic, bus travel times are measured from stop to

stop, and total travel time between selected points is calculated by the sum of appropriate stop-to-stop times.

Exhibit 3-5: Bus Route Westbound, from 11th Avenue & Broad Street to City Hall
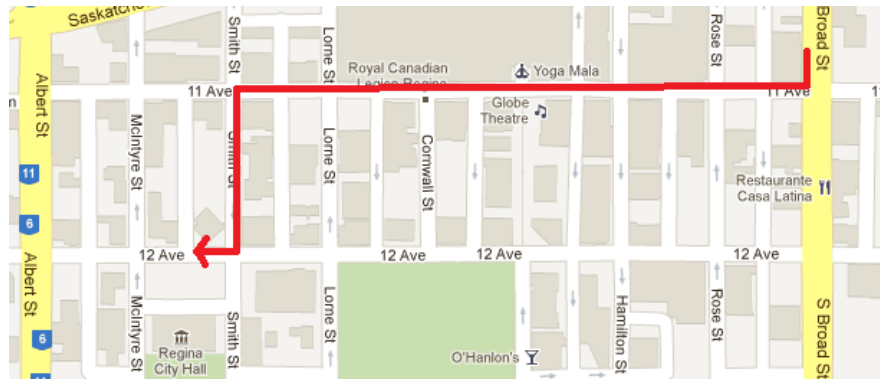
Total travel time: 251 seconds (4.2 minutes) if using Stop 0180 (nearside) at Cornwall Street
Total travel time: 283 seconds (4.7 minutes) if using Stop 0115 (farside) at Cornwall Street

Exhibit 3-6: Bus Route Eastbound, from City Hall to 11th Avenue & Broad Street
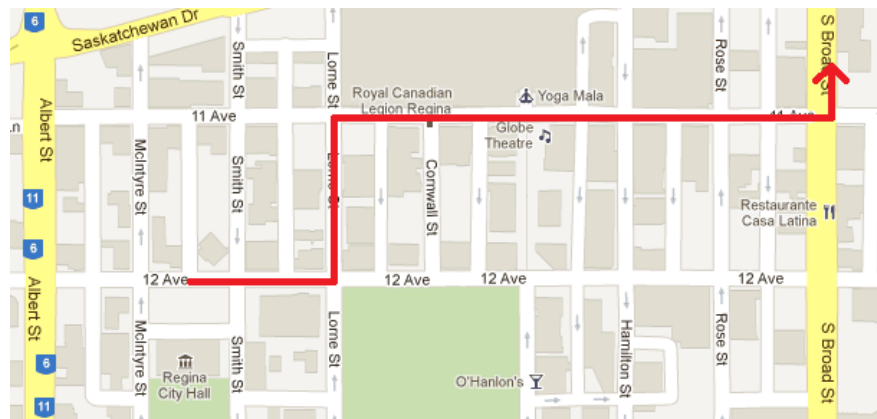
Total travel time: 273 seconds (4.6 minutes)

Exhibit 3-7: Bus Route, Loop, from and to 11th Avenue & Broad Street
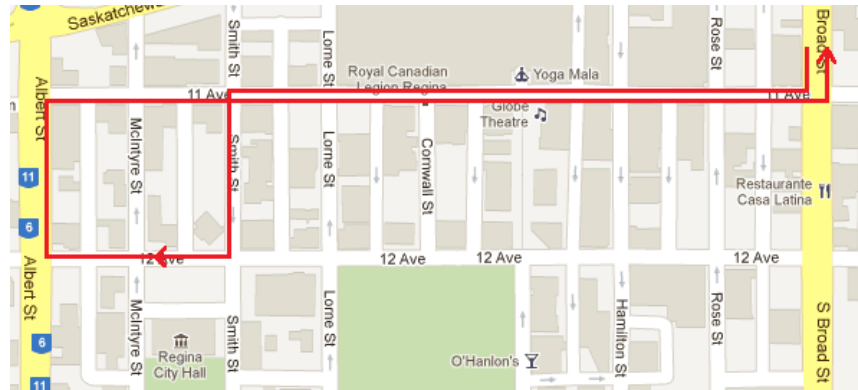
Total travel time: 560 seconds (9.3 minutes), if using Stop 0180 (nearside) at Cornwall Street
Total travel time: 592 seconds (9.9 minutes), if using Stop 0115 (farside) at Cornwall Street

Bus travel times are somewhat longer than auto travel times, despite having the advantage of the bus-only lanes on most of 11th Avenue between Albert Street and Broad Street. Routes that require the bus to take an eastbound left turn at 11th Avenue and Broad Street incur large travel times due to the fact that the particular movement suffers a LOS E (80s delay).

The intended vehicle disruptions at 11th Avenue and Scarth Street, as well as several patches of illegal roadside parking, all contribute to slower travel times for buses.

Additionally, due to the bus schedules, bus arrivals tend to be in large clumps, rather than spread out evenly throughout the simulation hour. It is possible that buses arrive in large packs consisting of 4 buses or more, which would cause queues at smaller bus stops.

4. PEDESTRIAN AND CYCLIST OPERATIONS

4.1 Pedestrians

Pedestrian crossings were implemented on every leg of all signalized intersections. Pedestrian crossings were also implemented at the two unsignalized intersections on McIntyre Street, but not for the parkade entrances.

As mentioned in section 1.4.4, at available locations, pedestrians volumes were based on counts.

Where counts were not available, pedestrian volumes were estimated at 60 pedestrians per hour for each leg for the following intersections:

- 11th Avenue at Hamilton Street, Lorne Street, Mcintyre Street, and Smith Street, and

- 12th Avenue at Hamilton Street, Lorne Street, Mcintyre Street, Rose Street, and Scarth Street.

The three pedestrian crossings on 12th Avenue at City Square Plaza (not at an intersection) were estimated to be 100 pedestrians per hour in each direction for each crossing. Thus, the total number of pedestrian crossings on 12th Avenue at City Square Plaza left of Cornwall Street is 200, and to the right of Cornwall Street is 400. Additionally, at 12th Avenue and Cornwall Street, there are 100 pedestrians per hour per direction for each intersection leg, for a total of 600 at the intersection

itself. In total, within the City Square Plaza area, there are 1200 pedestrian movements. With no actual counts available, the pedestrian volumes were intentionally over-estimated at these locations to simulate a scenario with large number of potential pedestrian-vehicle conflicts.

As mentioned in section 2.4.1, all visual problems were fixed, and the final calibrated model was observed to have pedestrians always prioritized over vehicles in the 12th Avenue and City Square Plaza stretch.

4.2 Cyclists

Cycling on-road was not modelled in VISSIM. Generally on-street cycling is limited on 11th Avenue and 12th Avenue which are the focus on the Phase 1 study. Isolated network tests were done on a stand-alone replica of the 12th Avenue at City Square Plaza. Bike lanes parallel to the 12th Avenue traffic made no impact on the adjacent traffic. Bike path crossings across 12th Avenue achieved essentially the same effect as the pedestrian crossings; when necessary, traffic came to a stop at a safe distance to allow cyclists across. Since the model only incorporates a finite number of crossing paths across 12th Avenue at City Square Plaza, and because it was possible to include cyclists in the same paths as pedestrians, explicit cycle paths were not modelled.

All pedestrian movements across the network consist of 94% pedestrian and 6% bicycle composition, a ratio based on the received City of Regina counts.

4.3 Operations and Conflicts

No significant problem was observed in all modelled pedestrian crossings. Although total pedestrian volumes were not measured in the model, all observed pedestrians and cyclists cleared the crossings within the appropriate walk and flash-don't-walk phases.

Due to pedestrians being given the highest priority within their green phase, no pedestrian delays or problems were observed during the simulation. Vehicles making permitted right turns yielded to pedestrians, and vehicles looking to make permitted left turns waited until sufficient space was cleared in the pedestrian link before making the turn. From the opposing perspective, high pedestrian volumes did not allow the cars to make the left turn despite having no opposite direction through-movement vehicle traffic.

5.   CONCLUSIONS

Regina Downtown Transportation Study Phase 1 Base Model features 12th Avenue closed between Lorne Street and Scarth Street, and is set in the PM peak hour. Network configurations, traffic volumes, signal timings, transit routes, and other relevant information were received and used to construct the base VISSIM model. Specific effort in model development focused on the following areas:

- Traffic volumes – base model volumes are based on 2011 turning movement counts where provided and 2011 approach volumes to fill any gaps. Traffic volumes were adjusted for balancing. Vehicle routing was coded in VISSIM based on traffic counts and on routing information derived from the City's regional EMME model. Following the route coding, a series of re-adjustments were made to volumes to meet logic checks and for balancing.

- Parking – although many VISSIM models ignore on-street parking, particularly where it has no effect on traffic operations, in downtown Regina it was in a few select locations in the

model. The locations were chosen where on-street parking interferes with intersection operations, and not coding the parking would under-represent congestion in the network. Locations coded include Broad Street near 11th Avenue, 11th Avenue, at select locations such as at Cornwall Street (to model transit lane violators or pick-up and drop-off activity), along 12th Avenue east of Albert Street, and on some north-south links west of 12th Avenue in the model. Overall, the coding resulted in better observational calibration at those problem locations in the model. Parking lots were also modelled in select locations, mainly for the purposes of balancing traffic volumes.

- Transit vehicle behaviour – transit vehicle behaviour was modelled as accurately as possible using available route and schedule data, stop data, and field observations. At bus stops within the study area, dwell times were coded to approximate observed dwell times. This task resulted in buses on 11th Avenue with behaviour similar to observed conditions. Transit routes and schedule times were also coded to the extent possible, and adjustments were made to lane choice and other transit behaviours to best match observed conditions.

The result of the model development was a calibrated model with all traffic volumes within 10% of target volumes and the vast majority within 5%.

