Ameliorate

A8ern8, Zaanstadt, The Netherlands

Background

The City Council of this small suburb 16 kilometers (10 miles) north of Amsterdam undertook in 2003 an initiative to create a new town square. The project sought to reactivate the space under A8, a 7-meter-tall elevated highway.

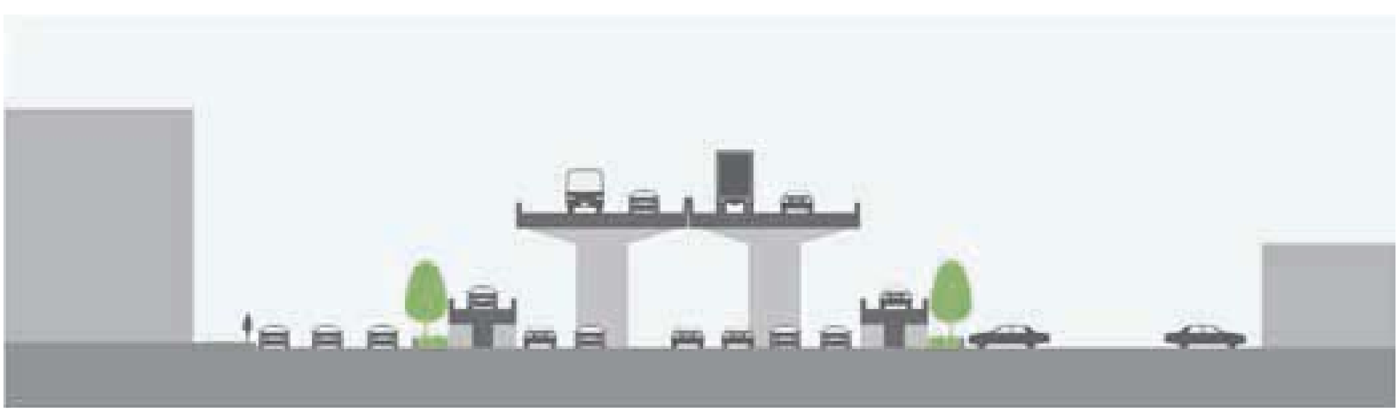
A8 enters town from the east, just after spanning the River Zaan. When constructed in the 1970s, A8 formed a harsh physical barrier between the town's two civic activity centers, the church and town hall. Residents of the low-slung apartment blocks and townhouses in the surrounding neighborhood lost their river views and access. The effort to redesign A8 was advocated for primarily by residents and private businesses. At the time of the Council's initiative, A8's underside was mostly used for parking.

NL Architects, the town's design consultant, conceptualized the 40- by 400-meter area as a long "civic arcade". The introduction of new programs, cladding of the elevated structure, and surface treatments transformed A8 from a barrier into a gathering place. In addition, adjacent streetscape improvements re-established visual and physical connections among the town's three public realms – the river, church, and town hall.

The project cost was €2.7 million. A8ernA was awarded the European Prize for Urban Public Space in 2006.

Urban Design

Stakeholder input established the key project objective to create an open and simple meeting place and public face for the town. This objective responded directly to A8's



A8ern8 Highway Section – Before (1970s to 2000s); an Albert Heijn grocery store opened under the highway along with other neighborhood retail (above).

impact on the town fabric. A8 is a physical barrier between the north and south sides of town and the River Zaan. Aesthetically, it detracts from the surrounding architecture and natural landscape. Lastly, it diminishes use of public spaces next to the church and town hall.

Program is key to achieving the project objective. A variety of uses were introduced into the site, appealing to a range of town resident needs and interests. For this reason, A8ernA attracts residents of all ages.

The retail program includes an Albert Heijn supermarket, a pet shop, and flower shop as well as 120 parking spaces. Albert Heijn, in particular, was attracted to the site because it offered a highway accessibility and a rare opportunity for a large floor plate in town.

A skateboarding park, basketball courts, and ping pong tables provide youth with recreation amenities. A graffiti gallery serves as a public art component. A small marina with public seating was constructed where A8 lifts over the Zaan, opening up river views.

Material selection and surface treatment makes A8's understory inviting and attractive. Structural columns were clad in a variety of materials, including herringbone-patterned timber and reflective steel, into which back-lit lettering is dye-cut. Similarly, ground treatments – from timber decking to orange surface paint – differentiate program spaces.

Process

The A8ernA project was coordinated with a larger, city-wide planning effort to identify redevelopment sites for 10 new squares in Zaanstadt. Alternatives for at-grade or tunnel replacement of A8 were not seriously considered due to high costs.

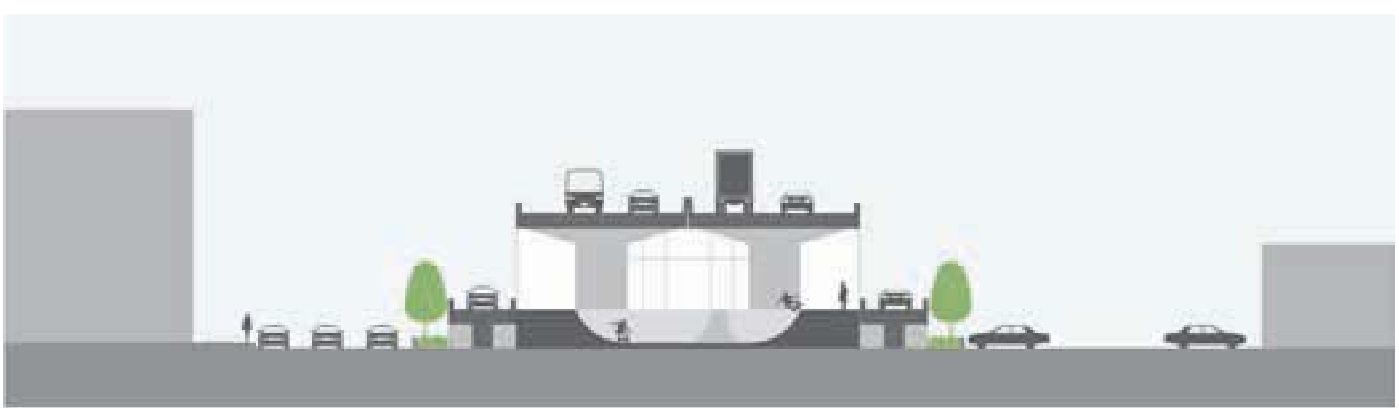
The Mayor and City Council, church officials, merchants, and residents participated in the planning process. Stakeholder objectives and desires guided the design process. NL Architects incorporated nearly all community program requests into the final design.

The businesses under A8 have been incredibly successful. Albert Heijn has expressed interest in expanding and bringing in additional in-line retail.

Cladding and lighting on the highway columns makes the space more inviting; the skate-park generates amble activity.

LESSONS OF A8ERN8

- A8ernA shows it is possible to live with an elevated structure. This project adapts a visually repetitive space (concrete overhead, evenly space piers) with programmatic and visual diversity. The provision of a density of small programs and spaces with different characters makes an unappealing environment attractive.
- The project was driven, in part, by private market interest in utilizing a unique retail site.
- A8ernA is a small scale project guided by a highly participatory planning process. The process illustrates that a full range of stakeholder desires can be incorporated into project implementation without diminishing design quality or resorting to the "lowest common denominator".



A8ern8 Highway Section – After (Existing)

Ameliorate

Viaduct des Arts, Paris, France

Background

The Viaduct des Arts / Promenade Plantee is a 2-kilometer (1.25-mile) elevated railway structure in the 12th arrondissment of Paris. The viaduct runs parallel to Avenue Daumesnil within a dense residential neighborhood of five- to six-story buildings.

