
The Regional Municipality of York

# TRAFFIC AND FINANCIAL MODEL STUDY FOR HIGHWAY 407 INTERCHANGE IMPROVEMENTS

FINAL REPORT

JUNE 2008

IBI GROUP

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# 1. INTRODUCTION

## 1.1 Background

Highway 407 was planned as a 400-series highway to serve as a by-pass of Highway 401 and to serve as a major east-west corridor across the emerging municipalities north of Toronto. Planning and land acquisition for Highway 407 adjacent to the existing hydro corridor was undertaken during the 1960s and 1970s. Design was initiated during the 1980s and early 1990s, with a short section being completed and becoming operational in the late 1980s in the west, including the upgrading of Highway 7 to six lanes through the Town of Richmond Hill. In addition, a number of advance structures (i.e., crossing road overpasses) and ramps were constructed between Highway 427 to Highway 400.

In the early 1990s, the provincial government initiated a public-private partnership to facilitate construction of the highway. The highway opened in 1997 between Highway 410 and Highway 404. In 1999, as part of the Province of Ontario's privatization efforts, Highway 407 was sold to a private consortium that assumed responsibility to operate and collect tolls, with obligations to construct and complete seven interchanges on the existing facility. While the original agreement identified specifically the ramps to build, it deferred construction of certain ramps to be analysed in the future.

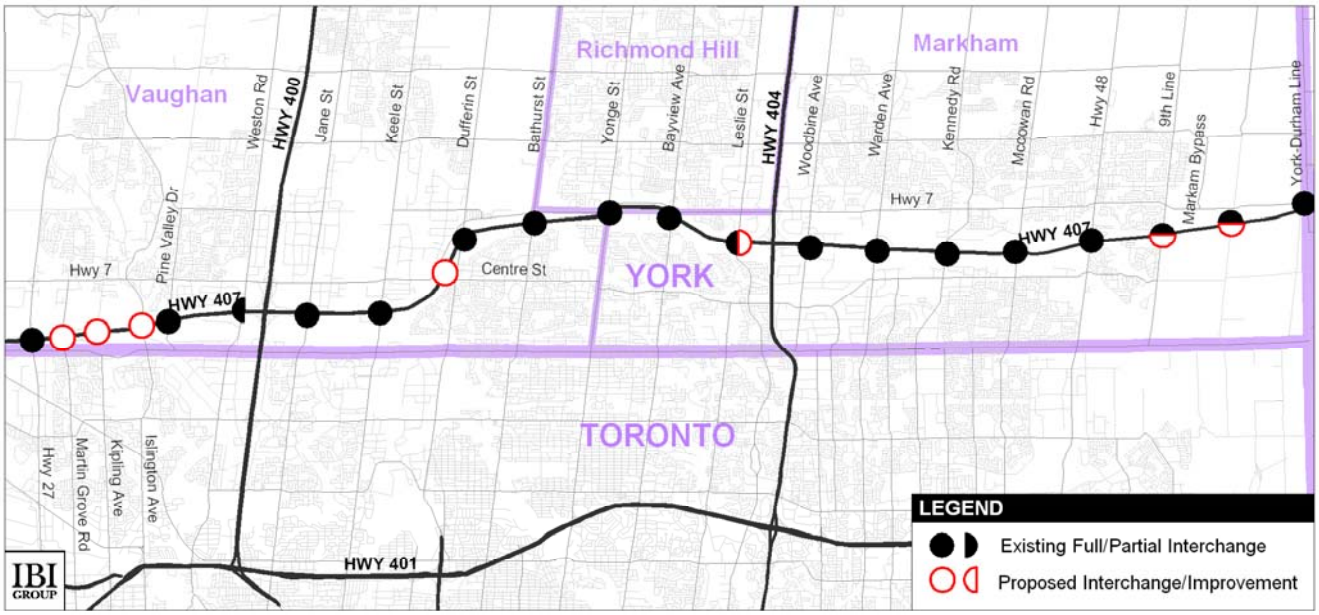
The provincial government maintained the ability to build a transitway facility within the Highway 407 right of way and is presently conducting an environmental assessment and preliminary design for the section through York Region from Highway 400 to Kennedy Road. A number of background studies have been completed for a 407 Transitway, including a Property Protection Study for the entire highway corridor.

## 1.2 Purpose & Approach

The purpose of this study is to prepare business cases for potential new interchanges or interchange improvements along Highway 407 in York Region at the locations shown in Exhibit 1-1, which are located at, from east to west:

- Donald Cousens Parkway;
- Ninth Line;
- Leslie Street;
- Centre Street;
- Kipling Avenue;
- Islington Avenue; and
- Martin Grove Road.

**Exhibit 1-1: Potential Interchange Improvement Study Locations**




These interchange improvements have been proposed to address congestion along the Highway 7/407 Corridor and other key roads in the vicinity, as well as safety concerns.

The initial step was to identify feasible interchange improvements including additional ramps that meet stakeholder functional requirements in order to proceed with the estimation of traffic volumes and the development of a business case. This report:

- Examines the feasibility of the seven potential interchange improvements.
- Recommends preferred feasible interchange ramp configurations, including discussion of the development, assessment and screening of alternative functional design concepts and associated capital costs including land requirements.
- For each of the feasible interchange ramp configurations and interdependent combinations:
  - Estimates the marginal Highway 407 traffic and toll revenue impacts of each recommended feasible interchange improvement;
  - Estimates the net local traffic impacts on significant surrounding arterial roads; and
  - Incorporates the capital cost estimates developed in the construction feasibility analysis and assumed operating and maintenance costs, and conducts a net present value financial analysis based on a five-year payback condition.

The Highway 407 traffic and financial analyses of the feasible options are conducted for the 2011, 2021 and 2031 horizon years representing both projected morning peak hour and annual results.

## 1.3 Agency Consultation

In addition to those from the Region, representatives from key local municipalities, the 407 ETR, and the MTO were consulted during the course of the study to ensure that appropriate standards and design concepts were applied. Together, these representatives form the study Transportation Advisory Committee (TAC), and comprise:

- From York Region, Paul May;
- From the City of Vaughan, Selma Hubjer;
- From the Town of Richmond Hill, Marcel Lanteigne;
- From the Town of Markham, Sabbir Saiyed, Prasenjit Roy;
- From the 407 ETR, Craig White, Jeff Booker, Sean Stewart and Fausto Conforti;
- From the MTO, Frank Martins and Slawomir Demianczuk.

To date, three TAC meetings have been held, occurring on:

- May 24, 2007;
- September 11, 2007; and
- November 21, 2007.

# 2. CONSTRUCTION FEASIBILITY & COSTS

The following steps were used to recommend preferred feasible interchange improvement configurations for each location, which were then developed in further detail in order to prepare appropriate construction cost estimates for use in the financial analysis of the business case:

- Collect information in order to establish existing conditions utilizing available materials such as: Highway 407 and Transitway planning and detail design documents; municipal documents, including previous studies, Official Plans, and Transportation Master Plans; MTO and Region of York mapping and property plans; and site visits;

- Establish the design basis for the potential interchange improvements (i.e., design criteria, stakeholder requirements with respect to traffic operations, operations and maintenance, and infrastructure);

- Establish an evaluation framework to apply in assessing the potential number of alternative interchange improvement concepts that may be presented at any interchange location (i.e., 407 ETR impacts, arterial road impacts, 407 Transitway impacts, environmental impacts, property, cost-effectiveness);

- Identify and map for each interchange location, constraints and considerations, providing a basis for developing interchange improvement concepts (i.e., geometric requirements, physical Highway 407 infrastructure constraints, proposed 407 Transitway, hydro/utilities corridors, development and property issues, environmental issues, etc.);

- Develop alternative interchange improvement concepts utilizing the established design basis and the identified constraint mapping;

- Screen and evaluate potential interchange improvement concepts at each location by applying the established evaluation framework; and

- Recommend an interchange improvement concept(s) at each location, where feasible.

The Region of York and the Town of Markham had previously initiated prior studies of additional ramps at Donald Cousens Parkway and Ninth Line. These studies had investigated and recommended interchange improvement concepts at each location. The findings of those studies were reviewed and adopted for this study.

For each recommended interchange improvement concept, the concept was developed in greater detail in order to develop appropriate construction and property costs. The following subsections summarize the findings for each proposed interchange improvement location.

## 2.1 Donald Cousens Parkway Ramp Option

At present, the Donald Cousens Parkway (previously the Markham Bypass) does not extend southward from Highway 407. The Region of York has prepared and submitted an Individual Environmental Assessment (EA) for the southern extension of the Markham Bypass, from Highway 407 to Morningside Avenue, which includes the missing northbound ramps. While the Donald Cousens Parkway southerly extension is still awaiting Ministry of Environment approval, the

recommended design concept in the EA was an MTO standard Parclo A-4 interchange configuration, and the design concept was adopted for the purposes of this study.

The recommended interchange improvements, the addition of a south-to-east ramp and a south-to-west ramp, were developed in sufficient detail based on available data in order to prepare appropriate construction cost estimates for use in the business case analysis. The developed construction cost estimates are $5.6 million and $2.0 million for the south-to-east ramp and south-to-west ramp, respectively. To be noted, no property costs were assumed, as the environmental assessment indicated that any grading requirements beyond the proposed 36 metre right-of-way would eventually be graded to match the Donald Cousens Parkway construction.

## 2.2 Ninth Line Ramp Option

With the recent and planned growth in the southeast area of the Town of Markham and the elimination of community traffic concerns due to the construction of the Ninth Line Bypass of the Hamlet of Box Grove, the Town recognized that additional capacity would be required at the Highway 407/Ninth Line interchange, specifically the provision of access for northbound traffic. In response, the Town of Markham retained an engineering consultant to review if there were more economical Highway 407 ramp access options than those concepts previously included in the Environmental Assessment Report and the Conceptual Preliminary Design Report for Highway 407 / Transitway, from Markham Road Easterly to Highway 7 East of Brock Road (February 1997). The findings of this review were submitted in a report to the Town's General Committee on October 17, 2005.

The study that reviewed the Highway 407 ramp access options identified and assessed alternative interchange improvement concepts and recommended completing a standard Parclo A-4 interchange configuration. As such, the findings of the study were adopted for the purposes of this study.

The recommended interchange improvements, the addition of a south-to-east ramp and a south-to-west ramp, were developed into sufficient detail based on available data in order to prepare appropriate construction cost estimates for use in the business case analysis. The developed construction cost estimates were $2.5 million and $2.0 million for the south-to-east ramp and south-to-west ramp, respectively. No property costs were assumed, as it is understood that the construction of the four-lane arterial and associated grading requirements south of the interchange would be the responsibility of local development initiatives.

## 2.3 Leslie Street Ramp Option

Two alternative interchange improvement design concepts were developed and identified for screening:

- **Option No. 1** – Provision of only an additional ramp in the westbound direction, diverging from the existing east-to-south ramp, ramping up to go over the north/south-to-west ramp, and connecting to a realigned and modified north/south-to-west ramp terminus. This alternative was immediately recognized as an unlikely feasible concept as it does not provide desirable paired ramp connections to and from the east, presents a shared ramp arrangement, introduces corresponding safety issues, requires resolution of the private development access at the ramp terminus, and presents a major conflict with the 407 ETR fibre optic plant. Despite this, it was evaluated to illustrate these issues.

- **Option No. 2** – Provision for a new roadway between Highway 7 and Leslie Street utilizing an as yet unopened local collector roadway (South Park Drive). Located approximately 600 m east of Bayview Avenue, the South Park Drive extension would cross over Highway 407 and run parallel along Highway 407 north of the hydro corridor to existing Leslie Street. In the westbound direction, a partial Parclo B2 interchange would be provided with the existing north/south-to-west ramp remaining. In the eastbound direction, a buttonhook interchange would be provided, replacing the existing west-to-north/west ramp. However, to provide this configuration, modifications are required to the existing high-speed west-to-north/south ramp. This alternative permits the development of a paired ramp connection, although it would be a circuitous connection.

Based on the feasibility evaluation, neither of the options should be carried forward for detailed development. The construction cost for Option No. 2 would be in the range of $30 to $35 million. Other potential options would have significantly greater construction costs and be considered cost prohibitive given the major modifications required to the existing 407 ETR infrastructure.

## 2.4 Centre Street Ramp Options

Three alternative interchange improvement design concepts were developed and identified for screening. The alternatives included two partial interchange configurations with access to and from the west, which avoided major property/development, environmental, and geometric constraints, and the full interchange configuration that was deferred from the construction obligation by the 407 ETR.

Amendment No. 1 to the Highway 407 Concession and Ground Lease Agreement between the Province and the 407 ETR indicated a deferral of the construction obligation of Kipling Avenue and Centre Street interchanges to 2020. During 2015, a jointly commissioned independent study to address the technical and financial viability of each interchange as they will be in 2020 will be conducted to decide whether construction of either or both or further deferral of the interchanges.

Although only the two partial interchange improvement alternatives were recommended for more detailed development following the screening and evaluation process, the full interchange improvement concept was also included for more detailed development in order to identify potential benefits for the Region of York.