The model was used to extract intersection operations and transit service levels. Both cars and buses experienced LOS A to LOS C throughout the network, with a few movements performing poorly at LOS D or LOS E. Auto travel times were found to be about 4 minutes from east end to the west end of the model boundary, and bus travel times were found to be slightly longer due to traffic disruptions. Observing the VISSIM animation, congestion along 11th Avenue westbound at Broad Street, Hamilton Street, and Cornwall Street is close to actual conditions. Several movements could benefit from reconfiguration of existing lanes, and addition of protected left turn phases where appropriate.

APPENDIX A-1

EMME OUTPUT

PM Base Closed - Volumes

PM Base Closed – Select Link Analysis on Traffic Exiting Cornwall Parkade

APPENDIX A-2

SYNCHRO OUTPUT

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↩			↟	↱		↫↦				
Volume (veh/h)	9	125	0	0	345	175	25	191	95	0	0	0
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	10	136	0	0	375	190	27	208	103	0	0	0
Pedestrians												
Lane Width (m)												
Walking Speed (m/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (m)		99			108							
pX, platoon unblocked												
vC, conflicting volume	565			136			530	721	136	738	530	375
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	565			136			530	721	136	738	530	375
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	99			100			94	40	89	100	100	100
cM capacity (veh/h)	1002			1442			454	349	910	154	448	669

Direction, Lane #	EB 1	WB 1	WB 2	NB 1	NB 2
Volume Total	146	375	190	131	207
Volume Left	10	0	0	27	0
Volume Right	0	0	190	0	103
cSH	1002	1700	1700	367	504
Volume to Capacity	0.01	0.22	0.11	0.36	0.41
Queue Length 95th (m)	0.2	0.0	0.0	12.7	15.9
Control Delay (s)	0.7	0.0	0.0	20.2	17.0
Lane LOS	A			C	C
Approach Delay (s)	0.7	0.0		18.3	
Approach LOS				C	

Intersection Summary				
Average Delay		6.0		
Intersection Capacity Utilization		41.6%	ICU Level of Service	A
Analysis Period (min)		15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↲			↑	↱		↲↳				
Volume (veh/h)	75	305	0	0	233	45	104	171	85	0	0	0
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	82	332	0	0	253	49	113	186	92	0	0	0
Pedestrians												
Lane Width (m)												
Walking Speed (m/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (m)		98			111							
pX, platoon unblocked				0.99			0.99	0.99	0.99	0.99	0.99	
vC, conflicting volume	302			332			748	797	332	933	748	253
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	302			322			742	791	322	929	742	253
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	93			100			64	38	87	100	100	100
cM capacity (veh/h)	1253			1222			312	298	711	102	318	783

Direction, Lane #	EB 1	WB 1	WB 2	NB 1	NB 2
Volume Total	413	253	49	206	185
Volume Left	82	0	0	113	0
Volume Right	0	0	49	0	92
cSH	1253	1700	1700	305	419
Volume to Capacity	0.07	0.15	0.03	0.68	0.44
Queue Length 95th (m)	1.7	0.0	0.0	36.5	17.7
Control Delay (s)	2.1	0.0	0.0	38.2	20.2
Lane LOS	A			E	C
Approach Delay (s)	2.1	0.0		29.7	
Approach LOS				D	

Intersection Summary				
Average Delay		11.3		
Intersection Capacity Utilization		60.4%	ICU Level of Service	B
Analysis Period (min)		15		

Lane Group	WBT	WBR	NBL	NBT	NBR	SBT	SBR
Lane Group Flow (vph)	171	210	28	1585	146	1134	25
v/c Ratio	0.50	0.52	0.14	1.04	0.21	0.57	0.03
Control Delay	51.3	24.0	18.3	49.9	6.1	12.1	2.7
Queue Delay	0.0	0.0	0.0	4.7	0.0	43.7	0.0
Total Delay	51.3	24.0	18.3	54.6	6.1	55.8	2.7
Queue Length 50th (m)	42.3	22.1	2.5	~211.5	3.9	76.4	0.0
Queue Length 95th (m)	m49.3	m30.1	m3.3	#238.7	m5.6	95.5	3.1
Internal Link Dist (m)	75.2			147.7		46.8	
Turn Bay Length (m)		25.0	20.0				
Base Capacity (vph)	462	493	194	1522	700	2007	806
Starvation Cap Reductn	0	0	0	18	0	962	0
Spillback Cap Reductn	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0
Reduced v/c Ratio	0.37	0.43	0.14	1.05	0.21	1.09	0.03

Intersection Summary

Description: Used projected 2009 counts. Used 2010 11th Ave counts

~   Volume exceeds capacity, queue is theoretically infinite.
    Queue shown is maximum after two cycles.
#   95th percentile volume exceeds capacity, queue may be longer.
    Queue shown is maximum after two cycles.
m   Volume for 95th percentile queue is metered by upstream signal.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations					↰	↱	↰	↑↑	↱		↑↑	↱
Volume (vph)	0	0	0	97	69	204	26	1458	134	0	1043	23
Ideal Flow (vphpl)	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
Lane Width	3.5	3.5	3.5	3.3	3.5	3.5	3.3	3.5	3.5	3.5	3.5	3.3
Total Lost time (s)					6.0	6.0	5.0	5.0	5.5		5.0	5.0
Lane Util. Factor					1.00	1.00	1.00	0.95	1.00		0.95	1.00
Frpb, ped/bikes					1.00	0.96	1.00	1.00	0.95		1.00	0.91
Flpb, ped/bikes					0.99	1.00	0.98	1.00	1.00		1.00	1.00
Frt					1.00	0.85	1.00	1.00	0.85		1.00	0.85
Flt Protected					0.97	1.00	0.95	1.00	1.00		1.00	1.00
Satd. Flow (prot)					1496	1269	1422	2955	1261		2955	1174
Flt Permitted					0.97	1.00	0.25	1.00	1.00		1.00	1.00
Satd. Flow (perm)					1496	1269	375	2955	1261		2955	1174
Peak-hour factor, PHF	0.92	0.92	0.92	0.97	0.97	0.97	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	0	0	0	100	71	210	28	1585	146	0	1134	25
RTOR Reduction (vph)	0	0	0	0	0	113	0	0	55	0	0	8
Lane Group Flow (vph)	0	0	0	0	171	97	28	1585	91	0	1134	17
Confl. Peds. (#/hr)	24		14	14		24	22		8	8		22
Turn Type				Perm		Perm	Perm		Perm			custom
Protected Phases					4			6			2 9	
Permitted Phases				4		4	6		6			2
Actuated Green, G (s)					27.0	27.0	62.3	62.3	62.3		82.0	82.0
Effective Green, g (s)					27.5	27.5	61.8	61.8	61.3		81.5	81.5
Actuated g/C Ratio					0.23	0.23	0.51	0.51	0.51		0.68	0.68
Clearance Time (s)					6.5	6.5	4.5	4.5	4.5			4.5
Vehicle Extension (s)					3.0	3.0	0.2	0.2	0.2			0.2
Lane Grp Cap (vph)					343	291	193	1522	644		2007	797
v/s Ratio Prot								c0.54			c0.38	
v/s Ratio Perm					0.11	0.08	0.07		0.07			0.01
v/c Ratio					0.50	0.33	0.15	1.04	0.14		0.57	0.02
Uniform Delay, d1					40.2	38.6	15.3	29.1	15.5		10.0	6.3
Progression Factor					1.22	1.68	0.98	0.66	1.11		1.00	1.00
Incremental Delay, d2					0.7	0.4	0.9	29.1	0.3		0.2	0.0
Delay (s)					49.8	65.1	15.9	48.3	17.5		10.2	6.3
Level of Service					D	E	B	D	B		B	A
Approach Delay (s)		0.0			58.2			45.2			10.2	
Approach LOS		A			E			D			B	

Intersection Summary			
HCM Average Control Delay	34.4	HCM Level of Service	C
HCM Volume to Capacity ratio	0.84		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	77.9%	ICU Level of Service	D
Analysis Period (min)	15		
Description: Used projected 2009 counts. Used 2010 11th Ave counts			

c   Critical Lane Group

Lane Group	EBT	EBR	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Group Flow (vph)	225	107	194	218	34	1364	167	185	1029	25
v/c Ratio	0.89	0.30	1.00	0.49	0.16	0.90	0.25	0.85	0.53	0.03
Control Delay	78.0	18.5	109.5	13.4	18.8	36.2	11.9	65.9	5.3	0.7
Queue Delay	0.0	0.0	0.0	0.0	0.0	8.3	0.0	0.0	0.1	0.0
Total Delay	78.0	18.5	109.5	13.4	18.8	44.5	11.9	65.9	5.4	0.7
Queue Length 50th (m)	53.9	8.0	~50.0	3.9	4.5	160.1	14.3	23.6	17.6	0.1
Queue Length 95th (m)	#102.0	24.1	#99.2	28.7	11.6	#214.0	28.8	#62.4	20.5	m0.2
Internal Link Dist (m)	184.3		74.6			161.0			147.7	
Turn Bay Length (m)		20.0		25.0	55.0		25.0	120.0		25.0
Base Capacity (vph)	253	352	194	444	212	1518	666	235	1945	769
Starvation Cap Reductn	0	0	0	0	0	141	0	0	142	0
Spillback Cap Reductn	0	0	0	2	0	41	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.89	0.30	1.00	0.49	0.16	0.99	0.25	0.79	0.57	0.03