The brick and masonry viaduct was constructed in the nineteenth century. The railroad closed in 1969. From its closure to the late-1990s, the viaduct's large archways were episodically occupied by assortments of antique shops, auto garages, used bookstores, and other uses.

Atelier Parisien d' Urbanisme (APUR), the city's urban design agency, developed in the 1980s an historic restoration strategy for the viaduct. The plan proposed re-tenanting the 64 archways with artists, craftspeople, and restaurants. In addition, it included a new linear park and gardens overhead, which were designed by Philippe Mathieu and Jacques Vergely. APUR partnered with a local development corporation to identify and manage new tenants.

Whereas there were studios and workshops in the viaduct prior to renovation, the APUR project represented significant up-scaling of both the viaduct and Avenue Daumesnil.

Urban Design

By the 1980s the viaduct was considered an urban eyesore. Its shops did not contribute positively to neighborhood identity. In addition, the city had recently invested in the *grand projet*, Opera Bastille. As such, the Opera Bastille brought with it benefits for other area redevelopment and public amenities. The viaduct's eventual restoration was intended to enhance neighborhood retail, but also to create a contemporary Paris landmark.

The viaduct and promenade design emphasizes the structure's character and visual connections to the city. The archway restoration, designed by Patrick Berger, is intended to minimally distract from the structure's historic character. Glass cladding over the archways is set back in order to accentuate the masonry, which was restored in

Views of the city below are a key element of the Promenade design.

The archways under the viaduct provide space for artist studios, workshops, and restaurants.

the style of the Place des Vosges arcades. The promenade offers a range of gardens – some of which enclose visitors in landscape, others frame city views.

At street-level, a six-meter-wide (20-feet) tree-lined sidewalk separates the viaduct from a three-lane one-way street.

The project also addresses railroad embankment reuse, though less successfully. At the viaduct's eastern end, the promenade continues on an embankment. The restoration includes new retail constructed along the embankment. The architecture here, however, is far less appealing than the restored viaduct.

Process

The decision to retain and renovate the viaduct was guided by both design considerations and strategic coordination with other planning initiatives. APUR studied two alternatives in the 1980s – demolish and redevelop reclaimed land, or restore and create an elevated linear park.

The park alternative was an opportunity to build upon the recently completed *grand project*, the Opera Bastille, by adding another new public amenity. At the same time, the viaduct's north side orients towards backs of existing buildings. Demolishing the viaduct would create the difficult task of integrating these revealed buildings, now visually prominent, into the streetscape.

Most importantly, the park alternative aligned with APUR's new agency focus on "greening the city".

The Viaduct des Arts and Promenade Plantee were advanced as two separate, but interconnected projects. The Paris parks department manages the Promenade. A local development corporation manages the archway spaces and adjacent developments under an 18-year lease.

The dual-management structure is faulted for the viaduct's limited economic impact. Because two organizations manage the structure, a clear strategy has not be defined for coordinating viaduct activities with neighborhood development and promoting it throughout the city.

LESSONS OF VIADUCT DES ARTS / PROMENADE PLANTEE

- APUR advanced partnership with a local development corporation as a strategy for enhancing retail and residential development as well as strengthening the neighborhood's identity.
- The Promenade Plantee illustrates how potentially incompatible programs – when distributed on different levels – might co-exist in the same place. The tranquil elevated linear park is separated from the bustle of the retail street below.
- The Viaduct des Arts demonstrates a potential benefit to retaining existing infrastructure. Containing new uses in an historic structure creates a sense of connections between the past and present.
- The Viaduct des Arts shows how existing infrastructure may be successfully integrated into the public realm.

The upper level of the viaduct is a a 4 kilometer (2.5 miles) linear park.

Some archways are left open to increase pedestrian connectivity within the neighborhood.

Ameliorate

East River Esplanade, New York, NY

Background

The East River Esplanade is a planned 3.2-kilometer-long (2-mile) series of public spaces along the Lower Manhattan waterfront and below F.D.R. Drive, an elevated highway.

The F.D.R. was constructed in 1954. The highway extends over more than 125 city blocks from Battery Park, north along the East River to Harlem. In Lower Manhattan, it forms a barrier between downtown neighborhoods and the waterfront. The Esplanade planning area includes six waterfront districts, from the Financial District to the Lower East Side. The area is characterized by high-density development – office towers to the south, "towers-in-the-park" housing development to the north.

This project is one among many public realm and redevelopment efforts sponsored since September 11th by the Lower Manhattan Development Corporation, Department of City Planning, and Economic Development Corporation. Population in Lower Manhattan has doubled – from 23,000 to 56,000 – in just eight years. The Esplanade is for that reason linked to Lower Manhattan's transformation into a residential neighborhood and efforts to attract investment.

SHoP and Ken Smith Landscape Architects, the City's consultants, developed a plan for new programs, upland connections, and open spaces on historic slips and piers. New program pavilions under the F.D.R. and surface treatments to its structure provide a transition from Lower Manhattan to the waterfront.

The project is funded by US $150 million from the Lower Manhattan Development Corporation.

Urban Design

The F.D.R. poses development barriers at both neighborhood and city scales. Within Lower Manhattan, it reduces access to inter-modal transportation – ferry and helicopter – and retail on East River piers. Improved access will most directly benefit new area residents. At

Rendering by SHoP of cladding, surfaces, plantings, and pavilions under F.D.R. Drive.

the same time, the Esplanade is one among several new open spaces in New York Harbor, including Governor's Island. The Esplanade is thus also considered a city-scale development strategy.

The Esplanade creates benefits at both neighborhood and city scales through connections, program, and public realm. The design includes a diverse, yet visually coordinated streetscape and exterior furnishings palette. New seating, planters, arbors, and landforms upland create public spaces and mark pedestrian paths to the river.

The environment under the F.D.R. is also improved so as to provide continuity of urban activity from upland neighborhoods to the river. New glass pavilions – 1,500 to 8,000 SF in size – are proposed to accommodate a range of retail, food, and community-requested programs. The underside of the F.D.R. will be clad with a modular system of noise-abating panels and lighting. The design approach treats the elevated structure as a "roof", creating a safe and inviting environment.

The plan also addresses, in contrast to the Westway, ecological impacts on aquatic life. Existing piers will be renovated to increase water flow through piles. Reef-balls will be installed at pile bases to encourage fish habitat formation.

Process

The purpose of the project was primarily esplanade design, and so highway removal alternatives were not considered in detail. The Environmental Impact Statement proposed two additional alternatives.

The first studied scenarios for building two to six residential towers over the F.D.R. Construction feasibility and cost ruled out this alternative. The second proposed replacing the F.D.R. with an at-grade boulevard.

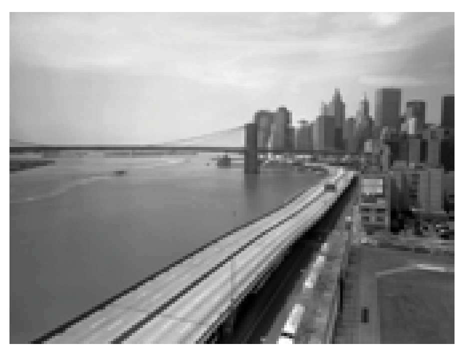
The F.D.R. has excess capacity in its Lower Manhattan segment. However, accommodating existing capacity would require a six-lane at-grade boulevard – which would limit land available for the esplanade. There was therefore a trade-off between the boulevard alternative and potential public space created.