The design options and their corresponding costs consist of:

- **Option No. 1** – Provision of loop ramp in the northeast quadrant, from Centre Street northbound to 407 ETR westbound (south to west ramp), and a directional ramp in the southwest quadrant from 407 ETR eastbound to a signalized “T” intersection at Centre Street (west to north/south ramp). Structure widening is required, with construction cost estimates of $3.4 million and $ 2.5 million for a south to west ramp and a west to north/south ramp, respectively (no property costs assumed);

- **Option No. 2** – Provision of loop ramp in the northeast quadrant, from Centre Street northbound to 407 ETR westbound (south to west ramp), and a loop ramp in the southeast quadrant from 407 ETR eastbound to a signalized “T” intersection at Centre Street (west to north/south ramp), with construction cost estimates of $3.4 million and $3.3 million for a south to west ramp and a west to north/south ramp respectively (no property costs assumed); and

- **Option No. 3** – Provision of loop ramp in the northeast quadrant, from Centre Street northbound to 407 ETR westbound (south to west ramp), a direction ramp in the southwest quadrant from 407 ETR eastbound that would split to directly connect to Centre Street and Dufferin Street, and a connecting road on the west side of Centre Street over Highway 407 between 407 ETR westbound and Dufferin Street northbound, with overall construction cost estimate of $70 million (property costs of $15 million were assumed).

## 2.5 Western Ramp Options (Martin Grove Road, Kipling Avenue, and Islington Avenue)

The three interchanges under consideration in the west end of the study area, Martin Grove Road, Kipling Avenue, and Islington Avenue, have been grouped together. Following the constraint mapping of geometric requirements and property issues, due to the spacing of the arterial road crossings of Highway 407 between the existing full interchanges at Pine Valley Drive and Highway 27, is was concluded that only one of the following interchange improvement initiatives is feasible:

- Partial interchange at Islington Avenue, to and from the west;
- Partial interchange at Martin Grove Road, to and from the east; or,
- Full/partial interchange at Kipling Avenue.

After further investigation, it was concluded that no interchange improvement configuration is practical at Islington Avenue. A full interchange is not geometrically and operationally feasible. A partial interchange at Islington Avenue, to and from the west, although feasible, would need to address numerous major issues including crossing the Humber River valley and the CPR line, both introducing significant regulatory requirements and prohibitive costs. Based on these major issues and constraints, and given that there is no distinct advantage for this initiative over the identified others, an Islington Avenue interchange was deemed not practical and screened out from further consideration.

Presently, Kipling Avenue is discontinuous between the Region of York and the City of Toronto, and separated by the 407 ETR and a major CNR line. The Ministry of Transportation has previously examined numerous Kipling Avenue interchange alternatives with different primary north-south routes in the Region of York (i.e., between Martin Grove Road and Kipling Avenue). The City of Vaughan, the Region of York, and the City of Toronto Official Plans and Transportation Master Plans do not specify a preferred route and / or interchange at this location. Direction from the Technical Advisory Committee was given to include the latest identified Ministry of Transportation interchange configuration that was deferred from construction obligation with the 407 ETR. This interchange improvement consists of a Parclo A-3 configuration that provides a direct connection to Martin Grove Road to the north of Highway 407 and avoids some significant environmental impacts, but provides no access to the west.

As previously mentioned, Amendment No. 1 to the Highway 407 Concession and Ground Lease Agreement between the Province and the 407 ETR indicated a deferral of the construction obligation of the Kipling Avenue interchange until 2020, with a study to be undertaken during 2015 to address the technical and financial viability of the interchange for the 2020 horizon year.

A full interchange at Martin Grove Road is not geometrically and operationally feasible. A partial interchange to and from the east is feasible, generally constructed within the existing Highway 407 right-of-way.

In summary, for the identified western interchange locations, only two alternatives remain, a partial interchange at Martin Grove Road and a partial interchange at Kipling Avenue. Both alternatives were subject to detailed development, with the following resulting construction cost estimates:

- Partial interchange at Martin Grove Road to and from the east with a construction cost estimate of $5.9 million, including $1.0 million for property costs; and

- Parclo A-3 interchange configuration at Kipling Avenue to and from the east and from the west with a construction cost estimate of $60 million (which includes the cost of extending Kipling Avenue north to Martin Grove Road), including $10 million for property costs.

# 3. TRAFFIC & FINANCIAL ANALYSES OF FEASIBLE OPTIONS

The following describes the financial, traffic, environmental, and land impacts of each feasible option identified in Section Two. The York Region Travel Demand Forecasting Model was applied to develop 2011, 2021 and 2031 morning peak hour traffic and toll revenue forecasts based on York Region's "thirty-percent" land use intensification scenario. Each scenario horizon includes York Region's program assumptions for future road and transit improvements and assumes the Highway 407 East Extension to Highway 35/115 to be operational in 2013.

IBI Group has an in-house toll-forecasting algorithm that had been previously developed. This includes a detailed approach in which the auto users are separated into toll-users and non-users, using a logit choice model based on the utility of toll and non-toll routes in terms of travel time and travel cost (vehicle operating cost plus the toll charge). This choice model was originally calibrated using the stated-preference data on willingness to pay and implied value of time for the Highway 407 users in 1998.

This toll-diversion algorithm has been incorporated into the York Travel Demand Forecasting Model and the logit model parameters have been re-calibrated to replicate the 2006 observed Highway 407 a.m. peak hour usage obtained from the 407 ETR. The model parameters were refined through an iterative process to match observed data. With re-calibration, the model reproduced the observed a.m. peak hour Highway 407 usage, both in terms of number of users and vehicle-km, within less than 1% difference, as shown in Exhibit 3-1. The average trip length of Highway 407 trips is predicted to be 20.0 km, within 0.5% difference compared to the observed. The trip length distribution is also well reproduced by the model, as shown in Exhibit 3-2.

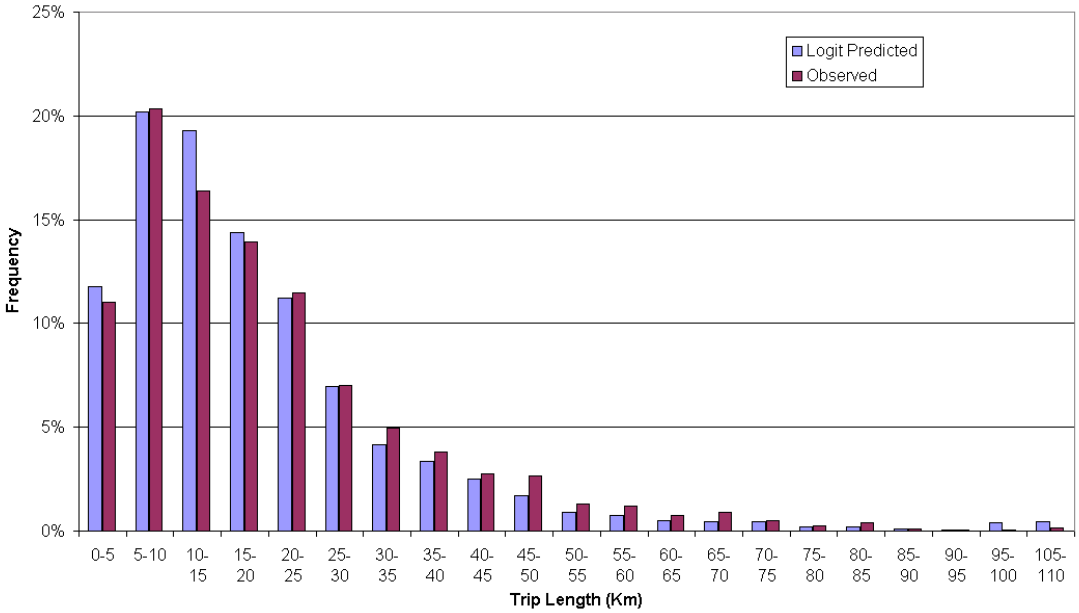
**Exhibit 3-1: Model Calibration Results, 2006 AM Peak Hour**

| Measure | Percent Difference (Model/Observed) |
|---|---|
| Total Vehicle-km | 0.21% |
| Total Demand (Highway 407 Trips) | 0.75% |
| Average Trip Length | -0.54% |

The toll forecasting algorithm was incorporated within the York Region Model and runs were made under a range of toll rates on Highway 407 from 20 to 30 cents per kilometre. An optimal rate was derived for each year and was then used to develop traffic and revenue estimates for the base, do-nothing case and with each interchange improvement (the build case). The traffic and revenue impacts of new interchange improvements are represented by the net differences between the base and build cases.

The total change in toll revenue from the construction of a new interchange will come from two sources. One will be that generated from new users of Highway 407, of which all of the revenue impacts will be positive. The other will be that generated from existing users, of which the revenue impacts could be positive or negative; that is, existing users may access Highway 407 at a different location when a new interchange improvement is constructed, potentially increasing or decreasing their travel on Highway 407 and therefore toll revenue.

**Exhibit 3-2: Predicted Versus Observed Trip Length Distribution, 2006 AM Peak Hour**




As the model represents car traffic only, the impacts of additional truck traffic were factored into the results using observed existing relationships of traffic volumes, vehicle-kilometres of travel and revenue (given higher toll rates) at existing, analogous interchanges.

The vehicle-trips, vehicle-kilometres and revenue were then expanded from the morning peak hour to, first, the full day based upon factors derived using observed origin-destination volumes from existing, analogous interchanges. Generally, the ratio of the total daily volumes to the peak hour was calculated and applied as a factor. However, the origin-destination values used to derive the factors depended on whether the option was a two-movement partial interchange ramp improvement (i.e., to and from east or west), or a single-movement partial interchange ramp improvement (e.g., south to east) to account for the different peak hour-to-day characteristics at each type. For the single-movement partial ramp improvements at Ninth Line and Donald Cousens Parkway (south to east and south to west) options, the ratio used the origin to east and origin to west totals from the analogous interchanges (here, taken as the average of the Kennedy Road, McCowan Road and Markham Road ratios).

To expand to the full year, it was assumed that there would be 251 weekdays and 114 weekend days per year with the weekend day assumed to be half of a weekday.

Together with the estimated construction and land acquisition costs developed in Section Two and anticipated annual operating and maintenance costs, the forecast toll revenues are used to complete a five-year net present value analysis for each feasible option. This consists of the present value of five years of toll revenue net of the capital and annual operating and maintenance costs. This is conservative in terms of financial performance in that it does not take into account revenues from beyond the first five years. Annual operating and maintenance costs include toll system and pavement costs. Constant 2007 dollars are used. A 2008 base year (extrapolated from the modelled years) and five percent discount rate are assumed. Detailed year-by-year five-year net present value results for all options are provided in Appendix A.

Traffic impacts in 2011 on adjacent local roads and Highway 407 ramps are assessed within the study area of each potential interchange qualitatively and in terms of the net change in traffic relative to the base case.

## 3.1 Donald Cousens Parkway South to West Ramp Option

### 3.1.1 TRAFFIC

For the purposes of this analysis, it is assumed that the Donald Cousens Parkway extension south of Highway 407 would be completed by 2011. The traffic impacts provided represent the impacts of opening the ramp after this facility is in operation, isolating the impacts of the ramp from those of the Donald Cousens Parkway south extension.

With the Donald Cousens Parkway south extension in place but prior to the implementation of this option (i.e., the base case), this road would be used to access the Ninth Line interchange from the north in addition to the continued illegal U-turns currently observed at Ninth Line. U-turns on the Parkway itself would also likely occur as on Ninth Line.

The provision of a ramp allowing traffic movements from the south to the west would lead to increases in northbound traffic on Donald Cousens Parkway south of Highway 407 and to decreases in both directions of travel north of Highway 407. Southbound traffic volumes south of Highway 407 would not be affected. Exhibit 3-3 shows the net change in traffic volumes for the 2011 morning peak hour.

As the new interchange would then accommodate traffic accessing Highway 407 from the south, there would be a net increase in northbound traffic on the Donald Cousens Parkway south of Highway 407 from traffic accessing it from the south. There would be a net decrease in northbound traffic north of Highway 407 from traffic that would have continued up to east-west facilities such as Highway 7 and Sixteenth Avenue now using the new interchange and Highway 407. There would be a net decrease in southbound traffic north of Highway 407 because traffic accessing Highway 407 from the south would no longer have to approach from the north via Reesor Road and Highway 7 or, based on the experience at Ninth Line, travelling northbound on the Parkway and making an illegal U-turn.

Traffic using the new interchange would be mostly local from the south, as local traffic would receive the greatest travel time savings benefits from the new interchange ramp. In the earlier years, it would come to/from the residential areas between Steeles Avenue East and Finch Avenue East, however it would also come from the Box Grove area immediately south between Steeles Avenue East and Highway 407 as this area develops. This traffic would be taking advantage of the improved accessibility to Highway 407.