Intersection Summary

Description: Used projected 2009 counts

~   Volume exceeds capacity, queue is theoretically infinite.
    Queue shown is maximum after two cycles.
95th percentile volume exceeds capacity, queue may be longer.
    Queue shown is maximum after two cycles.
m   Volume for 95th percentile queue is metered by upstream signal.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	102	105	98	105	74	201	31	1255	154	170	947	23
Ideal Flow (vphpl)	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
Lane Width	3.3	3.5	3.3	3.5	3.5	3.5	3.3	3.5	3.5	3.3	3.5	3.5
Total Lost time (s)		5.0	6.5		6.5	6.5	5.0	5.0	5.0	5.0	5.0	5.0
Lane Util. Factor		1.00	1.00		1.00	1.00	1.00	0.95	1.00	1.00	0.95	1.00
Frpb, ped/bikes		1.00	0.95		1.00	0.94	1.00	1.00	0.94	1.00	1.00	0.88
Flpb, ped/bikes		0.98	1.00		0.99	1.00	0.98	1.00	1.00	1.00	1.00	1.00
Frt		1.00	0.85		1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected		0.98	1.00		0.97	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)		1492	1230		1490	1242	1408	2955	1242	1444	2955	1160
Flt Permitted		0.64	1.00		0.51	1.00	0.28	1.00	1.00	0.08	1.00	1.00
Satd. Flow (perm)		978	1230		789	1242	413	2955	1242	122	2955	1160
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	111	114	107	114	80	218	34	1364	167	185	1029	25
RTOR Reduction (vph)	0	0	50	0	0	139	0	0	28	0	0	6
Lane Group Flow (vph)	0	225	57	0	194	79	34	1364	139	185	1029	19
Confl. Peds. (#/hr)	37		28	28		37	40		16	16		40
Turn Type	Perm		Perm	Perm		Perm	Perm		Perm	pm+pt		Perm
Protected Phases		8			4			6		5	2	
Permitted Phases	8		8	4		4	6		6	2		2
Actuated Green, G (s)		30.5	30.5		30.5	30.5	62.1	62.1	62.1	79.5	79.5	79.5
Effective Green, g (s)		31.0	29.5		29.5	29.5	61.6	61.6	61.6	77.5	79.0	79.0
Actuated g/C Ratio		0.26	0.25		0.25	0.25	0.51	0.51	0.51	0.65	0.66	0.66
Clearance Time (s)		5.5	5.5		5.5	5.5	4.5	4.5	4.5	3.0	4.5	4.5
Vehicle Extension (s)		3.0	3.0		3.0	3.0	0.2	0.2	0.2	4.0	0.2	0.2
Lane Grp Cap (vph)		253	302		194	305	212	1517	638	215	1945	764
v/s Ratio Prot								c0.46		c0.09	0.35	
v/s Ratio Perm		0.23	0.05		c0.25	0.06	0.08		0.11	0.46		0.02
v/c Ratio		0.89	0.19		1.00	0.26	0.16	0.90	0.22	0.86	0.53	0.03
Uniform Delay, d1		42.8	35.8		45.2	36.5	15.5	26.4	16.0	30.8	10.7	7.1
Progression Factor		1.00	1.00		0.98	1.11	1.00	1.00	1.00	1.56	0.40	0.17
Incremental Delay, d2		29.1	0.3		64.0	0.4	1.6	8.9	0.8	25.1	0.9	0.1
Delay (s)		72.0	36.1		108.4	40.9	17.1	35.2	16.8	73.1	5.2	1.3
Level of Service		E	D		F	D	B	D	B	E	A	A
Approach Delay (s)	60.4			72.7			32.9			15.3		
Approach LOS	E			E			C			B		

Intersection Summary

HCM Average Control Delay	33.9	HCM Level of Service	C
HCM Volume to Capacity ratio	0.92		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	16.5
Intersection Capacity Utilization	94.4%	ICU Level of Service	F
Analysis Period (min)	15		
Description: Used projected 2009 counts			

c   Critical Lane Group

Lane Group	EBT	EBR	WBT	WBR	NBL	NBT	NBR	SBL	SBT
Lane Group Flow (vph)	227	210	175	175	151	1512	67	117	1263
v/c Ratio	0.97	0.58	0.80	0.45	0.67	0.88	0.12	0.69	0.81
Control Delay	93.6	28.3	68.8	13.1	31.1	26.9	14.9	37.1	27.1
Queue Delay	0.0	0.3	0.0	0.0	0.0	0.5	0.0	0.0	1.3
Total Delay	93.6	28.6	68.8	13.1	31.1	27.5	14.9	37.1	28.4
Queue Length 50th (m)	56.2	23.1	40.5	5.1	20.1	99.4	5.7	9.2	127.4
Queue Length 95th (m)	m#99.0	m44.2	#78.0	25.9	m35.3	#156.8	m12.1	#34.7	171.0
Internal Link Dist (m)	82.7		773.1			152.7			168.0
Turn Bay Length (m)		20.0		45.0	75.0		10.0	65.0	
Base Capacity (vph)	244	373	228	394	255	1721	560	180	1563
Starvation Cap Reductn	0	17	0	0	0	39	0	0	134
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.93	0.59	0.77	0.44	0.59	0.90	0.12	0.65	0.88

Intersection Summary

Description: Actual Counts from Sept 2011 miovision

\#   95th percentile volume exceeds capacity, queue may be longer.

      Queue shown is maximum after two cycles.

m   Volume for 95th percentile queue is metered by upstream signal.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↵	↱		↵	↱	↰	↑↑	↱	↰	↑↱	
Volume (vph)	71	138	193	68	93	161	139	1391	62	108	1024	138
Ideal Flow (vphpl)	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
Lane Width	3.5	3.5	3.5	3.5	3.5	3.5	3.3	3.5	3.5	3.3	3.5	3.5
Total Lost time (s)		7.0	7.0		5.5	7.0	5.0	5.0	5.0	3.5	5.0	
Lane Util. Factor		1.00	1.00		1.00	1.00	1.00	0.95	1.00	1.00	0.95	
Frpb, ped/bikes		1.00	0.89		1.00	0.91	1.00	1.00	0.72	1.00	0.96	
Flpb, ped/bikes		0.98	1.00		0.97	1.00	1.00	1.00	1.00	1.00	1.00	
Frt		1.00	0.85		1.00	0.85	1.00	1.00	0.85	1.00	0.98	
Flt Protected		0.98	1.00		0.98	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)		1498	1182		1484	1199	1444	2955	952	1444	2799	
Flt Permitted		0.69	1.00		0.61	1.00	0.13	1.00	1.00	0.09	1.00	
Satd. Flow (perm)		1046	1182		926	1199	191	2955	952	137	2799	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	77	150	210	74	101	175	151	1512	67	117	1113	150
RTOR Reduction (vph)	0	0	98	0	0	115	0	0	5	0	8	0
Lane Group Flow (vph)	0	227	112	0	175	60	151	1512	62	117	1255	0
Confl. Peds. (#/hr)	60		69	69		60	91		84	84		91
Turn Type	Perm		Perm	Perm		Perm	pm+pt		Perm	pm+pt		
Protected Phases		8			4		1	6		5	2	
Permitted Phases	8		8	4		4	6		6	2		
Actuated Green, G (s)		28.0	28.0		28.0	28.0	81.5	70.4	70.4	75.3	67.2	
Effective Green, g (s)		27.0	27.0		28.5	27.0	77.7	69.9	69.9	74.3	66.7	
Actuated g/C Ratio		0.22	0.22		0.24	0.22	0.65	0.58	0.58	0.62	0.56	
Clearance Time (s)		6.0	6.0		6.0	6.0	3.0	4.5	4.5	3.0	4.5	
Vehicle Extension (s)		3.0	3.0		3.0	3.0	4.0	0.2	0.2	2.0	0.2	
Lane Grp Cap (vph)		235	266		220	270	221	1721	555	168	1556	
v/s Ratio Prot							c0.05	c0.51		0.04	0.45	
v/s Ratio Perm		c0.22	0.09		0.19	0.05	0.39		0.06	0.39		
v/c Ratio		0.97	0.42		0.80	0.22	0.68	0.88	0.11	0.70	0.81	
Uniform Delay, d1		46.0	39.8		43.0	37.9	14.9	21.4	11.2	17.0	21.5	
Progression Factor		1.17	1.42		1.00	1.00	2.00	0.98	1.47	1.00	1.00	
Incremental Delay, d2		39.0	0.7		17.8	0.4	6.3	4.7	0.3	9.7	4.6	
Delay (s)		92.7	57.3		60.8	38.3	36.1	25.8	16.7	26.7	26.0	
Level of Service		F	E		E	D	D	C	B	C	C	
Approach Delay (s)		75.7			49.6			26.3			26.1	
Approach LOS		E			D			C			C	

Intersection Summary				
HCM Average Control Delay	33.9	HCM Level of Service		C
HCM Volume to Capacity ratio	0.91			
Actuated Cycle Length (s)	120.0	Sum of lost time (s)		17.0
Intersection Capacity Utilization	111.3%	ICU Level of Service		H
Analysis Period (min)	15			
Description: Actual Counts from Sept 2011 miovision				

c   Critical Lane Group

Lane Group	EBT	WBT	NBL	NBT	NBR	SBL	SBT
Lane Group Flow (vph)	467	216	54	1340	75	102	1220
v/c Ratio	0.80	0.44	0.30	0.83	0.12	0.56	0.44
Control Delay	43.9	19.2	24.5	30.0	6.2	25.1	4.6
Queue Delay	0.4	0.1	0.0	5.1	0.0	0.0	0.0
Total Delay	44.3	19.3	24.5	35.1	6.2	25.1	4.6
Queue Length 50th (m)	51.1	10.9	6.8	134.8	1.5	3.5	14.7
Queue Length 95th (m)	69.2	21.0	21.1	#224.1	10.8	m10.4	21.2
Internal Link Dist (m)	83.4	772.0		158.3			152.7
Turn Bay Length (m)			25.0		75.0	55.0	
Base Capacity (vph)	730	597	181	1614	650	205	2759
Starvation Cap Reductn	22	0	0	218	0	0	0
Spillback Cap Reductn	44	33	0	16	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0
Reduced v/c Ratio	0.68	0.38	0.30	0.96	0.12	0.50	0.44

Intersection Summary

Description: Used munual counts from Nov 01, 2011

\#   95th percentile volume exceeds capacity, queue may be longer.