Though construction is publically funded, the Esplanade's US $3.5 million operating budget has a projected shortfall of 50 to 66 percent.

LESSONS OF THE EAST RIVER ESPLANADE

- The Esplanade design embraced the elevated structure and its form as an opportunity, leading to innovative approaches to public realm creation and a visually distinguished urban space.
- This public amenity is created in the context of an existing commuter population of hundreds of thousands, growing residential population, and public and private investments.
- The continued presence of the F.D.R. increases development costs for other waterfront sites. Construction costs for redevelopment of South Street Seaport, for example, were increased due to presence of the elevated highway.

Rendering by SHoP of Esplandade south of Brooklyn Bridge.



Views of F.D.R. along the East River facing south towards Lower Manhattan.

Do Nothing

Buffalo Skyway / Route 5, Buffalo, NY

Background

Ongoing improvement studies to Route 5, a limited access highway on Buffalo's south side, have prompted city and state leaders to call for removal of the Buffalo Skyway.

The Buffalo Skyway was constructed in 1966. The elevated structure is 360 meters tall (110 feet). It approaches downtown Buffalo from the south, crossing from the Outer Harbor over the Buffalo River. Route 5 is a grade-separated highway to the south and is the only highway that connects to the Skyway. Route 5 extends south 7 kilometers (4.3 miles) through the Outer Harbor, a manufacturing district on Lake Erie.

The New York State Department of Transportation (NYSDOT) undertook studies in 2006 to improve Outer Harbor access and potentially replace Route 5 with a boulevard. The studies did not consider alternatives for the Skyway. Yet because the Skyway is an extension of Route 5, its future is contingent on the EIS outcome.

Buffalo's Mayor and the local Congressman both support study of the Skyway's demolition. They cite another NYSDOT "management study" that shows long-term Skyway maintenance – ranging from 50 to 75 years – would cost more than demolition. However, the Route 5 EIS recommends a design that provides no new bridges over the Buffalo River.

Because the Skyway provides the only access from Route 5 into downtown, the recommended design for Route 5 rules out future removal of the Skyway.

Urban Design

The Skyway decreases access to a planned waterfront pedestrian and bicycle greenway and places an urban eyesore on views of Lake Erie and the Buffalo skyline. The Skyway is closed frequently due to snow and auto accidents.

Yet its most significant measure may be opportunity cost. Redevelopment of 25 acres of land reclaimed from Skyway demolition

The Skyway is 360 meters (110 feet) tall.

would return US $47.5 million. Altogether, an at-grade configuration would open up 77 acres to redevelopment, much of which would be sold by NYSDOT. In addition, the at-grade alternative makes redevelopment of Buffalo's Inner Harbor waterfront area complex. Similarly, Route 5, in its present configuration, reduces potential Outer Harbor development.

The broad benefits from replacing Route 5 and the Skyway with at-grade roads are public waterfront connections and new development opportunities. Urban design considerations, however, are for the most part absent from the NYSDOT EIS. The recommended alternative, for example, leaves in place the highway embankment, a significant physical and visual barrier. The alternative also recommends expanding a parallel service road – Furhmann Boulevard. Doing so uses land for infrastructure and offers minimal new waterfront access.

Process

NYSDOT evaluated four alternatives for Route 5: no action; modifying ramps and interchanges; replacement with a six-lane boulevard; and a hybrid of the modify and boulevard alternatives.

The selection of the second alternative – modify – appears most directly based on cost. All four alternatives scored roughly equal when evaluated against quantitative and qualitative objectives. These ranged from level-of-service and travel time to waterfront access and neighborhood impact. Yet the second alternative's estimated cost was US $95.1 million, whereas the boulevard's was US $124 million.

Despite NYSDOT's recommendation to retain the Skyway and Route 5, several public and private waterfront developments are planned. The "Greenbelt" project will spend US $14 million to improve 2 kilometers (1.25 miles) of Lake Erie Shoreline. A 12.5-acre, US $53 million redevelopment project was recently completed in Buffalo's Inner Harbor. Another $100 million of other cultural and civic improvements for the waterfront are also planned.

While the Mayor and Congressman support further study for Skyway demolition, decision-making authority rests with NYSDOT.

LESSONS OF THE BUFFALO SKYWAY

- At-grade alternative offers opportunity for state to recapture value of public infrastructure investment by selling land reclaimed through highway removal.
- Current NYSDOT recommendation uses waterfront land for infrastructure development and fragments existing development parcels.

View of Skyway facing south.

Route 5 is a significant barrier to the Outer Harbor.

Do Nothing

Whitehurst Freeway, Washington, D.C.

Background

The Whitehurst Freeway is a 1.2 kilometer (0.75 mile) four-lane elevated highway in the Georgetown neighborhood of Washington, D.C. The District Department of Transportation (DDOT) initiated in 2005 replacement studies for the Whitehurst, seven years following a major renovation. The Mayor abruptly discontinued DDOT's studies in 2007.

Georgetown is a medium density mixed-use neighborhood northwest of downtown D.C. The Whitehurst Freeway was constructed in 1949 along the Potomac River, which forms Georgetown's southern edge. 45,000 drivers use the highway daily, many of which commute downtown from northwest D.C., Maryland, and Virginia. A significant link exists at the Whitehurst's western end where it meets Francis Scott Key Bridge, which connects to Virginia.

A 10-acre park, Georgetown Waterfront Park, was constructed by the National Park Service in the mid-2000s along the Potomac River in the area riverside of the Whitehurst Freeway.

Urban Design

The Whitehurst's neighborhood impact is particularly accentuated by the development of the new waterfront park. Whereas the surrounding area was characterized by lumberyards and meat packing plants when the Whitehurst was constructed, today Georgetown is a gentrified, mixed-use neighborhood.

The freeway poses a barrier for pedestrian connections. Just a single transportation mode – automobile – is accommodated along the waterfront. Additionally, real estate values that might benefit from the new park are diminished by the Whitehurst's proximity.

The DDOT study focused most specifically on accommodating peak traffic volumes. Preserving river views and improving pedestrian connections were project objectives, but urban design was not a significant consideration. In fact, DDOT's emphasis on traffic appears to have focused public attention on congestion, distracting dialogue from potential design benefits.

The Whitehurst Freeway along the Potomac River.

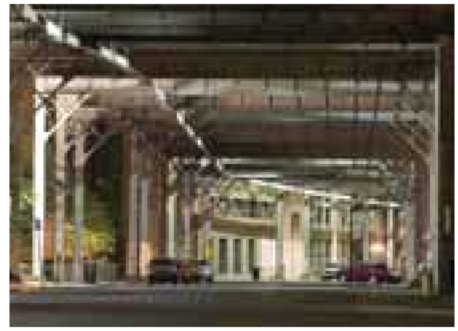
Process

The Whitehurst Freeway was renovated in 1998 at a cost of $35 million. The decision to rehabilitate the freeway followed a study that also considered demolition. Since then, the area experienced increasing high-value development, including a Ritz-Carlton residence and a movie theater. The case made regarding the elevated freeway was that its removal will help to achieve the waterfront's full revitalization potential.

DDOT studied four families of alternatives: no build; replacing the Whitehurst with a six-lane at-grade boulevard with connections to Key Bridge; a six-lane at-grade boulevard without connections to Key Bridge; and replacing the Whitehurst with a tunnel. Altogether, 19 alternatives were developed within these four families.

Design alternatives, however, dwelled on specific minor changes rather than posing distinct design concepts. The evaluation criteria were similarly complicated. Each alternative was scored against 28 criteria. Each criteria score was then weighted based on a level of significance established through public input.