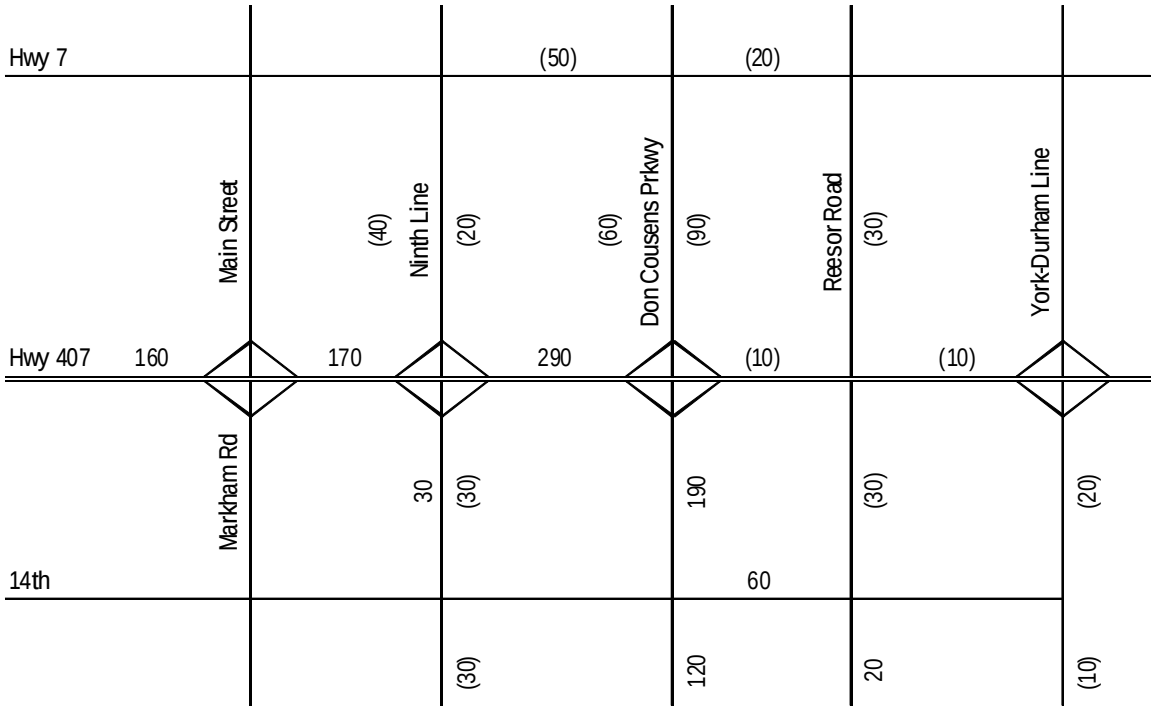
Northbound traffic volumes on Reesor Road, which is currently used to access Highway 407 from the north at the Parkway, would also decrease somewhat. However, with the Parkway south extension in place, the Parkway would be the primary means of accessing Highway 407 from the north and would be impacted more. There would also be some decreases in northbound traffic on Ninth Line from users accessing Highway 407 from the north by making an illegal U-turn diverting to the new interchange ramp.

Northbound traffic volumes on Markham Road and the York-Durham Line, the two parallel facilities with south-to-west ramps to Highway 407, would decrease marginally south of Highway 407 with the new interchange ramp in place, consistent with the northbound increase on the Donald

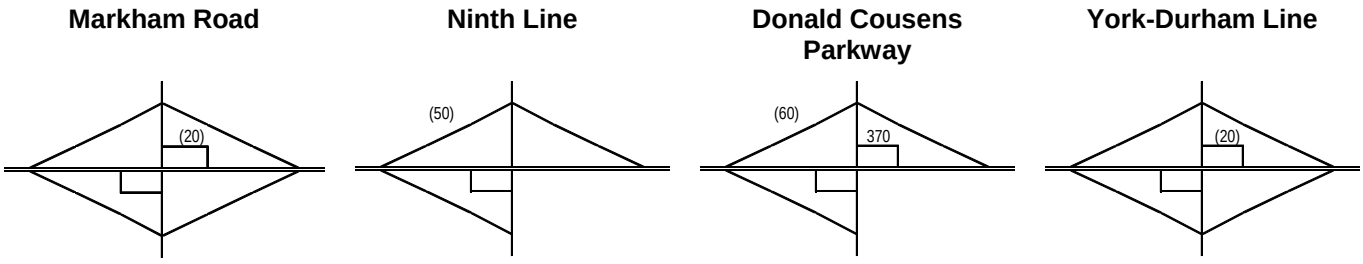
Cousens Parkway south of Highway 407, as traffic diverts to the new interchange ramp. The impact on these facilities would be marginal given their distances from the interchange (about three kilometres).

**Exhibit 3-3: Donald Cousens (South to West Ramp) Area Net Change in Traffic Volumes, 2011 AM Peak Hour**

**A. Area Roads**




**B. Area Ramps**




Note: Schematic representation of area roads and ramps only. Shows passenger car traffic only. Bracketed numbers refer to net decrease in traffic volumes.

Northbound through travel from areas further south of the interchange (i.e., non-local traffic from south of Finch Avenue East) to areas north of it (i.e., Markham) that would have used the Donald Cousens Parkway without the new interchange ramp would re-route to Reesor Road and Ninth Line due to the increased northbound volumes on the Donald Cousens Parkway.

As shown below in Exhibit 3-4, the introduction of a new ramp would lead to a net increase of about 210 vehicle-trips on Highway 407 in the morning peak hour in 2011. The diversion of east-west traffic heading westbound from the Donald Cousens Parkway to the new ramp and Highway 407 would generally result in some decreases on the adjacent parallel facilities of Highway 7 and Fourteenth Avenue west of the Donald Cousens Parkway, improving the level of service on them. There would be slight decreases on Highway 407 itself east of the Parkway from travellers who had backtracked to the York-Durham Line interchange prior to implementation of the new interchange ramp. These travellers would access the new ramp via Fourteenth Avenue, which would experience a modest increase in traffic east of the Parkway.

The increase in traffic on the Donald Cousens Parkway south extension noted above would be about 35% in 2011, leading to some reduction in level of service/increase in delay on this facility, although not approaching capacity.

Exhibit 3-3 also shows the net change on the new interchange ramp as well as the impacts on the adjacent Markham Road, Ninth Line and York-Durham Line ramps for the 2011 morning peak hour. The new interchange ramps would draw about 400 vehicles from new users, those diverted from the adjacent ramps and those who previously approached from the north.

The construction of these ramps would eliminate the U-turn movements that would likely occur after construction of the Parkway extension from northbound traffic noted above. All geometric elements of the design presented in Section 2 meet established safety standards.

### 3.1.2 FINANCIAL

The estimated morning peak hour and annual change in vehicle-trips, vehicle-kilometres and toll revenue are presented in Exhibit 3-4. Increases in all are expected from 2011 onward, with an additional $1.0 million in annual revenue expected in 2011 and $4.7 million expected in 2031. As shown in Exhibit 3-5, taking into account the $2.0 million in capital costs as well as annual operating and maintenance costs, the implementation of this ramp in 2008 would result in a positive five-year net present value of $1.8 million, with a value of $2.5 million if implemented in 2011.

**Exhibit 3-4: Donald Cousens (South to West Ramp) Highway 407 Traffic & Revenue Net Increase Forecasts**

| Time Period | Net Change In | Year | | |
|---|---|---|---|---|
| | | 2011 | 2021 | 2031 |
| Morning Peak Hour | Vehicle-trips | 210 | 420 | 630 |
| | Vehicle-kilometres | 2,700 | 6,400 | 9,800 |
| | Revenue[2] | $600 | $1,700 | $2,800 |
| Annual[1] | Vehicle-trips (M) | 0.3 | 0.7 | 1.0 |
| | Vehicle-kilometres (M) | 4.5 | 10.6 | 16.3 |
| | Revenue (M)[2] | $1.0 | $2.8 | $4.7 |

Note: Shows net increases relative to base, do-nothing case. Includes passenger car and truck traffic.
[1] Based on an existing peak hour to weekday factor provided by 407 ETR, and 251 weekdays and 114 weekend days per year with a weekend day (i.e., Saturdays, Sundays and holidays) assumed to be half a weekday.
[2] Year 2007 dollars.

**Exhibit 3-5: Donald Cousens (South to West Ramp) Five-Year Net Present Value by Year of Construction**

| Year Constructed | Five-Year NPV (millions)[1] |
|---|---|
| 2008 | $1.8 |
| 2011 | $2.5 |
| 2021 | $5.0 |
| 2031 | $7.7 |

Note: Net present value using 2008 as base year. Year 2008 results extrapolated from modelled years. Revenue includes first five years after year of construction. Costs include construction (ramps and toll systems), property and annual operating and maintenance. The cost of constructing the Donald Cousens Parkway south extension is not included. Discount rate of five percent is assumed.
[1] Year 2007 dollars.

## 3.2 Donald Cousens Parkway South to East Ramp Option

### 3.2.1 TRAFFIC

As with the Donald Cousens South to West Ramp option, for the purposes of this analysis, it is assumed that the Donald Cousens Parkway extension south of Highway 407 would be completed by 2011. The traffic impacts provided represent the impacts of opening the ramp after this facility is in operation, isolating the impacts of the ramp from those of the Donald Cousens Parkway south extension. With the Donald Cousens Parkway south extension in place but prior to the implementation of this option (i.e., the base case), the road would be used to access the Ninth Line interchange from the north in addition to the continued illegal U-turning currently observed at Ninth Line. U-turns on the Parkway itself would also likely occur as on Ninth Line.

As shown below in Exhibit 3-6, the introduction of a new south to east ramp would lead to a net increase of about 20 vehicle-trips on Highway 407 in the morning peak hour in 2011. Given the very low volumes involved, there would be no notable traffic impacts from the implementation of this option in the earlier years. Impacts in later years would be fairly analogous to those of the Donald Cousens South to West Ramp option presented above but would still be very modest in terms of magnitude. It should be noted that the actual peak hour for this ramp would occur in the afternoon, with volumes on it about four times higher than the morning.

### 3.2.2 FINANCIAL

The estimated morning peak hour and annual change in vehicle-trips, vehicle-kilometres and toll revenue are presented in Exhibit 3-6. Modest increases in all are expected from 2011 onward, with an additional $0.7 million in annual revenue expected in 2011 and $3.0 million expected in 2031. As shown in Exhibit 3-7, taking into account the $5.6 million in capital costs as well as annual operating and maintenance costs, the implementation of this ramp in 2008 would result in a negative five-year net present value of -$3.9 million, with a value of -$2.5 million if implemented in 2011. If implemented in isolation, this ramp would reach a neutral investment status sometime around 2020.

**Exhibit 3-6: Donald Cousens (South to East Ramp) Highway 407 Traffic & Revenue Net Increase Forecasts**

| Time Period | Net Change In | Year | | |
|---|---|---|---|---|
| | | 2011 | 2021 | 2031 |
| Morning Peak Hour | Vehicle-trips | 20 | 60 | 90 |
| | Vehicle-kilometres | 300 | 900 | 1,400 |
| | Revenue[2] | $100 | $200 | $400 |
| Annual[1] | Vehicle-trips (M) | 0.1 | 0.3 | 0.7 |
| | Vehicle-kilometres (M) | 2.2 | 6.7 | 10.5 |
| | Revenue (M)[2] | $0.7 | $1.5 | $3.0 |

Note: Shows net increases relative to base, do-nothing case. Includes passenger car and truck traffic.
[1] Based on an average of existing peak hour to weekday factors for Kennedy Road, McCowan Road, and Markham Road interchanges (existing characteristics at the Donald Cousens Parkway were not considered applicable in the future), and 251 weekdays and 114 weekend days per year with a weekend day (i.e., Saturdays, Sundays and holidays) assumed to be half a weekday.
[2] Year 2007 dollars.

**Exhibit 3-7: Donald Cousens (South to East Ramp) Five-Year Net Present Value by Year of Construction**

| Year Constructed | Five-Year NPV (millions)[1] |
|---|---|
| 2008 | -$3.9 |
| 2011 | -$2.5 |
| 2021 | $0.3 |
| 2031 | $3.7 |

Note: Net present value using 2008 as base year. Year 2008 results extrapolated from modelled years. Revenue includes first five years after year of construction. Costs include construction (ramps and toll systems), property and annual operating and maintenance. The cost of constructing the Donald Cousens Parkway south extension is not included. Discount rate of five percent is assumed.
[1] Year 2007 dollars.