     Queue shown is maximum after two cycles.

m   Volume for 95th percentile queue is metered by upstream signal.
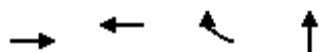
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		⬅⬆			⬅⬆		↱	↑↑	↗	↱	↑↑↳	
Volume (vph)	153	192	117	63	39	112	53	1327	74	101	1173	35
Ideal Flow (vphpl)	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
Lane Width	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.3	3.5	3.5
Total Lost time (s)		5.0			6.5		5.5	5.0	5.0	5.5	5.0	
Lane Util. Factor		0.95			0.95		1.00	0.95	1.00	1.00	0.91	
Frpb, ped/bikes		0.97			0.98		1.00	1.00	0.86	1.00	1.00	
Flpb, ped/bikes		0.99			0.99		0.98	1.00	1.00	1.00	1.00	
Frt		0.96			0.92		1.00	1.00	0.85	1.00	1.00	
Flt Protected		0.98			0.99		0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)		2700			2588		1453	2955	1140	1444	4215	
Flt Permitted		0.77			0.62		0.22	1.00	1.00	0.10	1.00	
Satd. Flow (perm)		2108			1624		333	2955	1140	155	4215	
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	155	194	118	64	39	113	54	1340	75	102	1185	35
RTOR Reduction (vph)	0	30	0	0	85	0	0	0	28	0	2	0
Lane Group Flow (vph)	0	437	0	0	131	0	54	1340	47	102	1218	0
Confl. Peds. (#/hr)	28		79	79		28	27		64	64		27
Turn Type	Perm			Perm			Perm		Perm	pm+pt		
Protected Phases		8			4			6		5	2	
Permitted Phases	8			4			6		6	2		
Actuated Green, G (s)		31.0			31.0		66.1	66.1	66.1	79.0	79.0	
Effective Green, g (s)		31.5			30.0		65.1	65.6	65.6	78.5	78.5	
Actuated g/C Ratio		0.26			0.25		0.54	0.55	0.55	0.65	0.65	
Clearance Time (s)		5.5			5.5		4.5	4.5	4.5	5.0	4.5	
Vehicle Extension (s)		3.0			3.0		0.2	0.2	0.2	2.0	0.2	
Lane Grp Cap (vph)		553			406		181	1615	623	181	2757	
v/s Ratio Prot								c0.45		0.03	c0.29	
v/s Ratio Perm		c0.21			0.08		0.16		0.04	0.33		
v/c Ratio		0.79			0.32		0.30	0.83	0.08	0.56	0.44	
Uniform Delay, d1		41.2			36.7		15.0	22.6	12.9	15.6	10.1	
Progression Factor		0.95			1.00		1.00	1.00	1.00	1.61	0.40	
Incremental Delay, d2		5.9			0.5		4.2	5.1	0.2	1.5	0.3	
Delay (s)		45.1			37.2		19.2	27.7	13.1	26.5	4.3	
Level of Service		D			D		B	C	B	C	A	
Approach Delay (s)		45.1			37.2			26.6			6.0	
Approach LOS		D			D			C			A	

Intersection Summary				
HCM Average Control Delay	21.9	HCM Level of Service		C
HCM Volume to Capacity ratio	0.80			
Actuated Cycle Length (s)	120.0	Sum of lost time (s)		15.0
Intersection Capacity Utilization	112.4%	ICU Level of Service		H
Analysis Period (min)	15			
Description: Used munual counts from Nov 01, 2011				

c   Critical Lane Group

Lane Group	EBT	WBT	WBR	NBT
Lane Group Flow (vph)	241	538	240	682
v/c Ratio	0.47	0.82	0.42	0.75
Control Delay	10.7	23.0	9.7	23.1
Queue Delay	0.0	2.0	0.0	0.0
Total Delay	10.7	25.0	9.7	23.1
Queue Length 50th (m)	12.4	44.4	10.7	35.2
Queue Length 95th (m)	17.4	m49.7	m12.1	#54.6
Internal Link Dist (m)	81.0	77.3		151.0
Turn Bay Length (m)			7.5	
Base Capacity (vph)	509	659	568	910
Starvation Cap Reductn	0	43	0	0
Spillback Cap Reductn	0	0	0	0
Storage Cap Reductn	0	0	0	0
Reduced v/c Ratio	0.47	0.87	0.42	0.75

Intersection Summary

Description: Manual count Nov. 16, 2011

\#   95th percentile volume exceeds capacity, queue may be longer.

Queue shown is maximum after two cycles.

m   Volume for 95th percentile queue is metered by upstream signal.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↰			↑	↱		↰↱				
Volume (vph)	46	193	0	0	533	238	87	387	201	0	0	0
Ideal Flow (vphpl)	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
Lane Width	3.5	3.5	3.5	3.3	3.3	3.3	3.3	3.3	3.5	3.5	3.5	3.5
Total Lost time (s)		6.5			6.0	6.0		6.0				
Lane Util. Factor		1.00			1.00	1.00		0.95				
Frpb, ped/bikes		1.00			1.00	0.92		0.96				
Flpb, ped/bikes		1.00			1.00	1.00		0.99				
Frt		1.00			1.00	0.85		0.96				
Flt Protected		0.99			1.00	1.00		0.99				
Satd. Flow (prot)		1534			1520	1191		2481				
Flt Permitted		0.77			1.00	1.00		0.99				
Satd. Flow (perm)		1199			1520	1191		2481				
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	46	195	0	0	538	240	88	391	203	0	0	0
RTOR Reduction (vph)	0	0	0	0	0	52	0	0	0	0	0	0
Lane Group Flow (vph)	0	241	0	0	538	188	0	682	0	0	0	0
Confl. Peds. (#/hr)	60		60	60		60	60		60	60		60
Parking (#/hr)							0	0	0			
Turn Type	Perm					Perm	Perm					
Protected Phases		8			4			6				
Permitted Phases	8					4	6					
Actuated Green, G (s)		26.5			26.5	26.5		22.5				
Effective Green, g (s)		25.5			26.0	26.0		22.0				
Actuated g/C Ratio		0.42			0.43	0.43		0.37				
Clearance Time (s)		5.5			5.5	5.5		5.5				
Lane Grp Cap (vph)		510			659	516		910				
v/s Ratio Prot					c0.35							
v/s Ratio Perm		0.20				0.16		0.27				
v/c Ratio		0.47			0.82	0.36		0.75				
Uniform Delay, d1		12.4			14.9	11.4		16.6				
Progression Factor		0.60			1.00	1.13		1.00				
Incremental Delay, d2		3.0			6.0	1.1		5.6				
Delay (s)		10.5			20.9	14.0		22.2				
Level of Service		B			C	B		C				
Approach Delay (s)		10.5			18.7			22.2			0.0	
Approach LOS		B			B			C			A	

Intersection Summary				
HCM Average Control Delay	19.0	HCM Level of Service	B	
HCM Volume to Capacity ratio	0.79			
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	12.0	
Intersection Capacity Utilization	90.9%	ICU Level of Service	E	
Analysis Period (min)	15			
Description: Manual count Nov. 16, 2011				

c Critical Lane Group

Lane Group	EBT →	EBR ↘	WBT ←	NBL ↖
Lane Group Flow (vph)	364	42	629	325
v/c Ratio	0.48	0.06	0.85	0.78
Control Delay	9.8	6.2	14.7	33.7
Queue Delay	0.4	0.0	0.0	0.0
Total Delay	10.2	6.2	14.7	33.7
Queue Length 50th (m)	25.5	2.6	18.7	33.1
Queue Length 95th (m)	37.9	m4.0	m26.3	#72.4
Internal Link Dist (m)	77.3		79.7	59.8
Turn Bay Length (m)		7.5		
Base Capacity (vph)	765	650	742	419
Starvation Cap Reductn	107	0	0	0
Spillback Cap Reductn	6	0	0	0
Storage Cap Reductn	0	0	0	0
Reduced v/c Ratio	0.55	0.06	0.85	0.78

Intersection Summary

Description: Used 2010 11th Ave counts

\#   95th percentile volume exceeds capacity, queue may be longer.

   Queue shown is maximum after two cycles.

m   Volume for 95th percentile queue is metered by upstream signal.