Ultimately, the five highest-scoring designs represented each of the three build alternatives. The alternatives evaluation process did not therefore provide a clear design direction.



Existing condition on K Street under the elevated structure.

LESSONS OF THE WHITEHURST FREEWAY

- Public dialogue focused on congestion issues and perceived potential for project to contribute to further gentrification of Georgetown.
- The Whitehurst Freeway serves a role in regional commuting patterns. However, the study did not analyze regional impacts of removing the highway.
- The case to remove the Whitehurst Freeway was weakened since $35 million had been invested in its rehabilitation in the last decade.

New Georgetown Waterfront Park – Whitehurst Freeway is visible to the right, Francis Scott Key Bridge in the background.

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"Teasers" and Boulevards

“Teasers”

WHAT IS A “TEASER”?

The following precedents address the challenges of urban highways and elevated structures in ambitious and innovative ways.

These projects combine landscape architecture, infrastructure design, pedestrian realm planning, and development to create unique and dramatic spaces in the city.

Waterfront Park – Louisville, KY

- This park designed by Hargreaves slopes under I-64, providing a new waterfront connection.

Voie George Pompidou – Paris, France

- In summer, the highway along the Seine riverbanks is closed, making way for “Paris plages” – temporary urban beaches.

Carrasco Square – Amsterdam, The Netherlands

- Surface materials activate the space under an eleavated rail in this project by West 8.





The High Line – New York, NY

- A decommissioned evelated rail in Manhattan has been re-imagined by Field Operations as a linear park. The new Standard Hotel is partially built on air-rights over the High Line. Steven Holl's 1981 conceptual project "Bridge of Houses" (left) proposed housing on the High Line.


Slussen International Design Competition (2009) – Stockholm, Sweden

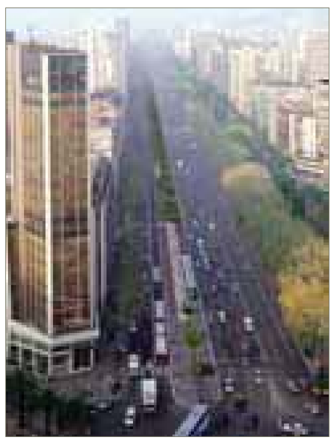
- Jean Nouvel proposes to create a Ponte Vecchio-esque pedestrian bridge of shops and restaurants atop a 1950s-era highway in downtown Stockholm.

“Teasers” and Urban Boulevards

STREETS AS CIVIC SPACES

Prominent urban boulevards often provide separate spaces for pedestrians and bicyclists as well as generous landscape and tree canopy.

These precedents from around the world offer ideas for improving the streetscape quality in the Gardiner Expressway and Lake Shore Boulevard area.



Avinguda Diagonal – Barcelona, Spain

- The Diagonal separates local and thru-traffic and provides bicycle and pedestrian realm.

Pacific Boulevard – Vancouver, British Columbia

- Vancouver recently enhanced landscape, lighting, and sidewalks on Pacific Boulevard.

University Avenue – Toronto, ON

- University Avenue serves as a significant civic space for the city.

Eastern Parkway – Brooklyn, NY

- A generous promenade is part on this Olmstead-designed boulevard.

Octavia Boulevard – San Francisco, CA

- This boulevard replaced the Central Freeway, an elevated highway.

Shanghai Street Greening – Shanghai, China

- Landscape planters enhance visual quality of elevated highways in Shanghai.

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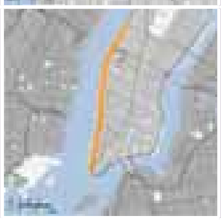
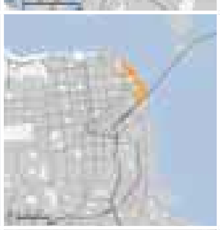
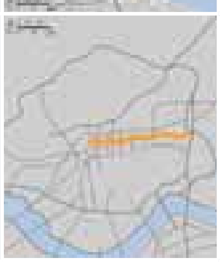
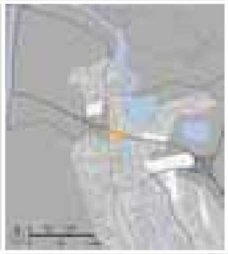
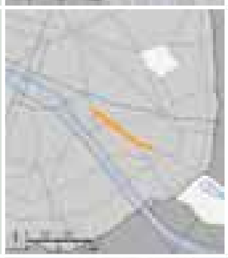
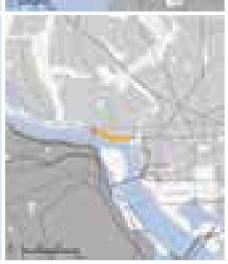
Summary Matrix

Case Study Summary Matrix

Name	Context	Type	Location	Age	Size	Vehicles per day
Gardiner Expressway	–	–	Toronto, Ontario	43	2.4 km (1.5 miles)	120,000
Alaskan Way Viaduct		Replace	Seattle, WA	50	3.2 km (2 mile)	110,000
West Side Highway Reconstruction Project / Westway		Replace / Remove	New York, NY	37 (at time of collapse in 1974)	8.2 km (5 miles)	140,000
Bonaventure Expressway		Remove	Montreal, Quebec	42	1 km (0.6 miles)	55,000
Riverfront Parkway / 21st Century Waterfront		Remove	Cattanooga, TN	50+ (at time of removal)	2.7 km (1.7 mile)	20,000
Embarcadero Freeway		Remove	San Francisco, CA	32 (at time of collapse)	2.5 km (1.6 mile)	80,000
Cheonggyecheon Restoration Project		Remove	Seoul, Korea	24 (at time of removal)	6.1 km (3.75 miles)	120,000
Sheridan Expressway		Remove	Bronx, NY	47	2 km (1.25 mile)	40,000

Urban Design Goals	Open Space Goals	Transportation Goals	Economic Dev. Goals
–	–	–	–
• Increase pedestrian access to the waterfront. • Preserve and enhance views of waterfront and mountains.	• No significant open space goals beyond enhancing waterfront access.	• Replace elevated structure with deep bored tunnel and six-lane at-grade boulevard. • Provide new light rail along Viaduct route. • Public dialogue about alternatives considered whether future scenario should accommodate current traffic volumes or encourage mode-shift.	• Increase downtown and waterfront property values. • Grow tourism through new waterfront amenities. • Most waterfront land is privately-owned, so limited opportunity for City to recapture $4.24 billion public investment in the bored tunnel.
• Enhance pedestrian connections to waterfront.	• Boulevard design coordinated with plans and design guidelines for Hudson River Park and Manhattan Greenway.	• Demolish elevated highway and replace with six-lane at-grade boulevard. • Limit access in order to reduce congestion on neighborhood streets, but enhance role as collector-distribution road.	• Whereas Westway was intended to create long-term development opportunities on filled land, the West Side Highway created demand for adaptive reuse and infill.
• Reclaim 4.5 acres of development parcels for residential and office. • Enhance value of redevelopment in Cite Multimedia and Griffintown. • Create new entrance to the city. • Develop new retail under railroad viaduct.	• Provide access to Peel Basin, waterfront park network, and waterfront amenities.	• Demolish elevated expressway and expand two at-grade boulevards. • New light rail to reduce automobile demand. • Create new underground pedestrian network with connections to transit stations.	• Develop 12,500 new housing units. • Develop 900,000 square meters of commercial, and 1 million square meters of cultural and recreation space.
• Integrate downtown street grid with new urban boulevard, thereby creating new development parcels. • Connect downtown cultural amenities to the waterfront.	• New and reconstructed waterfront park, amenities, and amphitheater. • New pedestrian connections across Tennessee River.	• Replace grade-separated parkway with at-grade boulevard. • Reduce excess road capacity to meet existing demand.	• Create a framework for new development downtown and on the Tennessee River's north shore. • 21st Century Waterfront is estimated to have attracted US $2 billion in private investment.
• Complement new urban boulevard with waterfront esplanade, public art, and new retail and housing development. • Reconnect downtown San Francisco to the bay. • Restoration of the historic Ferry Building as a regional food market.	• New waterfront esplanade and pedestrian and bicycle greenway.	• Replace earthquake-damaged elevated highway with six-lane at-grade urban boulevard. • Advance city's "transit first" policies by providing new waterfront streetcar route.	• Reclaim 100 acres for new housing, office, and public space. • Encourage development of over 10,000 new housing units in adjacent neighborhoods.
• Advance Mayor's commitment to making Seoul a model for sustainable development. • Reverse property value and population decline in commercial and retail districts facing Cheonggyecheon Expressway.	• Create new open space amenity for entire city. • Day-light historic creek and create waterfront esplanade.	• Replace four-lane elevated expressway and ten-lane at-grade highway with two two-lane boulevards. • Create new bus rapid transit service on Cheonggyecheon route. • Reduce traffic demand through incentives for commuters to use transit and increasing user fees.	• Strengthen Seoul's position as a global financial center. • Government reported cost at US $390 million, though may have been as high as US $900 million. •
• Reclaim land for housing and waterfront open space. • Improve access to Hunts Point Market (wholesale food distribution center).	• Connect to planned Bronx River watershed greenway.	• The purpose of the study was to improve truck circulation into Hunts Point Market. A community plan proposed removing the highway. While the NYSDOT included this option in their study, it was ultimately not selected.	• Provide 1,200 affordable housing units and 700 jobs. • Enhance upland neighborhood property values by improving waterfront connections.