## 3.3 Ninth Line Ramps from South Option

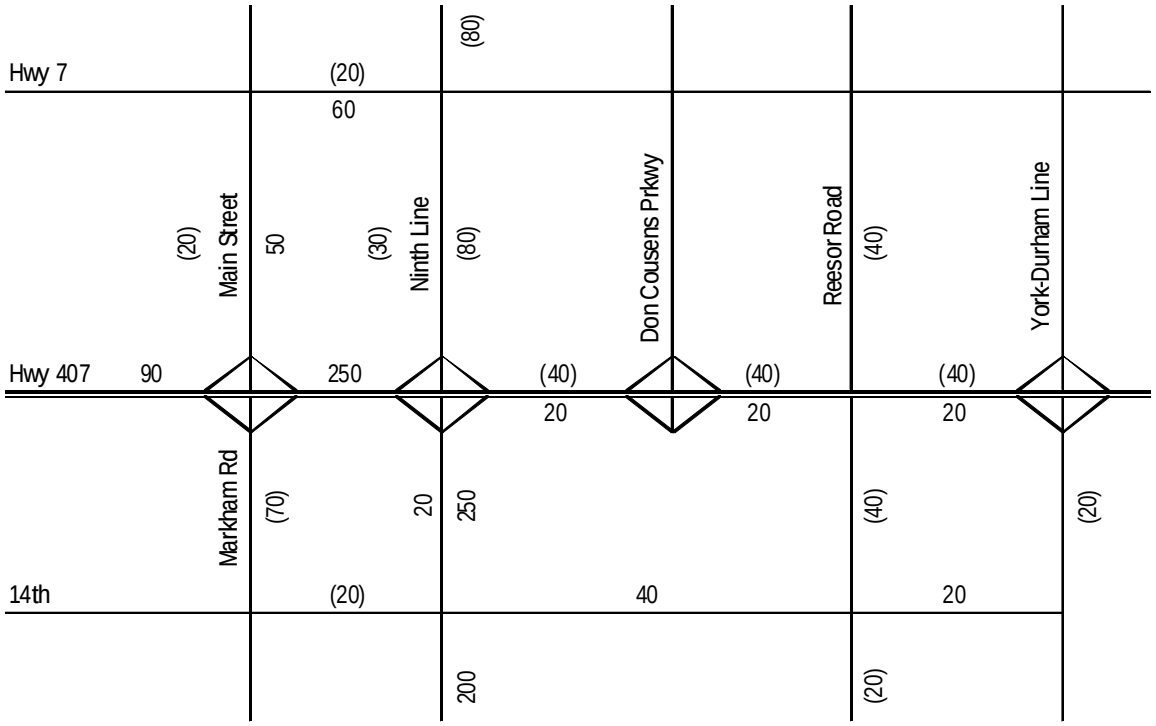
### 3.3.1 TRAFFIC

For the purposes of this analysis, it is assumed that the Donald Cousens Parkway extension south of Highway 407 would not be completed by 2011. It was assumed that both ramps (i.e., south to west and south to east) would be constructed at the same time because of the convenience of constructing them together and minimising interruptions to area residents.

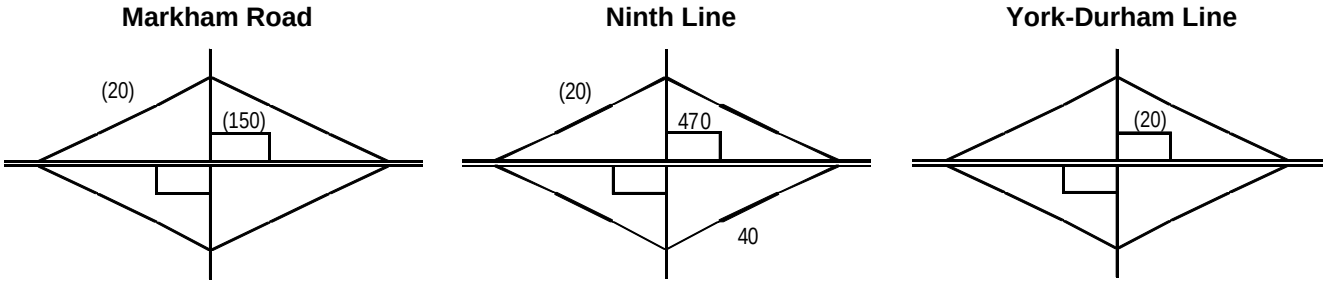
The provision of ramps allowing traffic movements from the south to the east and west would lead to increases in northbound traffic on Ninth Line south of Highway 407 and to decreases in both directions of travel north of Highway 407. Exhibit 3-8 shows the net change in traffic volumes for the 2011 morning peak hour.

**Exhibit 3-8: Ninth Line (from South) Area Net Change in Traffic Volumes, 2011 AM Peak Hour**

**A. Area Roads**




**B. Area Ramps**




Note: Schematic representation of area roads and ramps only. Shows passenger car traffic only. Bracketed numbers refer to net decrease in traffic volumes.

As the new interchange ramps would then accommodate traffic accessing Highway 407 from the south, there would be a significant net increase in northbound traffic on Ninth Line south of Highway 407 from traffic accessing it from the south. There would be a net decrease in northbound traffic north of Highway 407 from traffic that would have continued up to east-west facilities such as Highway 7 and Sixteenth Avenue now using the new interchange ramps and Highway 407. There would be a net decrease in southbound traffic north of Highway 407 because traffic accessing Highway 407 from the south would no longer have to approach from the north, which is currently typically accomplished by travelling northbound on Ninth Line and making an illegal U-turn. Southbound traffic volumes south of Highway 407 would increase marginally due to the reduced congestion north of it.

Traffic using the new interchange ramps would be mostly local from the south, as local traffic would receive the greatest travel time savings benefits from the new ramps. In the earlier years, traffic would come to/from the residential areas to the immediate southwest (down to Finch Avenue East) of the interchange, however it would also come from the immediate southeast as this Box Grove area develops. This traffic would be taking advantage of the improved accessibility to Highway 407.

Northbound traffic volumes on Markham Road, the parallel facility to the west with a south-to-west ramp to Highway 407, south of Highway 407 would decrease with the new interchange ramps in place, consistent with the northbound increase on Ninth Line south of Highway 407, as local traffic diverts to the new ramps. The impacts on the York-Durham Line, the next major parallel facility to the east with a south-to-west ramp, would be minor given the distance (over four kilometres away). Northbound traffic volumes on Reesor Road, which is currently used to access Highway 407 from the north at the Donald Cousens Parkway, would also decrease somewhat due to re-routing to the new ramps. These travellers would access the interchange via Fourteenth Avenue, which would experience a modest increase in traffic east of Ninth Line.

Northbound through travel from areas further south of the interchange (i.e., non-local traffic from south of Finch Avenue East) that would have used Ninth Line without the new interchange ramps would re-route to Markham Road and Reesor Road due to the increased northbound volumes on Ninth Line and the reduced volumes on these facilities as noted above.

As shown below in Exhibit 3-9, the introduction of new ramps would lead to a net increase of about 210 vehicle-trips on Highway 407 in the morning peak hour in 2011. The diversion of east-west traffic to the new ramps and Highway 407 would generally result in decreases on the adjacent parallel facilities of Highway 7 and Fourteenth Avenue (mostly to the west of Ninth Line), improving the level of service on them. As with the Donald Cousens Parkway option, there would be slight decreases on Highway 407 itself east of the Ninth Line from travellers who had backtracked to the York-Durham Line interchange to travel westbound prior to implementation of the new ramps. These travellers would access the new interchange via Fourteenth Avenue, which would experience a modest increase in traffic east of the Ninth Line.

The increases in traffic on Ninth Line noted above would be about 30% in 2011, leading to some reduction in level of service/increase in delay on this facility, although not approaching capacity.

Exhibit 3-8 also shows the net change on the new interchange ramps as well as the impacts on the adjacent Markham Road and York-Durham Line ramps for the 2011 morning peak hour. The new westbound interchange ramp would draw about 500 vehicles from new users, those diverted from the adjacent ramps and those who previously approached from the north. Again, given the proximity, the Markham Road ramp volumes would decrease by about 150 vehicles, while the York-Durham Line ramps would experience only minor impacts.

The construction of these ramps would eliminate the U-turn movements currently observed from northbound traffic noted above. All geometric elements of the design presented in Section 2 meet established safety standards.

### 3.3.2 FINANCIAL

The estimated morning peak hour and annual change in vehicle-trips, vehicle-kilometres and toll revenue are presented in Exhibit 3-9. Increases in all are expected from 2011 onward, with an additional $1.7 million in annual revenue expected in 2011 and $7.3 million expected in 2031. As shown in Exhibit 3-10, taking into account the $4.5 million in capital costs as well as annual

operating and maintenance costs, the implementation of these ramps in 2008 would result in a positive five-year net present value of $1.7 million, with a value of $4.2 million if implemented in 2011.

**Exhibit 3-9: Ninth Line (Ramps from South) Highway 407 Traffic & Revenue Net Increase Forecasts**

| Time Period | Net Change In | Year | | |
|---|---|---|---|---|
| | | 2011 | 2021 | 2031 |
| Morning Peak Hour | Vehicle-trips | 210 | 460 | 700 |
| | Vehicle-kilometres | 3,200 | 6,800 | 10,300 |
| | Revenue[2] | $700 | $1,800 | $3,000 |
| Annual[1] | Vehicle-trips (M) | 0.5 | 1.1 | 1.7 |
| | Vehicle-kilometres (M) | 7.1 | 16.0 | 24.9 |
| | Revenue (M)[2] | $1.7 | $4.2 | $7.3 |

Note: Shows net increases relative to base, do-nothing case. Includes passenger car and truck traffic.
[1] South-to-east component based on an average of existing peak hour to weekday factors for Kennedy Road, McCowan Road, and Markham Road interchanges. South-to west component factor provided by 407 ETR. Annual values assume 251 weekdays and 114 weekend days per year with a weekend day (i.e., Saturdays, Sundays and holidays) assumed to be half a weekday.
[2] Year 2007 dollars.

**Exhibit 3-10: Ninth Line (Ramps from South) Five-Year Net Present Value by Year of Construction**

| Year Constructed | Five-Year NPV (millions)[1] |
|---|---|
| 2008 | $1.5 |
| 2011 | $3.1 |
| 2021 | $6.7 |
| 2031 | $11.0 |

Note: Net present value using 2008 as base year. Year 2008 results extrapolated from modelled years. Revenue includes first five years after year of construction. Costs include construction (ramps and toll systems), property and annual operating and maintenance. Discount rate of five percent is assumed.
[1] Year 2007 dollars.

## 3.4 Ninth Line Ramps from South & Donald Cousens Parkway South to West Ramp Option

Since the five-year net present values for the Donald Cousens Parkway south-to-west ramp and Ninth Line ramps from south options are both positive in 2008, it is possible that they could be constructed at the same time and still be positive, taking into account the probable interactions/overlaps in market served between the two south-to-west ramps. A combined case was tested to determine the traffic and financial performance of this option.

### 3.4.1 TRAFFIC

As with the Donald Cousens Parkway ramp options presented above, for the purposes of this analysis, it is assumed that the Donald Cousens Parkway extension south of Highway 407 would be completed by 2011. The traffic impacts provided represent the impacts of opening the ramps after this facility is in operation, isolating the impacts of the ramps from those of the Donald Cousens Parkway south extension. With the Donald Cousens Parkway south extension in place but prior to the implementation of this option (i.e., the base case), the road would be used to access the Ninth Line interchange from the north in addition to the continued illegal U-turning currently observed on Ninth Line.

The implementation of this option would lead to significant increases in northbound traffic on Ninth Line south of Highway 407, due to decreases in northbound traffic on the Donald Cousens Parkway south of Highway 407, and to decreases in both directions of travel on both road facilities north of Highway 407. Southbound traffic volumes south of Highway 407 would increase marginally due to the reduced congestion north of it. This is shown in Exhibit 3-11, which shows the net change in traffic volumes for the 2011 morning peak hour.

While two south-to-west ramps would be made available with this option, the Ninth Line ramp would be in much more demand due to the westbound orientation of travel. The increase in northbound traffic on Ninth Line south of Highway 407 would occur for the same reasons noted above for the Donald Cousens South to West Ramp option. However, while there would also be some new traffic attracted to the corresponding portion of the Parkway with the new interchange ramp, the use of the Parkway to access the Ninth Line interchange from the north prior to the implementation of this option would end and much of this traffic would shift to using the Ninth Line interchange via Ninth Line itself. The magnitude of this shift would be such that a net decrease in northbound traffic would occur on Donald Cousens Parkway south of Highway 407.

Northbound traffic volumes on Markham Road and the York-Durham Line, the two parallel facilities with south-to-west ramps to Highway 407, south of Highway 407 would decrease with the new ramps in place, consistent with diversion of traffic to Ninth Line and the Parkway south of Highway 407, as local traffic diverts to the new ramps. The impact would be larger on Markham Road given the orientation of travel to the west and the close proximity of Ninth Line to Markham Road.

As shown below in Exhibit 3-12, the introduction of new ramps would lead to a net increase of about 320 vehicle-trips on Highway 407 in the morning peak hour in 2011. The diversion of east-west traffic to the new ramps and Highway 407 would generally result in decreases on the adjacent parallel facilities of Highway 7 and Fourteenth Avenue west of the Donald Cousens Parkway, improving the level of service on them. However, Fourteenth Avenue would experience an increase in traffic east of the Parkway from new users of the new ramps and those diverted from the York-Durham Line interchange.