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↑	↱		↰	Ⓨ	
Volume (vph)	353	41	27	583	188	127
Ideal Flow (vphpl)	1800	1800	1800	1800	1800	1800
Lane Width	3.5	3.5	3.3	3.3	3.3	3.5
Total Lost time (s)	5.5	5.5		5.0	5.0	
Lane Util. Factor	1.00	1.00		1.00	1.00	
Frt	1.00	0.85		1.00	0.95	
Flt Protected	1.00	1.00		1.00	0.97	
Satd. Flow (prot)	1555	1322		1517	1256	
Flt Permitted	1.00	1.00		0.98	0.97	
Satd. Flow (perm)	1555	1322		1483	1256	
Peak-hour factor, PHF	0.97	0.97	0.97	0.97	0.97	0.97
Adj. Flow (vph)	364	42	28	601	194	131
RTOR Reduction (vph)	0	0	0	0	0	0
Lane Group Flow (vph)	364	42	0	629	325	0
Parking (#/hr)					0	0
Turn Type		Perm	Perm			
Protected Phases	8			4	6	
Permitted Phases		8	4			
Actuated Green, G (s)	30.5	30.5		30.5	20.5	
Effective Green, g (s)	29.5	29.5		30.0	20.0	
Actuated g/C Ratio	0.49	0.49		0.50	0.33	
Clearance Time (s)	4.5	4.5		4.5	4.5	
Lane Grp Cap (vph)	765	650		742	419	
v/s Ratio Prot	0.23				c0.26	
v/s Ratio Perm		0.03		c0.42		
v/c Ratio	0.48	0.06		0.85	0.78	
Uniform Delay, d1	10.1	8.0		13.0	18.0	
Progression Factor	0.78	0.74		0.62	1.00	
Incremental Delay, d2	1.7	0.2		5.5	13.1	
Delay (s)	9.6	6.1		13.5	31.1	
Level of Service	A	A		B	C	
Approach Delay (s)	9.3			13.5	31.1	
Approach LOS	A			B	C	

Intersection Summary			
HCM Average Control Delay	16.5	HCM Level of Service	B
HCM Volume to Capacity ratio	0.82		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	91.4%	ICU Level of Service	F
Analysis Period (min)	15		

Description: Used 2010 11th Ave counts

c   Critical Lane Group

→   ←

Lane Group	EBT	WBT
Lane Group Flow (vph)	495	629
v/c Ratio	0.62	0.89
Control Delay	12.4	22.4
Queue Delay	0.2	6.1
Total Delay	12.6	28.5
Queue Length 50th (m)	30.4	44.3
Queue Length 95th (m)	38.4	m48.3
Internal Link Dist (m)	79.7	79.0
Turn Bay Length (m)		
Base Capacity (vph)	792	709
Starvation Cap Reductn	39	52
Spillback Cap Reductn	0	0
Storage Cap Reductn	0	0
Reduced v/c Ratio	0.66	0.96

Intersection Summary

Description: Used 2010 11th Ave counts

m   Volume for 95th percentile queue is metered by upstream signal.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↑			↑							
Volume (vph)	0	480	0	0	610	0	0	0	0	0	0	0
Ideal Flow (vphpl)	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
Lane Width	3.5	3.5	3.5	3.5	3.3	3.5	3.5	3.5	3.5	3.5	3.5	3.5
Total Lost time (s)		5.5			5.0							
Lane Util. Factor		1.00			1.00							
Frpb, ped/bikes		1.00			1.00							
Flpb, ped/bikes		1.00			1.00							
Frt		1.00			1.00							
Flt Protected		1.00			1.00							
Satd. Flow (prot)		1728			1520							
Flt Permitted		1.00			1.00							
Satd. Flow (perm)		1728			1520							
Peak-hour factor, PHF	0.92	0.97	0.97	0.97	0.97	0.92	0.97	0.92	0.97	0.92	0.92	0.92
Adj. Flow (vph)	0	495	0	0	629	0	0	0	0	0	0	0
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	0	495	0	0	629	0	0	0	0	0	0	0
Confl. Peds. (#/hr)							228		228			
Parking (#/hr)					0							
Turn Type												
Protected Phases		8			4							
Permitted Phases												
Actuated Green, G (s)		28.5			28.5							
Effective Green, g (s)		27.5			28.0							
Actuated g/C Ratio		0.46			0.47							
Clearance Time (s)		4.5			4.5							
Lane Grp Cap (vph)		792			709							
v/s Ratio Prot		0.29			c0.41							
v/s Ratio Perm												
v/c Ratio		0.62			0.89							
Uniform Delay, d1		12.3			14.6							
Progression Factor		0.73			0.79							
Incremental Delay, d2		3.1			9.3							
Delay (s)		12.2			20.8							
Level of Service		B			C							
Approach Delay (s)		12.2			20.8			0.0			0.0	
Approach LOS		B			C			A			A	

Intersection Summary				
HCM Average Control Delay	17.0	HCM Level of Service	B	
HCM Volume to Capacity ratio	0.89			
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	32.0	
Intersection Capacity Utilization	38.1%	ICU Level of Service	A	
Analysis Period (min)	15			
Description: Used 2010 11th Ave counts				
c Critical Lane Group				

Lane Group	EBT →	EBR ↘	WBT ←	SBT ↓
Lane Group Flow (vph)	317	168	515	632
v/c Ratio	0.46	0.29	0.93	0.60
Control Delay	8.4	7.8	32.8	17.8
Queue Delay	0.1	0.0	21.1	0.0
Total Delay	8.6	7.8	53.9	17.8
Queue Length 50th (m)	6.1	3.2	28.7	29.7
Queue Length 95th (m)	20.1	m11.0	#132.1	45.1
Internal Link Dist (m)	79.0		78.3	184.0
Turn Bay Length (m)		7.5		
Base Capacity (vph)	687	584	555	1052
Starvation Cap Reductn	40	0	0	0
Spillback Cap Reductn	0	0	56	0
Storage Cap Reductn	0	0	0	0
Reduced v/c Ratio	0.49	0.29	1.03	0.60

Intersection Summary

Description: Used 2011 manual counts from Oct 18

\#   95th percentile volume exceeds capacity, queue may be longer.

     Queue shown is maximum after two cycles.

m   Volume for 95th percentile queue is metered by upstream signal.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↑	↗		↰						↔↑	
Volume (vph)	0	314	166	77	433	0	0	0	0	97	351	177
Ideal Flow (vphpl)	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
Lane Width	3.5	3.5	3.5	3.3	3.3	3.3	3.5	3.5	3.5	3.3	3.3	3.3
Total Lost time (s)		5.5	5.5		5.0						5.0	
Lane Util. Factor		1.00	1.00		1.00						0.95	
Frt		1.00	0.85		1.00						0.96	
Flt Protected		1.00	1.00		0.99						0.99	
Satd. Flow (prot)		1555	1322		1358						2745	
Flt Permitted		1.00	1.00		0.90						0.99	
Satd. Flow (perm)		1555	1322		1233						2745	
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	0	317	168	78	437	0	0	0	0	98	355	179
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	0	317	168	0	515	0	0	0	0	0	632	0
Parking (#/hr)				0	0	0						
Turn Type			Perm	Perm							Perm	
Protected Phases		8			4						2	
Permitted Phases			8	4						2		
Actuated Green, G (s)		27.5	27.5		27.5						23.5	
Effective Green, g (s)		26.5	26.5		27.0						23.0	
Actuated g/C Ratio		0.44	0.44		0.45						0.38	
Clearance Time (s)		4.5	4.5		4.5						4.5	
Lane Grp Cap (vph)		687	584		555						1052	
v/s Ratio Prot		0.20										
v/s Ratio Perm			0.13		c0.42						0.23	
v/c Ratio		0.46	0.29		0.93						0.60	
Uniform Delay, d1		11.7	10.7		15.6						14.8	
Progression Factor		0.55	0.61		0.64						1.00	
Incremental Delay, d2		1.7	1.0		20.1						2.5	
Delay (s)		8.2	7.5		30.1						17.4	
Level of Service		A	A		C						B	
Approach Delay (s)		7.9			30.1			0.0			17.4	
Approach LOS		A			C			A			B	

Intersection Summary				
HCM Average Control Delay	18.6	HCM Level of Service	B	
HCM Volume to Capacity ratio	0.78			
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	10.0	
Intersection Capacity Utilization	85.3%	ICU Level of Service	E	
Analysis Period (min)	15			
Description: Used 2011 manual counts from Oct 18				
c Critical Lane Group				

Lane Group	EBT	WBT	WBR	NBT
Lane Group Flow (vph)	424	399	74	609
v/c Ratio	0.73	0.60	0.14	0.68
Control Delay	20.8	17.3	6.3	24.1
Queue Delay	0.0	0.4	0.0	0.0
Total Delay	20.8	17.7	6.3	24.1
Queue Length 50th (m)	29.5	41.5	3.1	31.5
Queue Length 95th (m)	#61.7	m63.9	m4.9	43.8
Internal Link Dist (m)	78.3	82.7		152.4
Turn Bay Length (m)			10.0	
Base Capacity (vph)	582	661	547	893
Starvation Cap Reductn	0	48	0	0
Spillback Cap Reductn	0	13	0	0
Storage Cap Reductn	0	0	0	0
Reduced v/c Ratio	0.73	0.65	0.14	0.68

Intersection Summary

Description: Used 2010 11th Ave counts

\#   95th percentile volume exceeds capacity, queue may be longer.