Case Study Summary Matrix

Name	Context	Type	Location	Age	Size	Vehicles per day
A8ern8		Ameliorate	Zaanstadt, Netherlands	30+	400 meters (0.25 miles)	N/A
Viaduct des Arts / Promenade Plantee		Ameliorate	Paris, France	150+	2 km (1.25 miles)	N/A
East River Waterfront Esplanade		Ameliorate	New York, NY	55	3.2 km (2 miles)	175,000
Buffalo Skyway / Route 5		Do Nothing	Buffalo, NY	43	1.6 km (1 mile)	43,400
Whitehurst Freeway		Do Nothing	Washington, D.C.	60	1.2 km (0.75 miles)	45,000

Urban Design Goals	Open Space Goals	Transportation Goals	Economic Dev. Goals
• Create a new "civic arcade". • Re-establish physical and visual connections between town center and waterfront. • Clad underside of elevated structure in order to create inviting environment. • Develop new retail under elevated structure.	• Provide a diversity of recreation programs that appeal to range of users and age-groups (skateboard park, basketball, and marina, among others).	• This project made no changes to existing highway configuration.	• Supermarket tenant was attracted to site that offered opportunity for highway accessibility and large floor-plate in town.
• Create a new Paris landmark through historic restoration of 19th-century infrastructure. • Strengthen role of Avenue Daumensil as a neighborhood cultural and retail corridor. • Advance city agency goal for "greening the city".	• Develop new 2.5-mile-long linear park on top of elevated rail viaduct.	• Railroad viaduct closed in 1969. This project had no significant transportation goals.	• Re-tenant retail and cultural spaces with up-scaled uses.
• Develop new public spaces and programmed pavilions under elevated highway. • Clad underside of elevated structure in order to create inviting environment. Elevated highway treated as "roof" for new public spaces. • Coordinate with and enhance other post-September 11th Lower Manhattan public realm and development initiatives.	• Develop network of upland public spaces, arbors, and planters that connect to waterfront esplanade.	• Street section and parking under elevated highway reconfigured in order to create pedestrian-friendly environment.	• Support overall post-September 11th planning for Lower Manhattan to provide new amenities for residents and works. • Advance transformation of Lower Manhattan into a residential district.
• Route 5 study does not consider significant urban design goals.	• Improve access to planned waterfront pedestrian and bicycle greenway.	• Improve access to Outer Harbor (manufacturing district on Lake Erie).	• At-grade option (not recommended by NYSDOT) would create value recapture opportunities for the state.
• Improve pedestrian access from neighborhood to Potomac River. • Preserve and improve river views.	• Connect to new waterfront park.	• Provide alternative route for 45,000 vehicles that use Whitehurst Freeway.	• Build on previous decade of increased property values by removing impediment to waterfront revitalization. • $35 million public investment in rehabilitating the freeway in 1998 weakened argument for its removal.

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Appendix C
PARAMICS Model Results Summary

TABLE OF CONTENTS

Page

List of Tables

1.0 Alternative Solutions

Four infrastructure networks were tested, referred to as Maintain, Improve, Replace, and Remove. All alternatives assumed the following new infrastructure projects as part of the transportation systems:

- Broadview Extension
- Richmond/Adelaide bicycle lanes
- Downtown Relief Line
- Waterfront West LRT
- Cherry Street LRT

The four Alternative Solutions are described below.

Maintain

This is the future base condition that is used as a baseline for comparison with the other alternatives. The Gardiner Expressway is not altered from today in this alternative; Lake Shore Boulevard is realigned between Parliament Street and the Don Roadway as per the local Precinct Plan. The basic cross-section assumptions within the Gardiner/ Lake Shore Boulevard corridor are described below.

Road Segment	Number of Traffic Lanes			
	Gardiner Expressway		Lake Shore Boulevard	
	W/B	E/B	W/B	E/B
Yonge – Jarvis	3	3	3	3
Jarvis – Sherbourne	3	3	3	3
Sherbourne – Parliament	3	3	3	3
Parliament – Cherry	3	3	3	3
Cherry – Don Roadway	3	3	3	3

Improve

The Improve alternative maintains the basic alignment and ramp locations of the Gardiner Expressway, but the cross-section of the Gardiner Expressway is reduced. Lake Shore Boulevard is realigned between Parliament Street and the Don Roadway as per the local Precinct

Plan. The basic cross-section assumptions within the Gardiner/ Lake Shore Boulevard corridor are described below.

Road Segment	**Number of Traffic Lanes**			
	Gardiner Expressway		**Lake Shore Boulevard**	
	W/B	**E/B**	**W/B**	**E/B**
Yonge – Jarvis	2	2	3	3
Jarvis – Sherbourne	2	2	3	3
Sherbourne – Parliament	2	2	3	3
Parliament – Cherry	2	2	3	3
Cherry – Don Roadway	2	2	3	3

Shoulders are added to the Gardiner Expressway to improve safety for users and modifications are made to the configuration of Gardiner Expressway ramp terminals to improve the pedestrian crossings of Lake Shore Boulevard. A multi-use pathway is also added to the north side of Lake Shore Boulevard between Jarvis Street and the Don Roadway.

Replace

The Replace alternative maintains the presence of the Gardiner Expressway and Lake Shore Boulevard, while reimagining the alignment, capacity, and access for both facilities. The Gardiner Expressway is reconstructed at a reduced capacity and modified alignment, as is Lake Shore Boulevard. The basic cross-section assumptions within the Gardiner/ Lake Shore Boulevard corridor are described below.