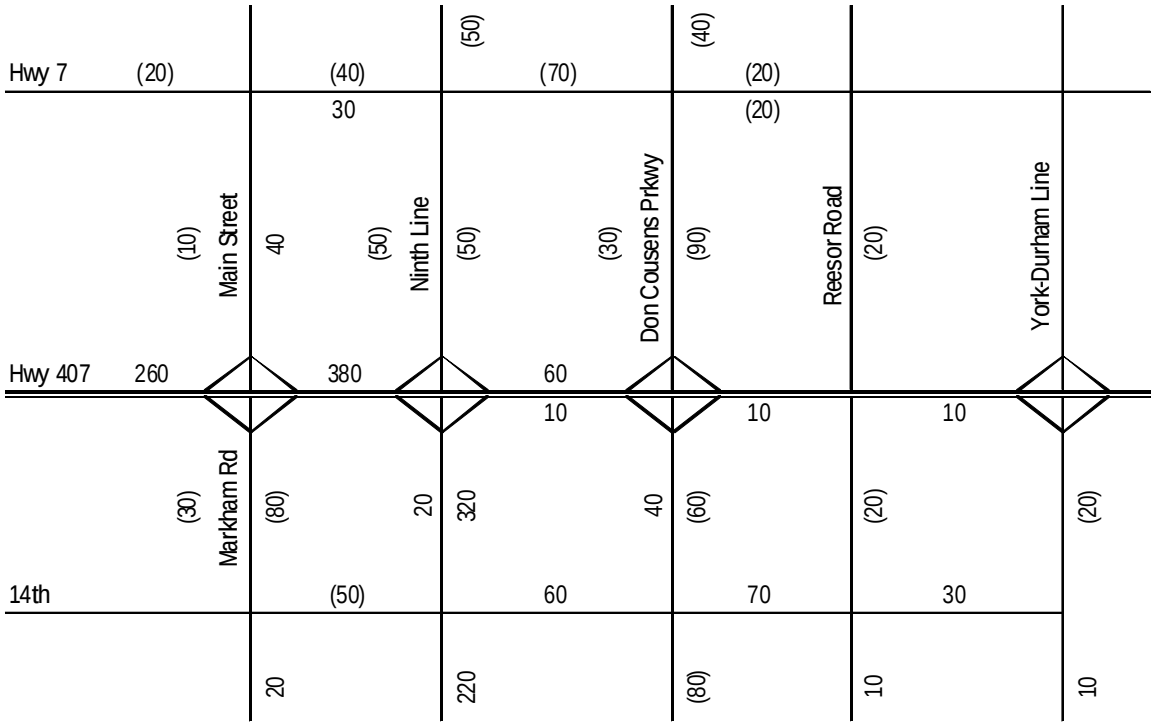
The increases in traffic on Ninth Line noted above would be about 50% in 2011, leading to some reduction in level of service/increase in delay on this facility, although not approaching capacity. Note that the increase for this option would be larger than that for the Ninth Line Ramps from South option due to the construction of the Donald Cousens Parkway south extension in the base case. The build scenario volumes would be only somewhat larger for this option.

Exhibit 3-11 also shows the net change on the new interchange ramps as well as the impacts on the adjacent Markham Road and York-Durham Line ramps for the 2011 morning peak hour. The new westbound interchange ramps would draw several hundred vehicles in total from new users, those diverted from the adjacent ramps and those who previously approached from the north. The

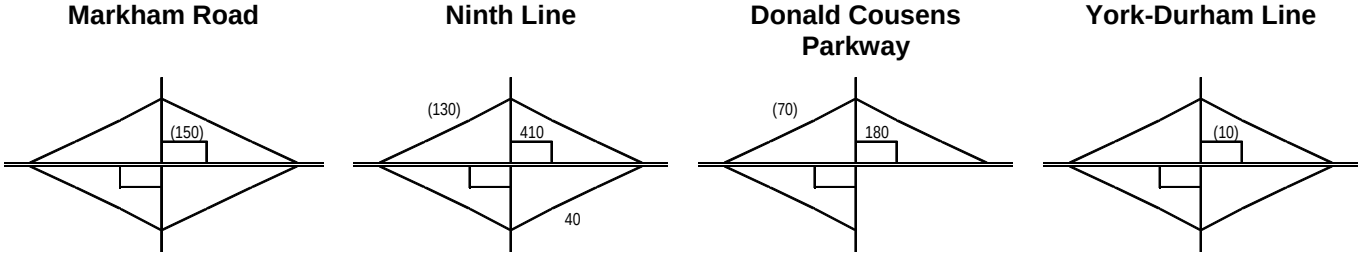
eastbound ramp would draw about 40 vehicles. Again, given the proximity, the Markham Road ramp volumes would decrease by about 150 vehicles while the York-Durham Line ramps would experience only minor impacts.

**Exhibit 3-11: Ninth Line (Ramps from South) & Donald Cousens (South to West Ramp) Area Net Change in Traffic Volumes, 2011 AM Peak Hour**

**A. Area Roads**




**B. Area Ramps**




Note: Schematic representation of area roads and ramps only. Shows passenger car traffic only. Bracketed numbers refer to net decrease in traffic volumes.

The construction of these ramps would eliminate the U-turn movements currently observed from northbound traffic noted above. All geometric elements of the design presented in Section 2 meet established safety standards.

### 3.4.2 FINANCIAL

The estimated morning peak hour and annual change in vehicle-trips, vehicle-kilometres and toll revenue are presented in Exhibit 3-12. Increases in all are expected from 2011 onward, with an additional $2.2 million in revenue expected in 2011 and $9.3 million expected in 2031. As shown in Exhibit 3-13, taking into account the $6.5 million in capital costs as well as annual operating and maintenance costs, the implementation of these ramps in 2008 would result in a positive five-year net present value of $1.1 million, with a value of $3.2 million if implemented in 2011.

**Exhibit 3-12: Ninth Line (Ramps from South) & Donald Cousens (South to West Ramp) Highway 407 Traffic & Revenue Net Increase Forecasts**

| Time Period | Net Change In | Year | | |
|---|---|---|---|---|
| | | 2011 | 2021 | 2031 |
| Morning Peak Hour | Vehicle-trips | 320 | 670 | 1,080 |
| | Vehicle-kilometres | 4,500 | 8,500 | 14,500 |
| | Revenue[2] | $900 | $2,200 | $4,200 |
| Annual[1] | Vehicle-trips (M) | 0.6 | 1.5 | 2.3 |
| | Vehicle-kilometres (M) | 9.2 | 18.6 | 31.7 |
| | Revenue (M)[2] | $2.2 | $4.8 | $9.3 |

Note: Shows net increases relative to base, do-nothing case. Includes passenger car and truck traffic.
[1] South-to-east component based on an average of existing peak hour to weekday factors for Kennedy Road, McCowan Road, and Markham Road interchanges. South-to west components factor provided by 407 ETR. Annual values assume 251 weekdays and 114 weekend days per year with a weekend day (i.e., Saturdays, Sundays and holidays) assumed to be half a weekday.
[2] Year 2007 dollars.

**Exhibit 3-13: Ninth Line (Ramps from South) & Donald Cousens (South to West Ramp) Five-Year Net Present Value by Year of Construction**

| Year Constructed | Five-Year NPV (millions)[1] |
|---|---|
| 2008 | $1.1 |
| 2011 | $3.2 |
| 2021 | $8.2 |
| 2031 | $13.8 |

Note: Net present value using 2008 as base year. Year 2008 results extrapolated from modelled years. Revenue includes first five years after year of construction. Costs include construction (ramps and toll systems), property and annual operating and maintenance. The cost of constructing the Donald Cousens Parkway south extension is not included. Discount rate of five percent is assumed.
[1] Year 2007 dollars.

## 3.5 Centre Street Ramps To/From West Options

The feasibility analysis found that all three design options are possible. The demand for each option would be about the same as would the traffic impacts for the most part. As the costs would be different, each is analysed separately from a financial performance perspective.

### 3.5.1 TRAFFIC

The introduction of a new full interchange at Centre Street would lead to increases in traffic on this facility and decreases on Dufferin Street (north of Centre Street), Highway 7, Steeles Avenue West and Keele Street. Through traffic on Centre Street (traffic travelling on this facility through the intersection with Highway 407) would be reduced with the new interchange in place. However, the increase in volumes from traffic using the new interchange would be larger and would result in a net increase in traffic on Centre Street as shown in Exhibit 3-14, which shows the net change in traffic volumes for the 2011 morning peak hour.

This new interchange traffic would be mostly local, as local traffic would receive the greatest travel time savings benefits from the new interchange. It would come from/be destined to the residential and commercial areas to the immediate southeast of the new interchange via Dufferin Street (south of Centre Street) and the industrial areas to the immediate northwest. This traffic would be taking advantage of the improved accessibility to Highway 407.

As a result of the above, traffic volumes on Dufferin Street (north of Centre Street) would decrease the most. Given the orientation of the road network in the study area, there would be significant travel time benefits for travellers to/from the west that currently use the Dufferin interchange causing them to reroute to the new interchange. Similar significant reductions would occur on Keele Street and on Highway 7 (from those currently accessing the Keele interchange from the north) and on Steeles Avenue West (from those currently accessing from the south).

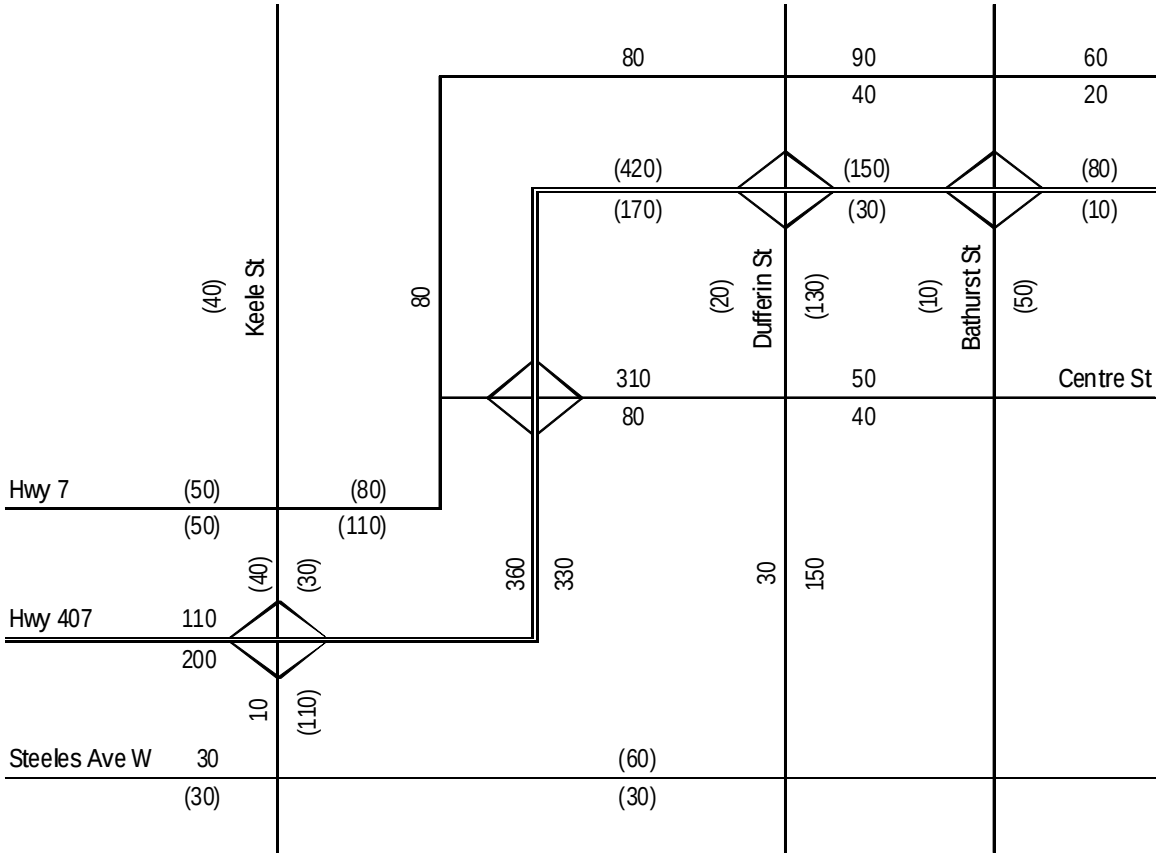
For Options No. 1 and No. 2, the increase in traffic on Centre Street noted above would be about 15% in the westbound direction between the interchange and Dufferin Street in 2011, pushing the facility from already high congestion conditions towards unacceptable levels of congestion. For option No. 3, this increase would be less as traffic to/from Dufferin Street south of Centre Street would be accommodated by ramps parallel to Centre Street.

As shown below in Exhibit 3-15, the introduction of a new interchange would lead to a net increase of about 560 vehicle-trips on Highway 407 in the morning peak hour in 2011. This is despite a net decrease in volumes in both directions between Centre Street and Bathurst Street due to the rerouting to the new interchange noted above. New traffic using the new ramps to and from the east would not be significant enough to negate this as it would generally remain more convenient to use the Dufferin interchange for this movement.

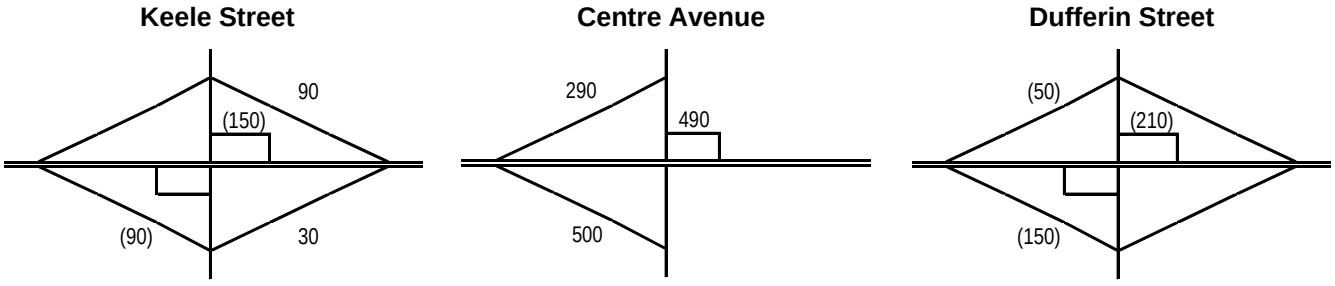
Exhibit 3-14 also shows the volumes on the new interchange ramps as well as the impacts on the Keele Street and Dufferin Street ramps for the 2011 morning peak hour. The new interchange ramps would draw several hundred vehicles each, with the westbound on-ramps drawing almost 900 vehicles combined. The corresponding ramps at Keele Street and Dufferin Street would decrease by almost 500 vehicles combined. Eastbound volumes would be much lower.