Queue shown is maximum after two cycles.

m   Volume for 95th percentile queue is metered by upstream signal.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↰			↑	↱		↔↱				
Volume (vph)	68	343	0	0	387	72	123	375	92	0	0	0
Ideal Flow (vphpl)	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
Lane Width	3.5	3.5	3.5	3.3	3.3	3.3	3.3	3.3	3.3	3.5	3.5	3.5
Total Lost time (s)		5.5			5.0	5.0		5.0				
Lane Util. Factor		1.00			1.00	1.00		0.95				
Frpb, ped/bikes		1.00			1.00	0.93		0.98				
Flpb, ped/bikes		0.99			1.00	1.00		0.98				
Frt		1.00			1.00	0.85		0.98				
Flt Protected		0.99			1.00	1.00		0.99				
Satd. Flow (prot)		1381			1368	1081		2549				
Flt Permitted		0.88			1.00	1.00		0.99				
Satd. Flow (perm)		1226			1368	1081		2549				
Peak-hour factor, PHF	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Adj. Flow (vph)	70	354	0	0	399	74	127	387	95	0	0	0
RTOR Reduction (vph)	0	0	0	0	0	25	0	0	0	0	0	0
Lane Group Flow (vph)	0	424	0	0	399	49	0	609	0	0	0	0
Confl. Peds. (#/hr)	60					60	60		60			
Parking (#/hr)	0	0	0	0	0	0	0	0	0			
Turn Type	Perm					Perm	Perm					
Protected Phases		8			4			6				
Permitted Phases	8					4	6					
Actuated Green, G (s)		29.5			29.5	29.5		21.5				
Effective Green, g (s)		28.5			29.0	29.0		21.0				
Actuated g/C Ratio		0.48			0.48	0.48		0.35				
Clearance Time (s)		4.5			4.5	4.5		4.5				
Lane Grp Cap (vph)		582			661	522		892				
v/s Ratio Prot					0.29							
v/s Ratio Perm		c0.35				0.05		0.24				
v/c Ratio		0.73			0.60	0.09		0.68				
Uniform Delay, d1		12.6			11.3	8.4		16.7				
Progression Factor		0.96			1.20	1.57		1.23				
Incremental Delay, d2		7.0			3.2	0.3		3.4				
Delay (s)		19.1			16.8	13.4		23.9				
Level of Service		B			B	B		C				
Approach Delay (s)		19.1			16.3			23.9			0.0	
Approach LOS		B			B			C			A	

Intersection Summary

HCM Average Control Delay		20.1	HCM Level of Service		C
HCM Volume to Capacity ratio		0.71			
Actuated Cycle Length (s)		60.0	Sum of lost time (s)		10.5
Intersection Capacity Utilization		82.9%	ICU Level of Service		E
Analysis Period (min)		15			
Description: Used 2010 11th Ave counts					

c Critical Lane Group

Lane Group	EBT →	WBT ←	WBR ↖	NBT ↑
Lane Group Flow (vph)	322	123	62	704
v/c Ratio	0.54	0.17	0.11	0.69
Control Delay	12.2	8.1	7.8	16.0
Queue Delay	0.1	0.0	0.0	0.0
Total Delay	12.3	8.1	7.8	16.0
Queue Length 50th (m)	23.4	7.1	3.4	25.0
Queue Length 95th (m)	32.0	16.7	9.7	43.0
Internal Link Dist (m)	76.7	83.4		156.6
Turn Bay Length (m)			7.5	
Base Capacity (vph)	594	739	581	1016
Starvation Cap Reductn	23	0	0	0
Spillback Cap Reductn	0	0	0	0
Storage Cap Reductn	0	0	0	0
Reduced v/c Ratio	0.56	0.17	0.11	0.69

Intersection Summary

Description: used 2010 volumes

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↲			↑	↱		↲↑↳				
Volume (vph)	68	228	0	0	113	57	0	414	234	0	0	0
Ideal Flow (vphpl)	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
Lane Width	3.3	3.3	3.3	3.5	3.5	3.5	3.3	3.3	3.3	3.5	3.5	3.5
Total Lost time (s)		5.0			5.5	5.5		5.0				
Lane Util. Factor		1.00			1.00	1.00		0.95				
Frpb, ped/bikes		1.00			1.00	0.93		0.97				
Flpb, ped/bikes		0.99			1.00	1.00		1.00				
Frt		1.00			1.00	0.85		0.95				
Flt Protected		0.99			1.00	1.00		1.00				
Satd. Flow (prot)		1336			1555	1224		2529				
Flt Permitted		0.91			1.00	1.00		1.00				
Satd. Flow (perm)		1228			1555	1224		2529				
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	74	248	0	0	123	62	0	450	254	0	0	0
RTOR Reduction (vph)	0	0	0	0	0	0	0	130	0	0	0	0
Lane Group Flow (vph)	0	322	0	0	123	62	0	574	0	0	0	0
Confl. Peds. (#/hr)	60		60	60		60	60		60	60		60
Parking (#/hr)	0	0					0	0	0			
Turn Type	Perm					Perm	Perm					
Protected Phases		8			4			6				
Permitted Phases	8					4	6					
Actuated Green, G (s)		29.5			29.5	29.5		21.5				
Effective Green, g (s)		29.0			28.5	28.5		21.0				
Actuated g/C Ratio		0.48			0.48	0.48		0.35				
Clearance Time (s)		4.5			4.5	4.5		4.5				
Lane Grp Cap (vph)		594			739	581		885				
v/s Ratio Prot					0.08			c0.23				
v/s Ratio Perm		c0.26				0.05						
v/c Ratio		0.54			0.17	0.11		0.65				
Uniform Delay, d1		10.9			9.0	8.7		16.4				
Progression Factor		0.80			0.83	0.83		1.00				
Incremental Delay, d2		3.2			0.5	0.4		3.7				
Delay (s)		11.9			8.0	7.6		20.1				
Level of Service		B			A	A		C				
Approach Delay (s)		11.9			7.9			20.1			0.0	
Approach LOS		B			A			C			A	

Intersection Summary

HCM Average Control Delay	16.0	HCM Level of Service	B	
HCM Volume to Capacity ratio	0.59			
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	10.0	
Intersection Capacity Utilization	69.4%	ICU Level of Service	C	
Analysis Period (min)	15			

Description: used 2010 volumes

c   Critical Lane Group

Lane Group	EBT →	WBT ←	SBT ↓
Lane Group Flow (vph)	173	122	646
v/c Ratio	0.26	0.27	0.70
Control Delay	10.5	6.2	15.1
Queue Delay	0.0	0.0	0.0
Total Delay	10.5	6.2	15.1
Queue Length 50th (m)	11.0	2.3	23.0
Queue Length 95th (m)	22.0	6.5	m31.2
Internal Link Dist (m)	36.4	76.7	152.3
Turn Bay Length (m)			
Base Capacity (vph)	660	454	924
Starvation Cap Reductn	0	0	0
Spillback Cap Reductn	0	0	0
Storage Cap Reductn	0	0	0
Reduced v/c Ratio	0.26	0.27	0.70

Intersection Summary

Description: used 2010 volumes-pre 2way conversion

m   Volume for 95th percentile queue is metered by upstream signal.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↟			↭						↭↟	
Volume (vph)	0	157	2	109	4	0	0	0	0	139	449	6
Ideal Flow (vphpl)	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
Lane Width	3.3	3.3	3.3	3.5	3.5	3.5	3.5	3.5	3.5	3.3	3.3	3.3
Total Lost time (s)		5.0			5.5						5.0	
Lane Util. Factor		1.00			1.00						0.95	
Frpb, ped/bikes		1.00			1.00						1.00	
Flpb, ped/bikes		1.00			0.95						0.98	
Frt		1.00			1.00						1.00	
Flt Protected		1.00			0.95						0.99	
Satd. Flow (prot)		1365			1412						2642	
Flt Permitted		1.00			0.65						0.99	
Satd. Flow (perm)		1365			957						2642	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	0	171	2	118	4	0	0	0	0	151	488	7
RTOR Reduction (vph)	0	1	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	0	172	0	0	122	0	0	0	0	0	646	0
Confl. Peds. (#/hr)	60		60	60		60	60		60	60		60
Parking (#/hr)		0	0							0	0	0
Turn Type				Perm						Perm		
Protected Phases		8			4						2	
Permitted Phases				4						2		
Actuated Green, G (s)		29.5			29.5						21.5	
Effective Green, g (s)		29.0			28.5						21.0	
Actuated g/C Ratio		0.48			0.48						0.35	
Clearance Time (s)		4.5			4.5						4.5	
Lane Grp Cap (vph)		660			455						925	
v/s Ratio Prot		0.13										
v/s Ratio Perm					c0.13						0.24	
v/c Ratio		0.26			0.27						0.70	
Uniform Delay, d1		9.2			9.5						16.8	
Progression Factor		1.00			0.49						0.66	
Incremental Delay, d2		1.0			1.4						3.8	
Delay (s)		10.1			6.0						14.9	
Level of Service		B			A						B	
Approach Delay (s)		10.1			6.0			0.0			14.9	
Approach LOS		B			A			A			B	

Intersection Summary

HCM Average Control Delay		12.9	HCM Level of Service		B
HCM Volume to Capacity ratio		0.45			
Actuated Cycle Length (s)		60.0	Sum of lost time (s)		10.5
Intersection Capacity Utilization		64.1%	ICU Level of Service		C
Analysis Period (min)		15			
Description: used 2010 volumes-pre 2way conversion					

c   Critical Lane Group

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations	ኻ			ዘ		
Sign Control	Stop			Stop	Stop	
Volume (vph)	282	0	197	357	0	0
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	307	0	214	388	0	0

Direction, Lane #	EB 1	NB 1	NB 2
Volume Total (vph)	307	343	259
Volume Left (vph)	307	214	0
Volume Right (vph)	0	0	0
Hadj (s)	0.25	0.36	0.05
Departure Headway (s)	5.5	5.8	5.5
Degree Utilization, x	0.47	0.55	0.39
Capacity (veh/h)	628	611	644
Control Delay (s)	13.3	14.4	10.7
Approach Delay (s)	13.3	12.8	
Approach LOS	B	B	

Intersection Summary			
Delay		13.0	
HCM Level of Service		B	
Intersection Capacity Utilization		47.0%	ICU Level of Service	A
Analysis Period (min)		15	

Lane Group	EBT →	EBR ↘	WBT ←	SBT ↓
Lane Group Flow (vph)	251	143	199	543
v/c Ratio	0.34	0.22	0.32	0.56
Control Delay	11.8	4.0	11.5	11.2
Queue Delay	0.0	0.0	0.0	0.0
Total Delay	11.8	4.0	11.5	11.2
Queue Length 50th (m)	27.6	4.8	13.3	9.7
Queue Length 95th (m)	m40.9	m7.4	26.0	m12.0
Internal Link Dist (m)	86.8		80.6	148.8
Turn Bay Length (m)		7.5		
Base Capacity (vph)	735	657	626	962
Starvation Cap Reductn	0	0	0	0
Spillback Cap Reductn	0	0	0	0
Storage Cap Reductn	0	0	0	0
Reduced v/c Ratio	0.34	0.22	0.32	0.56