Road Segment	**Number of Traffic Lanes**			
	Gardiner Expressway		**Lake Shore Boulevard**	
	W/B	**E/B**	**W/B**	**E/B**
Yonge – Jarvis	2	2	2	2
Jarvis – Sherbourne	2	2	2	2
Sherbourne – Parliament	2	2	2	2
Parliament – Cherry	2	2	2	2
Cherry – Don Roadway	2	2	2	2

Shoulders are added to the Gardiner Expressway to improve safety for users and modifications are made to the configuration of Gardiner Expressway ramp terminals to improve the pedestrian crossings of Lake Shore Boulevard. A multi-use pathway is also added to the north side of Lake Shore Boulevard between Jarvis Street and the Don Roadway.

Remove

Under the Remove alternative, the Gardiner Expressway is removed between Jarvis Street and the Don Roadway and is brought to the surface to create a larger Lake Shore Boulevard. This is a major modification to the function of the infrastructure through the study area. The basic cross-section assumptions within the Gardiner/ Lake Shore Boulevard corridor are described below.

Road Segment	**Number of Traffic Lanes**			
	Gardiner Expressway		**Lake Shore Boulevard**	
	W/B	**E/B**	**W/B**	**E/B**
Yonge – Jarvis			4	4
Jarvis – Sherbourne			4	4
Sherbourne – Parliament			4	4
Parliament – Cherry			4	4
Cherry – Don Roadway			4	4

A multi-use pathway is added to the north side of Lake Shore Boulevard between Yonge Street and the Don Roadway.

2.0 DEMAND FORECASTING

2.1. Approach and Method

Forecasting for the Gardiner Expressway EA was undertaken for a 2031 horizon year for AM and PM commuter peak hour conditions.

The transportation modelling process used an integrated application of City of Toronto's regional planning model (in EMME/2 software) and a detailed operations model (in Paramics software) developed specifically for the project.

The EMME model provided the regional perspective on travel demand forecasting. It was used to forecast demands in the primary travel modes for Existing and 2031 conditions under the various alternative solutions. The EMME model accounts for the impacts of major road and transit infrastructure projects; growth in population and employment levels; and changes in travel patterns due to the new residential and employment areas expected to develop across the City (e.g., development of Lower Yonge, Keating, Don Lands, Port Lands will increase percentage of downtown employees who live downtown).

The Paramics model was used to develop the local assignment of auto volumes to study area roads. The study area extends from Dundas Street to Lake Ontario and from Spadina Avenue to Woodbine Avenue. While the EMME model projected auto demands on all major roads in the study area, it is a planning tool that does not account for fine operational details (e.g., delay at traffic signals, interaction with streetcars, etc.) and can be unreliable when used to project demands within a specific corridor or on a specific segment. The Paramics model took the aggregate auto demand and travel patterns for the study area from EMME and generated a more robust estimate of future auto demands.

2.2. Regional Demand Forecasts

Model results show little difference between Maintain, Improve and Replace Alternatives at a regional travel demand level; therefore one regional demand estimate was used for these three Alternatives. Model results for the Remove Alternative showed a difference in demand estimates; therefore a unique demand construct was used for this solution.

Initial Mode Shares

Table 1 shows the Initial 2031 Mode Shares for AM peak hour travel inbound across the Study Area boundaries, as projected by the EMME strategic demand forecasting model.

Table 1:
Initial 2031 Mode Shares Across Study Area Boundary
Projected by EMME Model

Travel Mode	Existing 2006 TTS	2031 Maintain/Improve/Replace	2031 Remove
Auto (Driver + Passenger)	31%	28%	28%
Transit (GO + TTC)	60%	66%	66%
Walking/ Cycling	6%	6%	6%
Other	3%	--	--

TDM Adjustments

Traditional strategic travel demand models such as the City of Toronto's EMME model applied on this project inherently have difficulty in representing the attitudinal shifts towards travel that may occur over time. They are attempting to predict the future by looking at the past and therefore may not accurately represent the choices of travellers in the future. It was, therefore, necessary to adjust the travel demand forecasts into and out of the primary study area to account for expected changes in trip making characteristics for future travellers. This was accomplished through research and investigation into the underlying factors that affect trip making behaviour.

The results of the research can be found in **Appendix D** to the *Gardiner East Alternative Solutions Evaluation – INTERIM REPORT*. In summary, adjustments to trip-making behaviour were considered in four different areas, as follows:

- Transit mode shares were increased beyond the levels forecasted by EMME to reflect the impacts of additional transit opportunities (e.g., Downtown Relief Line), negative effects of increased auto congestion and an increase in propensity to use transit by workers between the ages of 20-40.
- Walking and cycling mode shares were increased to reflect the forecasted increase in the number of work trips under 5km in length and the attractiveness of walking and cycling modes for such trips. It is expected that the current trend of increasing population in the study area will continue (as planned by the various Precinct Plans) and that the increasing portion of people "living downtown/ working downtown" will continue.

- Overall travel demand levels were decreased to reflect an increase in the opportunity to avoid trip making altogether (home-based work, flexible work arrangements, e-commerce, etc.).
- Overall peak hour travel demand levels were decreased to reflect the movement of trips outside of the traditional commuter peak hour to avoid peak hour travel times.

The memorandum concluded that, according to current research and real-world observations, there is a potential range of auto demand reduction between 16% and 27%. The elements that make up these potential reductions are shown in **Table 2**.

Final Mode Shares

Table 3 presents the Final Mode Shares for AM peak hour travel inbound across the study area boundary assumed for the demand forecasting exercise.

Table 3:
Final 2031 Mode Shares Across Study Area Boundary

Travel Mode	Existing 2006 TTS	2031 Maintain/Improve/Replace		2031 Remove	
		Initial	Final	Initial	Final
Auto (Driver + Passenger)	31%	28%	22%	28%	20%
Transit (GO + TTC)	60%	66%	71%	66%	73%
Walking/ Cycling	6%	6%	7%	6%	7%
Other	3%	--	--	--	--

As **Table 3** shows, it was determined that the shift away from auto travel in the Remove scenario would be higher due to the extent of capacity removal. The symbolism of removal of a significant portion of a high capacity elevated freeway will also contribute to this shift from long distance auto travel.

Two items are noted in reading **Tables 2 and 3**:

1. Table 2 shows reductions in AM peak hour demands (all modes) that are unrelated to shifts to non-auto modes (peak spreading, trip reductions, and trip elimination). These factors were used to reduce the auto volumes assigned to the Study Area roads. It is noted that these reductions were higher under the Remove Alternative than the Maintain/ Improve/ Replace Alternatives due to the impacts of increased congestion.

Table 2 – Travel Demand Management Trip Reductions

Recommended Post-EMME Modelling Adjustments to Auto Demand Forecasts		
Areas for Adjustment to Forecasted Peak Hour Auto Trip Generation	**Magnitude of Adjustment***	**Trip Forecasts Requiring Adjustment**
Trip Reassignment *Trip shifts to alternate route, but not within the FGE/LSB corridor*	0%	Handled by EMME model, no additional change
Mode Shift *Trip occurs, but not as auto driver* • Transit Mode Share increase • Cycling and Walking Mode Share increase	5 - 7% 5 - 7%	Global reduction to Study Area Demand Primarily applied to shorter, internal trips (under 5 km)
Auto Occupancy	0%	No substantive change expected
Peak Spreading *Trip occurs, but not in peak commuter hour/period*	3 - 7%	Global reduction
Trip Redistribution *Origin and/or destination of trip is changed*	0%	Handled by EMME model, no additional change
Trip Reduction *Trips are reduced due to telework, teleconferencing, compressed work week, etc.*	2 - 4%	Global reduction
Trip Elimination *Trip is completely eliminated*	1 - 2%	Global reduction
Overall	**16 - 27%**	
** Note the term "adjustment" in this case refers to reductions to peak hour auto trip generation rate*		

2. Table 2 shows increases in walking and cycling mode shares of 5%-7% for short trips (5km or less). The increase in walking/cycling mode share at the Study Area boundary is modest (1%), as trips crossing the boundary tend to be longer trips. Walking and cycling mode shares for short trips (particularly those within the Study Area) were increased to the levels indicated in **Table 2**.