**Exhibit 3-14: Centre (to/from West) Area Net Change in Traffic Volumes, 2011 AM Peak Hour**

**A. Area Roads**




**B. Area Ramps**




Note: Schematic representation of area roads and ramps only. Shows passenger car traffic only.

### 3.5.2 FINANCIAL

The estimated morning peak hour and annual change in vehicle-trips, vehicle-kilometres and toll revenue are presented in Exhibit 3-15. Increases in all are expected from 2011 onward, with an additional $0.3 million in annual revenue expected in 2011 and $3.4 million expected in 2031.

As shown in Exhibit 3-16, for options No. 1 and No. 2, taking into account the $6 to $7 million in capital costs as well as annual operating and maintenance costs, the implementation of these ramps in 2008 would result in a negative five-year net present value of about -$5 million, with a value of about -$3.5 million if implemented in 2011. These ramps would reach a neutral investment status sometime around 2021. The much more significant costs of option No. 3 would preclude this option from reaching a positive investment status within the timeframe of the study regardless of property acquisition costs.

**Exhibit 3-15: Centre (to/from West) Highway 407 Traffic & Revenue Net Increase Forecasts**

| Time Period | Net Change In | Year | | |
|---|---|---|---|---|
| | | 2011 | 2021 | 2031 |
| Morning Peak Hour | Vehicle-trips | 380 | 510 | 700 |
| | Vehicle-kilometres | 700 | 1,900 | 3,700 |
| | Revenue[2] | $100 | $500 | $1,100 |
| Annual[1] | Vehicle-trips (M) | 1.2 | 1.6 | 2.2 |
| | Vehicle-kilometres (M) | 2.2 | 5.9 | 11.5 |
| | Revenue (M)[2] | $0.3 | $1.6 | $3.4 |

Note: Shows net increases relative to base, do-nothing case. Includes passenger car and truck traffic.
[1] Based on existing peak hour to weekday factors for Dufferin interchange and 251 weekdays and 114 weekend days per year with a weekend day (i.e., Saturdays, Sundays and holidays) assumed to be half a weekday.
[2] Year 2007 dollars.

**Exhibit 3-16: Centre (to/from West) Five-Year Net Present Value by Year of Construction**

| Year Constructed | Five-Year Net Present Value (Millions)[1] | | | |
|---|---|---|---|---|
| | Option No. 1 | Option No. 2 | Option No. 3 | |
| | | | With Property | Without Property |
| 2008 | -4.5 | -5.3 | -68.8 | -53.8 |
| 2011 | -3.3 | -4.0 | -58.9 | -45.9 |
| 2021 | 0.4 | 0.0 | -33.7 | -25.8 |
| 2031 | 4.3 | 4.1 | -16.6 | -11.7 |

Note: Net present value using 2008 as base year. Year 2008 results extrapolated from modelled years. Revenue includes first five years after year of construction. Costs include construction (ramps and toll systems), property and annual operating and maintenance. Discount rate of five percent is assumed.
[1] Year 2007 dollars.

## 3.6 Kipling Avenue Ramps To/From East & From West Option

### 3.6.1 TRAFFIC

As described previously, the option for Kipling Avenue assumes a new crossing of Highway 407 and the implementation of a new interchange with all movements except for ramps to the west. For the purposes of this analysis, it is assumed that the Kipling Avenue extension north of Steeles Avenue West to Martin Grove Road would be completed by 2011, although no planned/approved completion date is available at this time. The traffic impacts provided represent the impacts of opening the ramps after this facility is in operation, isolating the impacts of the ramps from those of the Kipling Avenue extension.

The introduction of a new interchange at Kipling Avenue would lead to increases in traffic on this facility and decreases on the parallel facilities of Martin Grove Road and Highway 27 to the west and Pine Valley Drive to the east. Through traffic on Kipling Avenue (traffic travelling on this facility through the intersection with Highway 407) would be reduced with the new interchange in place. However, the increase in volumes from traffic using the new interchange would be larger and would result in a net increase in traffic on Kipling Avenue as shown in Exhibit 3-17, which shows the net change in traffic volumes for the 2011 morning peak hour.

This new interchange traffic would be mostly local, as local traffic would receive the greatest travel time savings benefits from the new interchange. It would come from/be destined to the residential area to the immediate southwest of the new interchange (down to Finch Avenue West) and immediate north of the interchange (up to Highway 7). This traffic would be taking advantage of the improved accessibility to Highway 407.

As a result of the above, traffic volumes on Martin Grove Road, Highway 27 and Pine Valley Drive would decrease. Islington Avenue, the next major parallel facility to the east without an interchange, would not be notably affected due to the lack of an interchange.

Through travel to and from areas further north and south of the interchange (i.e., non-local traffic from north of Highway 7 and south of Finch Avenue) that would have used Kipling Avenue without the new interchange would re-route to Highway 27 and Martin Grove Road due to the increased volumes on Kipling Avenue and the reduced volumes on these two facilities noted above.

The increase in traffic on Kipling avenue noted above would be about 160% in the southbound direction south of Highway 407 in 2011, leading to some reduction in level of service/increase in delay on this facility, although not approaching capacity even with this significant increase.

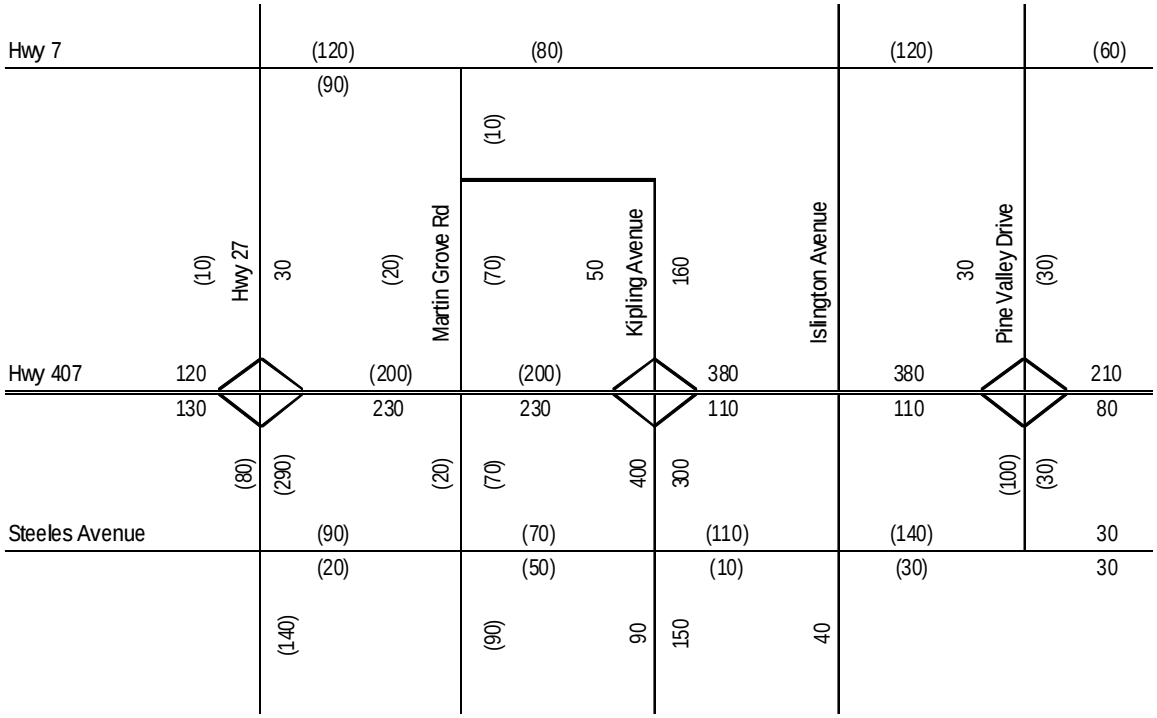
As shown below in Exhibit 3-18, the introduction of a new interchange would lead to a net increase of about 360 vehicle-trips on Highway 407 in the morning peak hour in 2011. This is despite a net decrease in westbound volumes on the section between Highway 27 and Kipling Avenue. Westbound traffic exiting Highway 407 between these facilities that would have exited at Highway 27 and backtracked under the base case would exit via the new interchange at Kipling Avenue, with this volume larger not counter-balanced by any new westbound traffic accessing at the interchange (as this movement is not provided). Otherwise, the diversion of east-west traffic to this facility would generally result in decreases on the adjacent parallel facilities of Highway 7 and Steeles Avenue West, improving the level of service on them.

Exhibit 3-17 also shows the volumes on the new interchange ramps as well as the impacts on the Highway 27 and Pine Valley Drive ramps for the 2011 morning peak hour. The new interchange

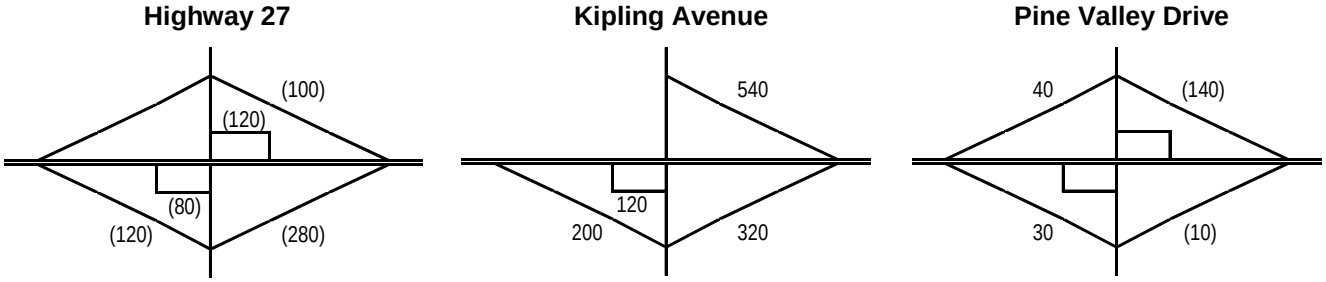
ramps would draw several hundred vehicles each, with the westbound off-ramp drawing over 500 vehicles. The south-to-east on-ramp at Highway 27 would decrease by almost 300 vehicles.

**Exhibit 3-17: Kipling (to/from East & from West) Area Net Change in Traffic Volumes, 2011 AM Peak Hour**

**A. Area Roads**




**B. Area Ramps**




Note: Schematic representation of area roads and ramps only. Shows passenger car traffic only.

### 3.6.2 FINANCIAL

The estimated morning peak hour and annual change in vehicle-trips, vehicle-kilometres and toll revenue are presented in Exhibit 3-18. Increases in all are expected from 2011 onward, with an additional $2.9 million in annual revenue expected in 2011 and $11.1 million expected in 2031. As shown in Exhibit 3-19, taking into account the $50 million in capital costs (which includes the new

crossing of Highway 407 and the extension to Kipling north from Steeles Avenue West to Martin Grove Road), $10 million in property acquisition costs as well as annual operating and maintenance costs, the implementation of these ramps would reach a positive investment status around 2030 if property costs are not included. It would not reach a positive investment status within the timeframe of this study if property costs are included.

**Exhibit 3-18: Kipling (to/from East & from West) Highway 407 Traffic & Revenue Net Increase Forecasts**

| Time Period | Net Change In | Year | | |
|---|---|---|---|---|
| | | 2011 | 2021 | 2031 |
| Morning Peak Hour | Vehicle-trips | 360 | 490 | 750 |
| | Vehicle-kilometres | 4,300 | 6,800 | 11,100 |
| | Revenue[2] | $900 | $1,900 | $3,400 |
| Annual[1] | Vehicle-trips (M) | 1.2 | 1.6 | 2.4 |
| | Vehicle-kilometres (M) | 14.0 | 22.2 | 36.2 |
| | Revenue (M)[2] | $2.9 | $6.2 | $11.1 |

Note: Shows net increases relative to base, do-nothing case. Includes passenger car and truck traffic.
[1] Based on existing peak hour to weekday factors for Highway 27 interchange and 251 weekdays and 114 weekend days per year with a weekend day (i.e., Saturdays, Sundays and holidays) assumed to be half a weekday.
[2] Year 2007 dollars.

**Exhibit 3-19: Kipling (to/from East & from West) Five-Year Net Present Value by Year of Construction**

| Year Constructed | Five-Year Net Present Value (Millions)[1] | |
|---|---|---|
| | With Property | Without Property |
| 2008 | -$47.3 | -$37.8 |
| 2011 | -$38.4 | -$30.2 |
| 2021 | -$15.9 | -$10.9 |
| 2031 | -$0.8 | $2.3 |

Note: Net present value using 2008 as base year. Year 2008 results extrapolated from modelled years. Revenue includes first five years after year of construction. Costs include construction (access roads, ramps and toll systems), annual operating and maintenance and the cost of constructing the Kipling Avenue extension north of Steeles Avenue West to Martin Grove Road. Discount rate of five percent is assumed.
[1] Year 2007 dollars.