Intersection Summary

Description: Manual count Nov. 17, 2011. Added Trucks/ heavy vehicles

m   Volume for 95th percentile queue is metered by upstream signal.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↑	↗		↰						↔↱	
Volume (vph)	0	248	142	60	137	0	0	0	0	34	363	141
Ideal Flow (vphpl)	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
Lane Width	3.3	3.3	3.3	3.5	3.5	3.5	3.5	3.5	3.5	3.3	3.3	3.3
Total Lost time (s)		5.0	5.5		5.5						5.0	
Lane Util. Factor		1.00	1.00		1.00						0.95	
Frpb, ped/bikes		1.00	0.96		1.00						0.98	
Flpb, ped/bikes		1.00	1.00		0.99						1.00	
Frt		1.00	0.85		1.00						0.96	
Flt Protected		1.00	1.00		0.98						1.00	
Satd. Flow (prot)		1520	1244		1523						2579	
Flt Permitted		1.00	1.00		0.85						1.00	
Satd. Flow (perm)		1520	1244		1318						2579	
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	0	251	143	61	138	0	0	0	0	34	367	142
RTOR Reduction (vph)	0	0	66	0	0	0	0	0	0	0	59	0
Lane Group Flow (vph)	0	251	77	0	199	0	0	0	0	0	484	0
Confl. Peds. (#/hr)	30		30	30		30	30		30	30		30
Parking (#/hr)										0	0	
Turn Type			Perm	Perm						Perm		
Protected Phases		8			4						2	
Permitted Phases			8	4						2		
Actuated Green, G (s)		29.5	29.5		29.5						21.5	
Effective Green, g (s)		29.0	28.5		28.5						21.0	
Actuated g/C Ratio		0.48	0.48		0.48						0.35	
Clearance Time (s)		4.5	4.5		4.5						4.5	
Lane Grp Cap (vph)		735	591		626						903	
v/s Ratio Prot		c0.17										
v/s Ratio Perm			0.06		0.15						0.19	
v/c Ratio		0.34	0.13		0.32						0.54	
Uniform Delay, d1		9.6	8.8		9.7						15.6	
Progression Factor		1.09	1.59		1.00						0.70	
Incremental Delay, d2		1.1	0.4		1.3						1.9	
Delay (s)		11.6	14.4		11.1						12.8	
Level of Service		B	B		B						B	
Approach Delay (s)		12.6			11.1			0.0			12.8	
Approach LOS		B			B			A			B	

Intersection Summary				
HCM Average Control Delay	12.4	HCM Level of Service		B
HCM Volume to Capacity ratio	0.42			
Actuated Cycle Length (s)	60.0	Sum of lost time (s)		10.0
Intersection Capacity Utilization	70.2%	ICU Level of Service		C
Analysis Period (min)	15			

Description: Manual count Nov. 17, 2011. Added Trucks/ heavy vehicles

c   Critical Lane Group

Lane Group	→ EBT	↘ EBR	← WBT	↓ SBT
Lane Group Flow (vph)	194	33	639	430
v/c Ratio	0.25	0.05	0.93	0.49
Control Delay	10.4	8.6	24.6	18.2
Queue Delay	0.0	0.0	0.0	0.0
Total Delay	10.4	8.6	24.6	18.2
Queue Length 50th (m)	18.7	2.7	21.8	20.0
Queue Length 95th (m)	28.4	6.1 m	#105.9	32.1
Internal Link Dist (m)	83.5		81.0	80.0
Turn Bay Length (m)		7.5		
Base Capacity (vph)	773	638	690	878
Starvation Cap Reductn	0	0	0	0
Spillback Cap Reductn	0	0	0	0
Storage Cap Reductn	0	0	0	0
Reduced v/c Ratio	0.25	0.05	0.93	0.49

Intersection Summary

Description: Used 2010 11th Ave counts

\#   95th percentile volume exceeds capacity, queue may be longer.

Queue shown is maximum after two cycles.

m   Volume for 95th percentile queue is metered by upstream signal.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↑	↗		↔						↔↔	
Volume (vph)	0	188	32	134	486	0	0	0	0	51	332	34
Ideal Flow (vphpl)	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
Lane Width	3.5	3.3	3.3	3.3	3.3	3.5	3.3	3.5	3.3	3.5	3.5	3.5
Total Lost time (s)		5.5	5.5		5.0						5.0	
Lane Util. Factor		1.00	1.00		1.00						0.95	
Frpb, ped/bikes		1.00	0.97		1.00						1.00	
Flpb, ped/bikes		1.00	1.00		1.00						1.00	
Frt		1.00	0.85		1.00						0.99	
Flt Protected		1.00	1.00		0.99						0.99	
Satd. Flow (prot)		1520	1255		1500						2736	
Flt Permitted		1.00	1.00		0.88						0.99	
Satd. Flow (perm)		1520	1255		1335						2736	
Peak-hour factor, PHF	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Adj. Flow (vph)	0	194	33	138	501	0	0	0	0	53	342	35
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	11	0
Lane Group Flow (vph)	0	194	33	0	639	0	0	0	0	0	419	0
Confl. Peds. (#/hr)	15		15	15		15	15		15	15		15
Parking (#/hr)										0	0	0
Turn Type			Perm	Perm						Perm		
Protected Phases		8			4						2	
Permitted Phases			8	4						2		
Actuated Green, G (s)		31.5	31.5		31.5						19.5	
Effective Green, g (s)		30.5	30.5		31.0						19.0	
Actuated g/C Ratio		0.51	0.51		0.52						0.32	
Clearance Time (s)		4.5	4.5		4.5						4.5	
Lane Grp Cap (vph)		773	638		690						866	
v/s Ratio Prot		0.13										
v/s Ratio Perm			0.03		c0.48						0.15	
v/c Ratio		0.25	0.05		0.93						0.48	
Uniform Delay, d1		8.3	7.4		13.4						16.5	
Progression Factor		1.13	1.11		0.52						1.00	
Incremental Delay, d2		0.8	0.2		13.6						1.9	
Delay (s)		10.2	8.4		20.6						18.5	
Level of Service		B	A		C						B	
Approach Delay (s)		9.9			20.6			0.0			18.5	
Approach LOS		A			C			A			B	

Intersection Summary			
HCM Average Control Delay	18.0	HCM Level of Service	B
HCM Volume to Capacity ratio	0.76		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	82.2%	ICU Level of Service	E
Analysis Period (min)	15		

Description: Used 2010 11th Ave counts

c   Critical Lane Group

APPENDIX A-3

VISSIM OUTPUT – INTERSECTION OPERATIONS

Node #	Intersection
101	11th Avenue & Albert Street
102	11th Avenue & Mcintyre Street
103	11th Avenue & Smith Street
104	11th Avenue & Lorne Street
105	11th Avenue & Cornwall Street
106	11th Avenue & Scarth Street
107	11th Avenue & Hamilton Street
108	11th Avenue & Rose Street
109	11th Avenue & Broad Street
201	12th Avenue & Albert Street
202	12th Avenue & Mcintyre Street
203	12th Avenue & Smith Street
204	12th Avenue & Lorne Street
205	12th Avenue & Cornwall Street
206	12th Avenue & Scarth Street
207	12th Avenue & Hamilton Street
208	12th Avenue & Rose Street
209	12th Avenue & Broad Street
801	Parkade on Cornwall Street
802	Parkade on Rose Street
901	City Square Plaza west of Cornwall Street
902	City Square Plaza east of Cornwall Street

Results for Mixed Traffic Movements

Node	Vehicles	Mvmt	LOS	Delay	Queue
Total	28928	All	B	20	13
101	3060	All	B	14	10
101	28	NBL	C	25	1
101	138	NBR	B	16	23
101	1462	NBT	B	16	27
101	0	NBT	A	0	1
101	24	SBR	B	11	3
101	1050	SBT	B	10	7
101	92	WBL	D	40	11
101	195	WBR	A	9	11
101	71	WBT	C	34	11
102	967	All	A	7	2
102	9	EBL	A	3	0
102	122	EBT	A	1	0
102	8	EBT	A	5	0
102	23	NBL	B	15	5
102	93	NBR	B	15	5
102	201	NBT	B	17	5

102	179	WBR	A	3	0
102	334	WBT	A	2	0
103	1254	All	B	12	5
103	31	EBR	A	8	1
103	8	EBT	C	24	1
103	184	EBT	A	8	2
103	51	SBL	B	17	6
103	35	SBR	B	16	6
103	322	SBT	B	16	6
103	145	WBL	B	13	11
103	478	WBT	B	11	11
103	0	WBT	A	0	0
104	1671	All	C	22	22
104	47	EBL	C	26	6
104	188	EBT	B	17	6
104	8	EBT	A	7	6
104	87	NBL	C	23	12
104	32	NBR	B	14	9
104	174	NBR	B	15	9
104	364	NBT	B	19	12
104	234	WBR	C	26	53
104	19	WBT	C	32	53
104	517	WBT	C	27	53
105	1324	All	D	37	28
105	36	EBR	B	13	3
105	325	EBT	B	13	6
105	41	EBT	B	12	3
105	187	NBL	E	67	45
105	124	NBR	E	59	45
105	26	WBL	D	36	47
105	586	WBT	D	41	47
106	1103	All	C	29	22
106	450	EBT	B	12	14
106	41	EBT	C	25	14
106	541	WBT	D	42	52
106	72	WBT	C	29	11
107	1635	All	C	30	22
107	164	EBR	A	8	4
107	289	EBT	B	11	5
107	38	EBT	B	12	3
107	99	SBL	C	22	37
107	183	SBR	E	70	32
107	357	SBT	C	25	37
107	73	WBL	D	39	40
107	36	WBT	C	26	6
107	397	WBT	D	42	40
108	1457	All	C	29	18
108	67	EBL	C	30	14
108	357	EBT	C	22	14
108	121	NBL	D	50	17