Final Auto Demand Forecasts

The resulting 2031 total AM peak hour auto volume forecasts within the study area are:

- 70,500 vehicles per hour (vph) for the Maintain/ Improve/ Replace Alternatives; and
- 63,000 vph for the Remove Alternative.

3.0 System Performance

3.1. Automobile

Commuter Travel Time

Table 4 and **Figures 1-4** present the projected AM peak hour commuter travel times under the four Alternative Solutions. The model results show that the travel times are lowest for the Maintain Alternative, roughly equivalent and slightly higher for the Improve and Replace Alternatives, and highest for the Remove Alternative.

Modelling also showed that all alternatives have an equivalent sensitivity to the transit assumptions. Increases in travel time of between two and four minutes were observed for all alternatives for all origin-destination pairs.

Impact on Average Auto Travel Time

Table 5 shows the impact on the average auto travel time for all auto users in the AM peak hour within the study area. The calculation is based on all auto trips travelling in any direction in the study area in the AM peak hour.

The model results show that the travel time impacts are lowest for the Maintain alternative, roughly equivalent and slightly higher for the Improve and Replace alternatives and highest for the Remove alternative.

Road Network Flexibility

The existing configuration of the Gardiner Expressway/ Gardiner Expressway ramps/ Lake Shore Blvd has a number of awkward intersections with offsets, poor angles of intersection for the side roads, or ramp conflicts at intersections. The result is turn prohibitions at intersections; at least one turning movement is prohibited at every major intersection on Lake Shore Boulevard. In total, there are 12 movements currently prohibited at five intersections.

The geometric changes proposed under the four alternative scenarios reduce the prohibitions to six (Maintain), three (Improve), and zero (Replace and Remove) under the various alternatives. Given the improved simplicity and opportunity for circulation, the Replace and Remove alternatives are preferred, followed by the Improve alternative, and the Maintain alternative.

Table 4 – Regional Travel Times

Existing AM						
From	To	Trip	EMME	Paramics	Total	Nearest 5
Victoria Park / Finch	Union Station	A-D	38	6	44	45
Don Mills / Eglinton	Union Station	B-D	18	6	24	25
Victoria Park / Kingston	Union Station	C-D	8	12	20	20
Kipling / Lake Shore	Union Station	E-D	21	6	27	25

Maintain AM						
From	To	Trip	EMME	Paramics	Total	Nearest 5
Victoria Park / Finch	Union Station	A-D	43	9	52	50
Don Mills / Eglinton	Union Station	B-D	21	9	30	30
Victoria Park / Kingston	Union Station	C-D	11	12	23	25
Kipling / Lake Shore	Union Station	E-D	22	4	26	25

Improve AM						
From	To	Trip	EMME	Paramics	Total	Nearest 5
Victoria Park / Finch	Union Station	A-D	43	11	54	55
Don Mills / Eglinton	Union Station	B-D	21	11	32	30
Victoria Park / Kingston	Union Station	C-D	11	12	23	25
Kipling / Lake Shore	Union Station	E-D	22	6	28	30

Replace AM						
From	To	Trip	EMME	Paramics	Total	Nearest 5
Victoria Park / Finch	Union Station	A-D	43	12	55	55
Don Mills / Eglinton	Union Station	B-D	21	12	33	35
Victoria Park / Kingston	Union Station	C-D	11	16	27	25
Kipling / Lake Shore	Union Station	E-D	22	6	28	30

Remove AM						
From	To	Trip	EMME	Paramics	Total	Nearest 5
Victoria Park / Finch	Union Station	A-D	45	13	58	60
Don Mills / Eglinton	Union Station	B-D	24	13	37	35
Victoria Park / Kingston	Union Station	C-D	8	20	28	30
Kipling / Lake Shore	Union Station	E-D	22	6	28	30

Figure 1

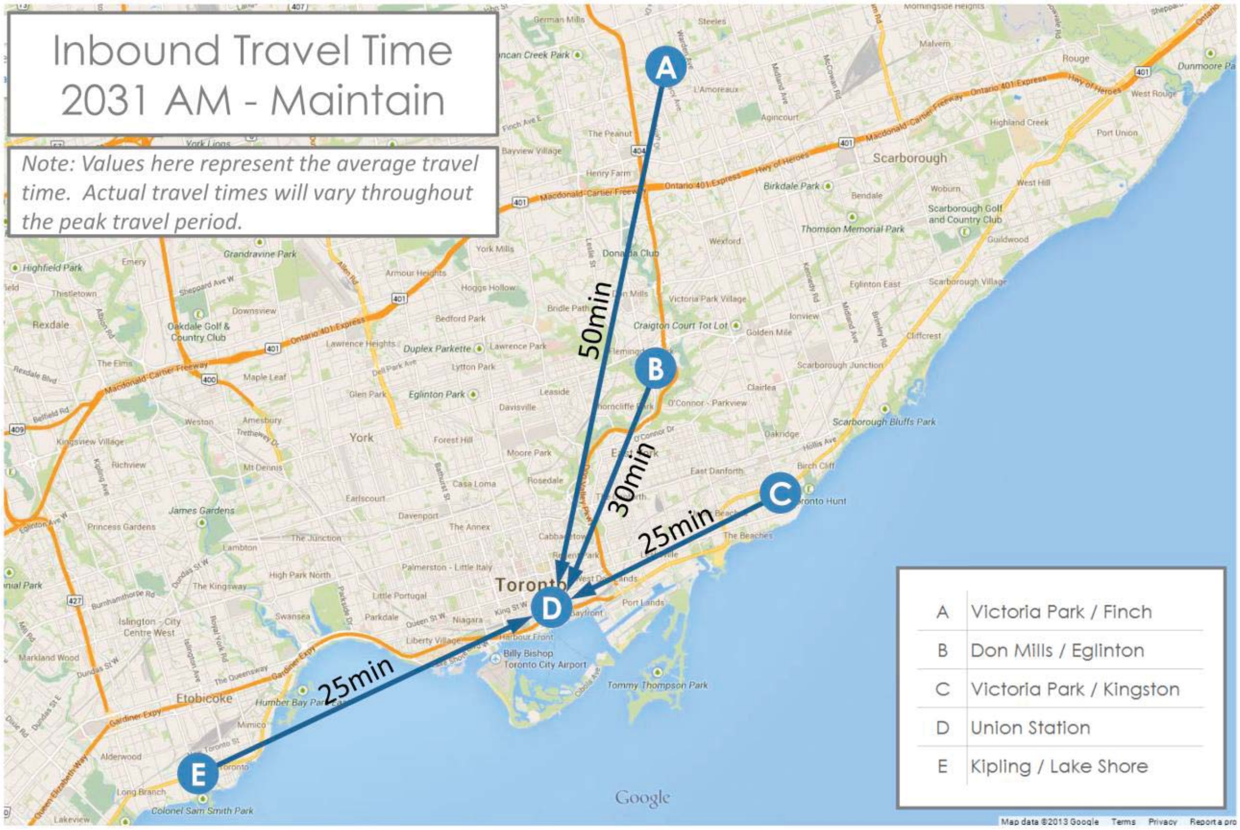

Inbound Travel Time
2031 AM - Maintain
Note: Values here represent the average travel time. Actual travel times will vary throughout the peak travel period.
50min
30min
25min
25min
A Victoria Park / Finch
B Don Mills / Eglinton
C Victoria Park / Kingston
D Union Station
E Kipling / Lake Shore