## 3.7 Martin Grove Road Ramps To/From East Option

### 3.7.1 TRAFFIC

The introduction of a new interchange at Martin Grove Road would lead to increases in traffic on this facility and decreases on the parallel Highway 27 to the west. Through traffic on Martin Grove Road (traffic travelling on this facility through the intersection with Highway 407) would be reduced with the new interchange in place. However, the increase in volumes from traffic using the new interchange would be larger and would result in a net increase in traffic on Martin Grove Road as shown in Exhibit 3-20, which shows the net change in traffic volumes for the 2011 morning peak hour.

This new interchange traffic would be mostly local, as local traffic would receive the greatest travel time savings benefits from the new interchange. It would come from/be destined to the residential area to the immediate southeast of the new interchange and the industrial areas to the immediate southwest (down to Finch Avenue West) and immediate north of the interchange (up to Highway 7). This traffic would be taking advantage of the improved accessibility to Highway 407.

As a result of the above, traffic volumes on Highway 27 would decrease. Islington Avenue, the next major parallel facility to the east without an interchange, and Pine Valley Drive, the next major parallel facility to the east with an interchange, are too far away (over two kilometres) to be significantly impacted by a new interchange, although volumes on Pine Valley Drive would decrease somewhat for the same reasons as Highway 27.

Through travel to and from areas further north and south of the interchange (i.e., non-local traffic from north of Highway 7 and south of Finch Avenue) that would have used Martin Grove Road without the new interchange would re-route to Highway 27 due to the increased volumes on Martin Grove Road and the reduced volumes on Highway 27 noted above.

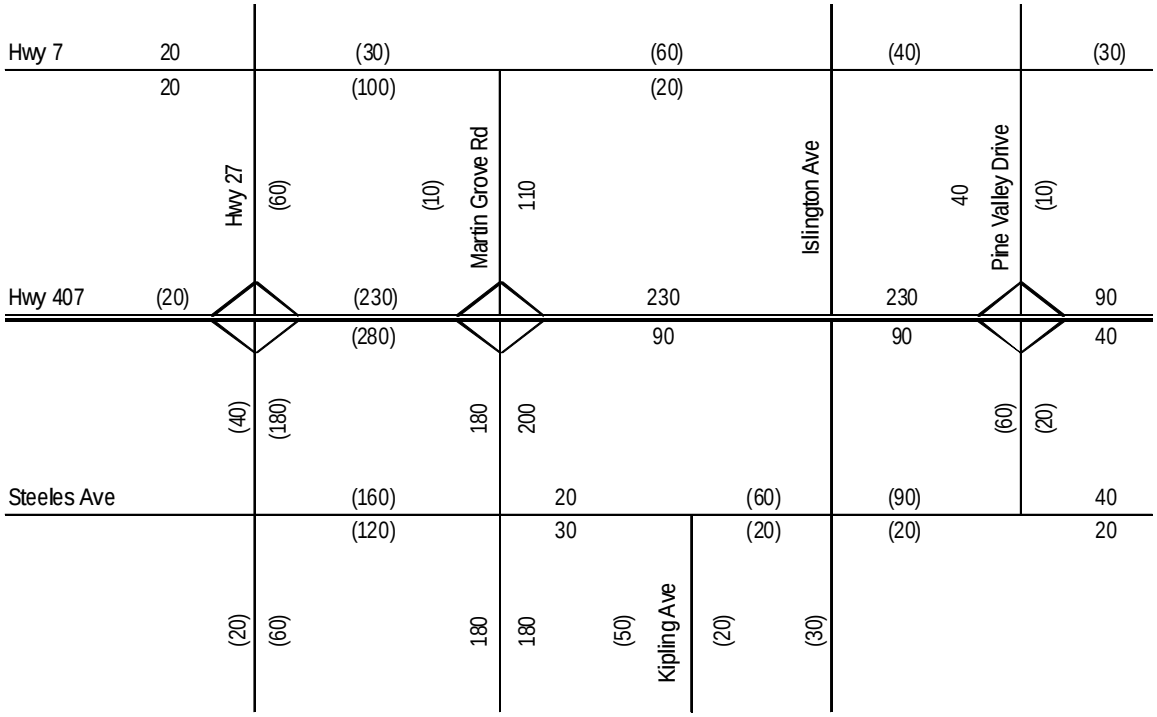
The increase in traffic on Martin Grove Road noted above would be about 65% at the most in 2011, leading to some reduction in level of service/increase in delay on this facility, although not approaching capacity.

As shown below in Exhibit 3-21, the introduction of a new interchange would lead to a net increase of about 310 vehicle-trips on Highway 407 in the morning peak hour in 2011. The diversion of east-west traffic to this facility would generally result in decreases on the adjacent parallel facilities of Highway 7 and Steeles Avenue West east of Martin Grove Road, improving the level of service on them. Decreases would occur on Highway 407 itself between Highway 27 and Martin Grove Road.

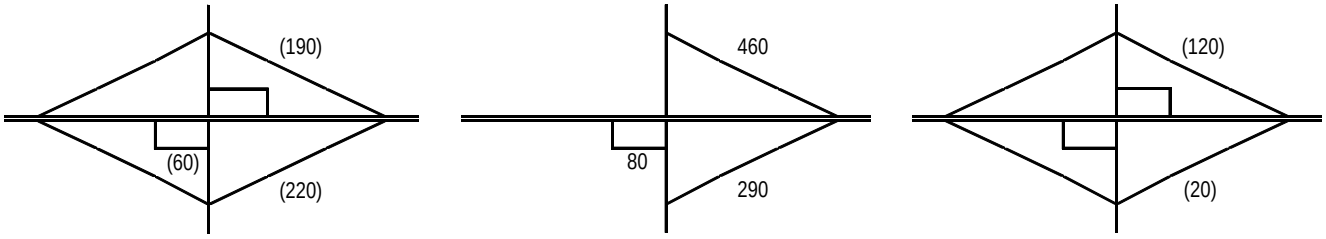
Exhibit 3-20 also shows the volumes on the new interchange ramps as well as the impacts on the Highway 27 and Pine Valley Drive ramps for the 2011 morning peak hour. The new interchange ramps would draw several hundred vehicles each, with the westbound off-ramp drawing almost 500 vehicles. The corresponding ramps at Highway 27 and Pine Valley Drive would decrease by about 300 vehicles combined.

**Exhibit 3-20: Martin Grove (to/from East) Area Net Change in Traffic Volumes, 2011 AM Peak Hour**

**A. Area Roads**




**B. Area Ramps**




Note: Schematic representation of area roads and ramps only. Shows passenger car traffic only.

### 3.7.2 FINANCIAL

The estimated morning peak hour and annual change in vehicle-trips, vehicle-kilometres and toll revenue are presented in Exhibit 3-21. Increases in all are expected from 2011 onward, with an additional $2.6 million in annual revenue expected in 2011 and $9.8 million expected in 2031. As shown in Exhibit 3-22, taking into account the $4.9 million in capital costs, $1.0 million in property acquisition costs as well as annual operating and maintenance costs, the implementation of this ramp in 2008 would result in positive five-year net present values regardless of the property acquisition costs.

### Exhibit 3-21: Martin Grove (to/from East) Highway 407 Traffic & Revenue Net Increase Forecasts

| Time Period | Net Change In | Year | | |
|---|---|---|---|---|
| | | 2011 | 2021 | 2031 |
| Morning Peak Hour | Vehicle-trips | 310 | 430 | 650 |
| | Vehicle-kilometres | 3,700 | 5,900 | 9,700 |
| | Revenue[2] | $800 | $1,600 | $3,000 |
| Annual[1] | Vehicle-trips (M) | 1.0 | 1.4 | 2.1 |
| | Vehicle-kilometres (M) | 12.1 | 19.2 | 31.6 |
| | Revenue (M)[2] | $2.6 | $5.2 | $9.8 |

Note: Shows net increases relative to base, do-nothing case. Includes passenger car and truck traffic.
[1] Based on existing peak hour to weekday factors for Highway 27 interchange and 251 weekdays and 114 weekend days per year with a weekend day (i.e., Saturdays, Sundays and holidays) assumed to be half a weekday.
[2] Year 2007 dollars.

### Exhibit 3-22: Martin Grove (to/from East) Five-Year Net Present Value by Year of Construction

| Year Constructed | Five-Year Net Present Value (Millions)[1] | |
|---|---|---|
| | With Property | Without Property |
| 2008 | $5.2 | $6.2 |
| 2011 | $6.6 | $7.5 |
| 2021 | $10.8 | $11.3 |
| 2031 | $14.4 | $14.7 |

Note: Net present value using 2008 as base year. Year 2008 results extrapolated from modelled years. Revenue includes first five years after year of construction. Costs include construction (ramps and toll systems), and annual operating and maintenance. Discount rate of five percent is assumed.
[1] Year 2007 dollars.

# 4. SUMMARY

## 4.1 Findings

A conceptual design and construction feasibility analysis was completed for each of the potential interchange ramp improvements. The findings include:

- **Donald Cousens Parkway** – The design concept from the Region's individual EA (still pending) for this option was adopted and developed into sufficient detail to prepare construction cost estimates of $2.0 million and $5.6 million for the south to west and south to east ramps, respectively. No property acquisition costs were assumed; and

- **Ninth Line** – The design concept from the Town of Markham's Conceptual Preliminary Design Report for Highway 407/Transitway for this option was adopted and developed into sufficient detail to prepare construction cost estimates of $2.0 million and $2.5 million for the south to west and south to east ramps, respectively. No property acquisition costs were assumed;

- **Leslie Street** – Two design concepts were identified:

  – Option No. 1 provides only an additional ramp in the westbound direction and has numerous operational, safety, and property acquisition issues. It was evaluated merely to illustrate these issues; a construction cost estimate was not determined for this option.

  – Option No. 2 provides a new roadway between Highway 7 and Leslie Street at a construction cost of up to $35 million. This option was deemed cost prohibitive and was eliminated from further analysis.

- **Centre Street** – Three design concepts were identified serving travel to and from the west. Two partial interchanges avoid major constraints while the third is a full configuration that was deferred from construction obligation by the 407 ETR:

  – Option No. 1 provides a loop ramp in the northeast quadrant at a cost of $3.4 million and a directional ramp in the southwest quadrant at a cost of $2.5 million. No property costs are assumed.

  – Option No. 2 provides a loop ramp in the northeast quadrant at a cost of $3.4 million and a loop ramp in the southwest quadrant at a cost of $3.3 million. No property costs are assumed.

  – Option No. 3 provides a loop ramp in the northeast quadrant, a directional ramp in the southwest quadrant, and a connecting road on the west side of Centre Street. Construction costs would total about $70 million, including about $15 million for property acquisition.

  All three options were carried forward for traffic and financial performance analysis.

- **Western Options** – Of the three potential locations, constraint mapping determined that partial interchanges are feasible at Martin Grove Road (to/from the east) and

Islington Avenue (to/from the west) and that a full interchange is feasible at Kipling Avenue:

- The Islington Avenue option was eliminated given major regulatory and cost issues.

- At Kipling Avenue, the most recent configuration plans consist of a Parclo A-3 configuration that provides a direct connection to Martin Grove Road and avoids some significant environmental impacts, but provides no westbound access to Highway 407. Construction costs were estimated at about $60 million (which includes the cost of extending Kipling Avenue north to Martin Grove Road), including about $10 million for property acquisition.

- The partial interchange at Martin Grove Road (to/from the east) would cost above $5.9 million, including $1.0 million for property acquisition.

The feasible options were carried forward for further analysis from a traffic and financial performance perspective. Various individual ramps and combinations thereof were analysed based on the probable timing, ease of construction, and interaction effects of ramps in close proximity serving overlapping markets. The year-by-year construction and five-year net present value analysis results are shown in Appendix A. The findings are summarised below with the five-year net present values by year of construction summarised in Exhibit 4-1:

- **Donald Cousens Parkway Individual Ramp South to West** – Local traffic conditions would not be adversely affected, with net increases of about 35% by 2011 in northbound traffic on the Donald Cousens Parkway south extension. Net increases in travel on Highway 407 would result in a positive investment status if constructed in 2008;

- **Donald Cousens Parkway Individual Ramp South to East** – Local traffic conditions would not be adversely affected, with very modest net increases in northbound traffic on the Donald Cousens Parkway south extension. Net increases in travel on Highway 407 would result in a net positive investment status if constructed after 2020;

- **Ninth Line Ramps from South** – Local traffic conditions would not be adversely affected, with net increases of about 30% by 2011 in northbound traffic on Ninth Line south of Highway 407. Net increases in travel on Highway 407 would result in a positive investment status if constructed in 2008; and

- **Ninth Line Ramps from South & Donald Cousens Parkway South to West Ramp Package** – Local traffic conditions would not be adversely affected, with net increases of about 50% by 2011 in northbound traffic on Ninth Line south of Highway 407. This increase in traffic does not lead to unacceptable levels of congestion[1]. Net increases in travel on Highway 407 would result in a positive investment status if constructed in 2008.