108	95	NBR	C	22	17
108	361	NBT	B	20	17
108	66	WBR	C	25	23
108	354	WBT	D	42	23
108	36	WBT	C	24	23
109	3599	All	C	23	21
109	71	EBL	F	83	35
109	197	EBR	B	16	35
109	131	EBT	E	77	35
109	147	NBL	D	37	16
109	65	NBR	C	23	20
109	1383	NBT	B	15	22
109	108	SBL	C	24	3
109	149	SBR	C	22	19
109	1027	SBT	B	18	22
109	70	WBL	E	61	17
109	159	WBR	A	7	10
109	93	WBT	E	60	17
201	3280	All	C	21	12
201	99	EBL	D	49	18
201	97	EBR	B	11	1
201	107	EBT	D	49	18
201	0	EBT	A	0	1
201	31	NBL	C	21	1
201	163	NBR	B	14	9
201	1267	NBT	B	17	16
201	154	SBL	C	33	8
201	23	SBR	B	14	5
201	964	SBT	B	13	9
201	104	WBL	E	69	23
201	203	WBR	B	20	23
201	69	WBT	E	64	23
202	1024	All	A	7	4
202	73	EBL	A	3	0
202	306	EBT	A	2	0
202	102	NBL	B	13	5
202	86	NBR	B	10	2
202	175	NBT	B	15	5
202	49	WBR	A	3	10
202	234	WBT	A	6	10
203	1123	All	B	14	13
203	133	EBR	B	12	31
203	258	EBT	B	16	31
203	34	SBL	B	18	7
203	144	SBR	B	17	7
203	353	SBT	B	15	7
203	60	WBL	B	14	2
203	140	WBT	A	9	2
204	853	All	B	17	8
204	294	EBL	B	20	10

204	200	NBL	B	10	12
204	359	NBT	B	18	4
205	0	All	A	0	0
206	163	All	A	8	3
206	163	NBR	A	8	3
207	868	All	B	14	5
207	2	EBR	A	6	2
207	162	EBT	A	10	2
207	141	SBL	B	18	9
207	5	SBR	B	17	9
207	443	SBT	B	17	9
207	111	WBL	A	6	1
207	4	WBT	A	3	1
208	1117	All	B	17	10
208	64	EBL	A	8	3
208	238	EBT	A	9	3
208	0	NBL	A	0	19
208	231	NBR	C	24	19
208	411	NBT	C	22	19
208	58	WBR	B	12	2
208	116	WBT	A	8	2
209	3474	All	C	20	11
209	163	EBL	D	39	17
209	119	EBR	C	25	11
209	195	EBT	C	34	17
209	57	NBL	C	27	2
209	76	NBR	B	13	9
209	1335	NBT	B	15	13
209	97	SBL	E	58	9
209	37	SBR	B	14	6
209	1178	SBT	B	14	11
209	70	WBL	D	46	13
209	114	WBR	C	32	8
209	34	WBT	D	43	13
801	374	All	B	16	1
801	62	SBL	A	1	0
801	312	WBR	B	19	3
802	583	All	A	5	1
802	51	EBL	A	8	0
802	3	NBL	A	0	2
802	0	NBR	A	0	2
802	529	NBT	A	4	2
802	0	WBR	A	0	0
901	0	All	A	0	0
902	0	All	A	0	0

Results for Transit-Only Movements

Node	Vehicles	Mvmt	LOS	Delay	Queue
102	8	EBT	A	5	0
103	8	EBT	C	24	1
103	0	WBT	A	0	0
104	8	EBT	A	7	6
104	19	WBT	C	32	53
105	41	EBT	B	12	3
106	41	EBT	C	25	14
107	38	EBT	B	12	3
107	36	WBT	C	26	6
108	36	WBT	C	24	23

APPENDIX A-4

VISSIM OUTPUT – TRAVEL TIMES

Travel Time Measurement Section - PM	Time (s)
No. 601 (Sask SB Input to S..): from link 1 at 0.7 m to link 52 at 39.9 m, Distance 560.6 m	53
No. 602 (Stop 0037 to Stop ..): from link 52 at 55.3 m to link 110 at 17.3 m, Distance 229.1 m	73
No. 603 (Stop 0038 (City Ha..): from link 110 at 62.3 m to link 46 at 1.2 m, Distance 404.2 m	92
No. 604 (Stop 1354 to Stop ..): from link 46 at 31.3 m to link 123 at 0.4 m, Distance 174.7 m	38
No. 605 (Stop 1355 to Stop ..): from link 123 at 30.6 m to link 98 at 96.7 m, Distance 274.7 m	143
No. 606 (Broad SB Input to ..): from link 12 at 0.4 m to link 12 at 342.4 m, Distance 341.9 m	25
No. 607 (Stop 0112 to Stop ..): from link 12 at 357.3 m to link 309 at 49.2 m, Distance 259.8 m	70
No. 608 (Stop 0114 to Stop ..): from link 309 at 79.8 m to link 206 at 52.4 m, Distance 174.6 m	41
No. 609 (Stop 0114 to Stop ..): from link 309 at 79.8 m to link 312 at 0.5 m, Distance 227.3 m	144
No. 610 (Stop 0115 Nearside..): from link 206 at 82.5 m to link 115 at 18.1 m, Distance 403.9 m	140
No. 611 (Stop 0115 Farside ..): from link 312 at 31.0 m to link 115 at 18.1 m, Distance 351.3 m	69
No. 612 (Stop 1356 (City Ha..): from link 115 at 63.4 m to link 102 at 89.5 m, Distance 219.6 m	49
No. 613 (Stop 1360 to Stop ..): from link 102 at 105.3 m to link 310 at 3.1 m, Distance 161.8 m	24
No. 614 (Stop 1357 to Stop ..): from link 310 at 18.4 m to link 46 at 1.1 m, Distance 289.5 m	55
No. 615 (Stop 1355 to Stop ..): from link 123 at 30.6 m to link 95 at 42.0 m, Distance 203.2 m	53
No. 616 (Stop 0041 to Stop ..): from link 136 at 92.7 m to link 309 at 49.2 m, Distance 232.6 m	97
No. 617 (Stop 1356 (City Ha..): from link 115 at 63.6 m to link 57 at 29.7 m, Distance 175.6 m	101
No. 618 (Stop 1354 to Stop ..): from link 46 at 31.3 m to link 124 at 13.3 m, Distance 348.2 m	72
No. 619 (12th WB Input to S..): from link 16 at 0.7 m to link 136 at 77.3 m, Distance 337.6 m	0
No. 620 (Broad NB Input to ..): from link 11 at 2.3 m to link 136 at 77.2 m, Distance 458.1 m	63
No. 621 (11th WB Input to S..): from link 14 at 0.4 m to link 14 at 190.7 m, Distance 190.3 m	17
No. 622 (Stop 0690 to Stop ..): from link 14 at 206.4 m to link 309 at 49.3 m, Distance 199.8 m	97
No. 1101 (11th Albert to Mci..): from link 13 at 1.2 m to link 44 at 0.4 m, Distance 101.0 m	12
No. 1102 (11th Mcintyre to S..): from link 44 at 0.5 m to link 73 at 0.5 m, Distance 102.5 m	16
No. 1103 (11th Smith to Lorne): from link 73 at 0.5 m to link 79 at 0.6 m, Distance 102.9 m	25
No. 1104 (11th Lorne to Corn..): from link 79 at 0.8 m to link 83 at 0.6 m, Distance 101.8 m	21
No. 1105 (11th Cornwall to S..): from link 83 at 0.7 m to link 207 at 1.1 m, Distance 102.2 m	20
No. 1106 (11th Scarth to Ham..): from link 207 at 1.2 m to link 86 at 0.8 m, Distance 102.8 m	19
No. 1107 (11th Hamilton to R..): from link 86 at 0.9 m to link 90 at 1.6 m, Distance 102.5 m	27
No. 1108 (11th Rose to Broad): from link 90 at 1.7 m to link 96 at 0.4 m, Distance 111.2 m	86
No. 1109 (11th Broad to Rose): from link 308 at 1.5 m to link 91 at 0.7 m, Distance 101.2 m	45
No. 1110 (11th Rose to Hamil..): from link 91 at 0.8 m to link 87 at 1.3 m, Distance 103.0 m	50
No. 1111 (11th Hamilton to S..): from link 87 at 1.5 m to link 206 at 0.8 m, Distance 98.9 m	48
No. 1112 (11th Scarth to Cor..): from link 206 at 1.0 m to link 84 at 0.8 m, Distance 104.3 m	49
No. 1113 (11th Cornwall to L..): from link 84 at 0.9 m to link 80 at 1.2 m, Distance 103.0 m	34
No. 1114 (11th Lorne to Smith): from link 80 at 1.3 m to link 75 at 0.7 m, Distance 101.9 m	18
No. 1115 (11th Smith to Mcin..): from link 75 at 0.8 m to link 45 at 0.8 m, Distance 102.5 m	12
No. 1116 (11th Mcintyre to A..): from link 45 at 1.0 m to link 51 at 0.8 m, Distance 116.4 m	45
No. 1120 (11th Rose to Broad..): from link 90 at 1.7 m to link 95 at 1.3 m, Distance 90.0 m	26
No. 1121 (11th Mcintyre to A..): from link 45 at 1.1 m to link 54 at 1.1 m, Distance 89.3 m	21
No. 1201 (12th Albert to Mci..): from link 104 at 0.6 m to link 99 at 0.7 m, Distance 102.3 m	9
No. 1202 (12th Mcintyre to S..): from link 99 at 0.7 m to link 114 at 0.7 m, Distance 101.8 m	20