- **Centre Street Ramps to/from West** – Local traffic conditions would be adversely affected, with net increases of about 15% by 2011 in westbound traffic for Options No. 1 and No. 2 on Centre Street east of Highway 407 leading to very high levels of

[1] Note that the increase for this option would be larger than that for the Ninth Line Ramps from South option due to the construction of the Donald Cousens Parkway south extension in the base case.

congestion from already poor conditions. Impacts for Option No. 3 would be reduced. For Options No. 1 and No. 2, net increases in travel on Highway 407 would not result in a neutral investment status if constructed around 2021. Option No. 3 would not reach a positive investment status within the timeframe of the study regardless of property acquisition costs;

- **Kipling Avenue Ramps to/from East and from West –** Local traffic conditions would not be adversely affected, with net increases of about 160% by 2011 in southbound traffic on the Kipling extension south of Highway 407 not leading to unacceptable levels of congestion. Net increases in travel on Highway 407 would result in a neutral investment status if constructed around 2031 if property acquisition costs are not included; otherwise, it would not become positive within the timeframe of this study; and

- **Martin Grove Road Ramps to/from East –** Local traffic conditions would not be adversely affected, with net increases of about 65% by 2011 in northbound traffic on Martin Grove Road south of Highway 407 not leading to unacceptable levels of congestion. Net increases in travel on Highway 407 would result in a positive investment status if constructed in 2008, regardless of property acquisition costs.

**Exhibit 4-1: Summary of Five-Year Net Present Value for New Ramps by Year of Construction, Millions of Year 2007 Dollars**

| Year Constructed | Donald Cousens South to West | Donald Cousens South to East | Ninth Line from South | Ninth Line & Don Cousens South to West | Centre to/from West Opt. No. 1 | Centre to/from West Opt. No. 2 | Centre to/from West Opt. No. 3 w/ Property | Centre to/from West Opt. No. 3 w/o Property | Kipling to/from East & from West w/ Property | Kipling to/from East & from West w/o Property | Martin Grove to/from E w/ Property | Martin Grove to/from E w/o Property |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2008 | $1.8 | -$3.9 | $1.5 | $1.1 | -$4.5 | -$5.3 | -$68.8 | -$53.8 | -$47.3 | -$37.8 | $5.2 | $6.2 |
| 2011 | $2.5 | -$2.5 | $3.1 | $3.2 | -$3.3 | -$4.0 | -$58.9 | -$45.9 | -$38.4 | -$30.2 | $6.6 | $7.5 |
| 2021 | $5.0 | $0.3 | $6.7 | $8.2 | $0.4 | $0.0 | -$33.7 | -$25.8 | -$15.9 | -$10.9 | $10.8 | $11.3 |
| 2031 | $7.7 | $3.7 | $11.0 | $13.8 | $4.3 | $4.1 | -$16.6 | -$11.7 | -$0.8 | $2.3 | $14.4 | $14.7 |

## 4.2 Final Conclusions

The final conclusions of this study are summarised in Exhibit 4-2.

**Exhibit 4-2: Summary of Study Final Conclusions**

| Interchange Option | Feasible? | Five-Year Payback | |
|---|---|---|---|
| | | Within Study Horizon? | If Yes, When? |
| Donald Cousens Parkway South to West | Yes | Yes | Now |
| Donald Cousens Parkway South to East | Yes | Yes | About 2021 |
| Ninth Line from South | Yes | Yes | Now |
| Ninth Line from South and DCP South to West | Yes | Yes | Now |
| Leslie Street Option #1 | No | N/a | N/a |
| Leslie Street Option #2 | No | N/a | N/a |
| Centre Street Option #1 | Yes | Yes | About 2021 |
| Centre Street Option #2 | Yes | Yes | About 2021 |
| Centre Street Option #3 | Yes | No | N/a |
| Islington Avenue to/from West | No | N/a | N/a |
| Kipling Avenue to/from East and from West[1] | Yes | Yes | About 2031 |
| Martin Grove Road to/from East[1] | Yes | Yes | Now |

[1] Note that the Kipling Avenue and Martin Grove Road ramps cannot be constructed together.

# APPENDIX A

## FEASIBLE OPTION FIVE-YEAR NET PRESENT VALUE RESULTS

| Year Constructed | Martin Grove to/from East w/ Property | Martin Grove to/from East w/o Property | Kipling to/from East & from West w/ Property | Kipling to/from East & from West w/o Property | Centre to/from West Opt. #1 | Centre to/from West Opt. #2 | Centre to/from West Opt. #3 w/ Property | Centre to/from West Opt. #3 w/o Property | Ninth Line South to West | Ninth Line South to East | Ninth Line from South | Don Cousens South to West | Don Cousens South to East | Don Cousens from South | Ninth Line S to W & Don Cousens S to W | Ninth Line S to E & Don Cousens S to E | Ninth Line from South & Don Cousens S to W | Ninth Line from South & Don Cousens S to E | Ninth Line S to W & Don Cousens from South | Ninth Line S to E & Don Cousens from South | Ninth Line from South & Don Cousens from South |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2008 | $5.2 | $6.2 | -$47.3 | -$37.8 | -$4.5 | -$5.3 | -$68.8 | -$53.8 | $2.1 | -$0.6 | $1.5 | $1.8 | -$3.9 | -$2.1 | $1.7 | -$5.7 | $1.1 | -$3.7 | -$2.2 | -$3.9 | -$4.0 |
| 2009 | $5.7 | $6.6 | -$44.2 | -$35.2 | -$4.1 | -$4.8 | -$65.4 | -$51.1 | $2.3 | -$0.3 | $2.0 | $2.1 | -$3.4 | -$1.3 | $2.1 | -$5.0 | $1.8 | -$2.7 | -$1.3 | -$3.0 | -$2.9 |
| 2010 | $6.1 | $7.0 | -$41.3 | -$32.7 | -$3.7 | -$4.4 | -$62.1 | -$48.4 | $2.5 | $0.1 | $2.6 | $2.3 | -$2.9 | -$0.6 | $2.5 | -$4.3 | $2.5 | -$1.8 | -$0.4 | -$2.0 | -$1.9 |
| 2011 | $6.6 | $7.5 | -$38.4 | -$30.2 | -$3.3 | -$4.0 | -$58.9 | -$45.9 | $2.7 | $0.4 | $3.1 | $2.5 | -$2.5 | $0.1 | $2.8 | -$3.7 | $3.2 | -$1.0 | $0.4 | -$1.2 | -$0.9 |
| 2012 | $7.1 | $7.9 | -$35.7 | -$27.9 | -$2.9 | -$3.6 | -$55.8 | -$43.5 | $2.9 | $0.7 | $3.6 | $2.8 | -$2.0 | $0.7 | $3.2 | -$3.1 | $3.9 | -$0.2 | $1.2 | -$0.3 | $0.1 |
| 2013 | $7.5 | $8.3 | -$33.1 | -$25.7 | -$2.5 | -$3.1 | -$52.9 | -$41.2 | $3.1 | $0.8 | $3.9 | $3.0 | -$1.8 | $1.2 | $3.5 | -$2.7 | $4.3 | $0.4 | $1.8 | $0.3 | $0.8 |
| 2014 | $7.9 | $8.7 | -$30.7 | -$23.6 | -$2.1 | -$2.7 | -$50.2 | -$39.0 | $3.3 | $0.9 | $4.2 | $3.3 | -$1.5 | $1.7 | $3.9 | -$2.4 | $4.8 | $1.0 | $2.4 | $0.9 | $1.5 |
| 2015 | $8.4 | $9.1 | -$28.3 | -$21.5 | -$1.8 | -$2.3 | -$47.5 | -$36.9 | $3.5 | $1.0 | $4.5 | $3.5 | -$1.3 | $2.2 | $4.2 | -$2.0 | $5.2 | $1.5 | $3.0 | $1.5 | $2.2 |
| 2016 | $8.8 | $9.4 | -$26.0 | -$19.6 | -$1.4 | -$2.0 | -$45.0 | -$34.8 | $3.7 | $1.1 | $4.8 | $3.7 | -$1.1 | $2.7 | $4.6 | -$1.7 | $5.7 | $2.0 | $3.5 | $2.0 | $2.9 |
| 2017 | $9.2 | $9.8 | -$23.8 | -$17.7 | -$1.0 | -$1.6 | -$42.5 | -$32.9 | $4.0 | $1.2 | $5.2 | $4.0 | -$0.8 | $3.2 | $4.9 | -$1.4 | $6.1 | $2.6 | $4.1 | $2.6 | $3.5 |
| 2018 | $9.6 | $10.2 | -$21.7 | -$15.9 | -$0.7 | -$1.2 | -$40.2 | -$31.0 | $4.2 | $1.4 | $5.5 | $4.2 | -$0.6 | $3.7 | $5.3 | -$1.0 | $6.6 | $3.1 | $4.7 | $3.2 | $4.2 |
| 2019 | $10.0 | $10.6 | -$19.7 | -$14.1 | -$0.3 | -$0.8 | -$37.9 | -$29.2 | $4.4 | $1.5 | $5.9 | $4.5 | -$0.3 | $4.2 | $5.6 | -$0.6 | $7.1 | $3.7 | $5.3 | $3.8 | $5.0 |
| 2020 | $10.4 | $10.9 | -$17.8 | -$12.5 | $0.0 | -$0.4 | -$35.8 | -$27.4 | $4.6 | $1.7 | $6.3 | $4.7 | $0.0 | $4.7 | $5.9 | -$0.2 | $7.6 | $4.3 | $6.0 | $4.5 | $5.7 |
| 2021 | $10.8 | $11.3 | -$15.9 | -$10.9 | $0.4 | $0.0 | -$33.7 | -$25.8 | $4.8 | $1.9 | $6.7 | $5.0 | $0.3 | $5.3 | $6.3 | $0.2 | $8.2 | $5.0 | $6.6 | $5.2 | $6.5 |
| 2022 | $11.1 | $11.6 | -$14.1 | -$9.3 | $0.8 | $0.4 | -$31.7 | -$24.2 | $5.0 | $2.1 | $7.1 | $5.2 | $0.7 | $5.9 | $6.6 | $0.6 | $8.7 | $5.6 | $7.3 | $5.9 | $7.2 |
| 2023 | $11.5 | $12.0 | -$12.4 | -$7.8 | $1.1 | $0.8 | -$29.8 | -$22.6 | $5.2 | $2.3 | $7.5 | $5.5 | $1.0 | $6.5 | $6.9 | $1.1 | $9.3 | $6.2 | $7.9 | $6.5 | $8.0 |
| 2024 | $11.9 | $12.3 | -$10.8 | -$6.4 | $1.5 | $1.2 | -$28.0 | -$21.1 | $5.4 | $2.5 | $7.9 | $5.7 | $1.3 | $7.0 | $7.3 | $1.5 | $9.8 | $6.9 | $8.6 | $7.2 | $8.8 |
| 2025 | $12.3 | $12.7 | -$9.2 | -$5.0 | $1.9 | $1.5 | -$26.2 | -$19.6 | $5.6 | $2.8 | $8.3 | $6.0 | $1.6 | $7.6 | $7.6 | $1.9 | $10.4 | $7.5 | $9.2 | $7.9 | $9.5 |
| 2026 | $12.6 | $13.0 | -$7.6 | -$3.7 | $2.3 | $1.9 | -$24.5 | -$18.2 | $5.8 | $3.0 | $8.8 | $6.3 | $2.0 | $8.2 | $7.9 | $2.4 | $10.9 | $8.2 | $9.9 | $8.7 | $10.3 |
| 2027 | $13.0 | $13.4 | -$6.2 | -$2.4 | $2.7 | $2.4 | -$22.8 | -$16.9 | $6.0 | $3.2 | $9.2 | $6.5 | $2.3 | $8.8 | $8.3 | $2.8 | $11.5 | $8.8 | $10.6 | $9.4 | $11.1 |
| 2028 | $13.3 | $13.7 | -$4.7 | -$1.2 | $3.1 | $2.8 | -$21.2 | -$15.5 | $6.2 | $3.4 | $9.6 | $6.8 | $2.6 | $9.5 | $8.6 | $3.3 | $12.0 | $9.5 | $11.2 | $10.1 | $11.9 |
| 2029 | $13.7 | $14.1 | -$3.4 | $0.0 | $3.5 | $3.2 | -$19.6 | -$14.2 | $6.4 | $3.7 | $10.1 | $7.1 | $3.0 | $10.1 | $8.9 | $3.7 | $12.6 | $10.1 | $11.9 | $10.8 | $12.7 |
| 2030 | $14.1 | $14.4 | -$2.1 | $1.2 | $3.9 | $3.6 | -$18.1 | -$13.0 | $6.6 | $3.9 | $10.5 | $7.4 | $3.3 | $10.7 | $9.3 | $4.2 | $13.2 | $10.8 | $12.6 | $11.6 | $13.5 |
| 2031 | $14.4 | $14.7 | -$0.8 | $2.3 | $4.3 | $4.1 | -$16.6 | -$11.7 | $6.8 | $4.2 | $11.0 | $7.7 | $3.7 | $11.4 | $9.6 | $4.6 | $13.8 | $11.5 | $13.3 | $12.3 | $14.3 |