Figure 2

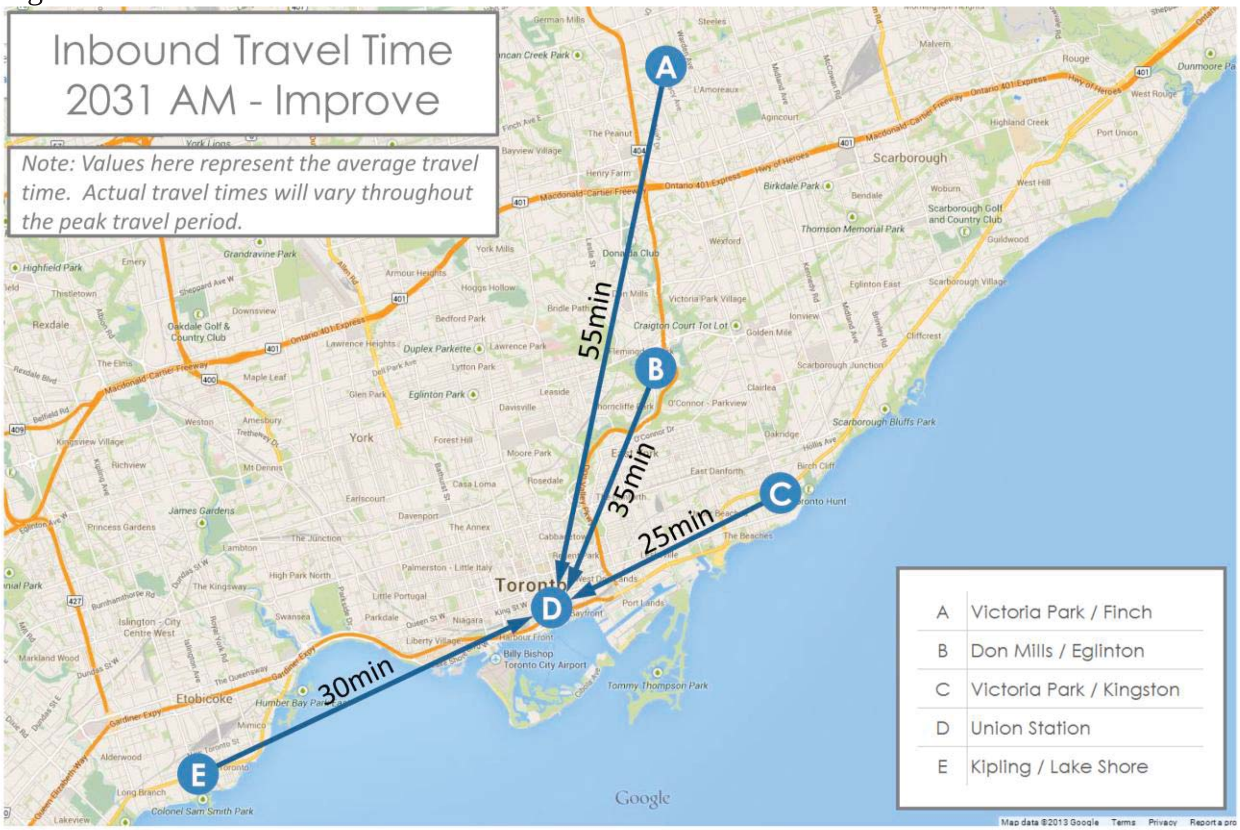

Inbound Travel Time
2031 AM - Improve
Note: Values here represent the average travel time. Actual travel times will vary throughout the peak travel period.
55min
35min
25min
30min
A Victoria Park / Finch
B Don Mills / Eglinton
C Victoria Park / Kingston
D Union Station
E Kipling / Lake Shore

Figure 3

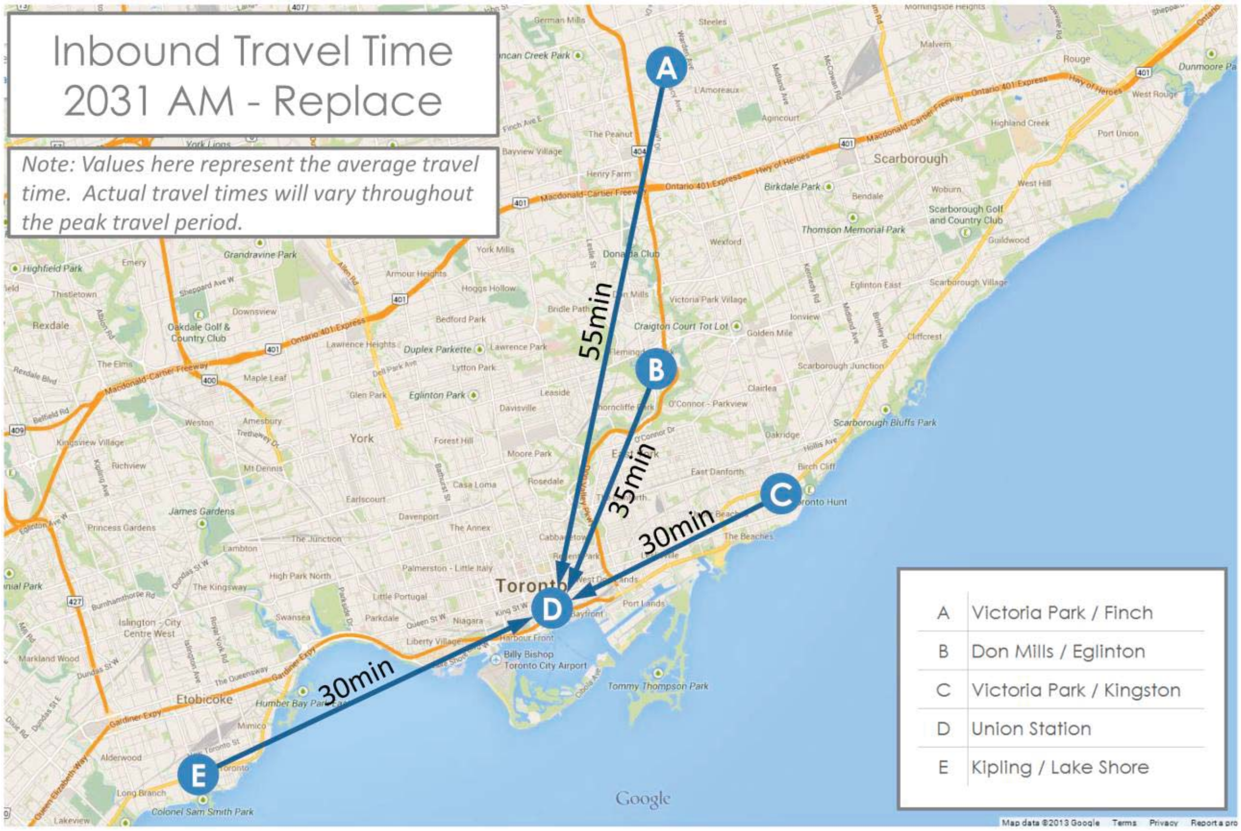

Inbound Travel Time
2031 AM - Replace
Note: Values here represent the average travel time. Actual travel times will vary throughout the peak travel period.
55min
35min
30min
30min
A Victoria Park / Finch
B Don Mills / Eglinton
C Victoria Park / Kingston
D Union Station
E Kipling / Lake Shore

Figure 4

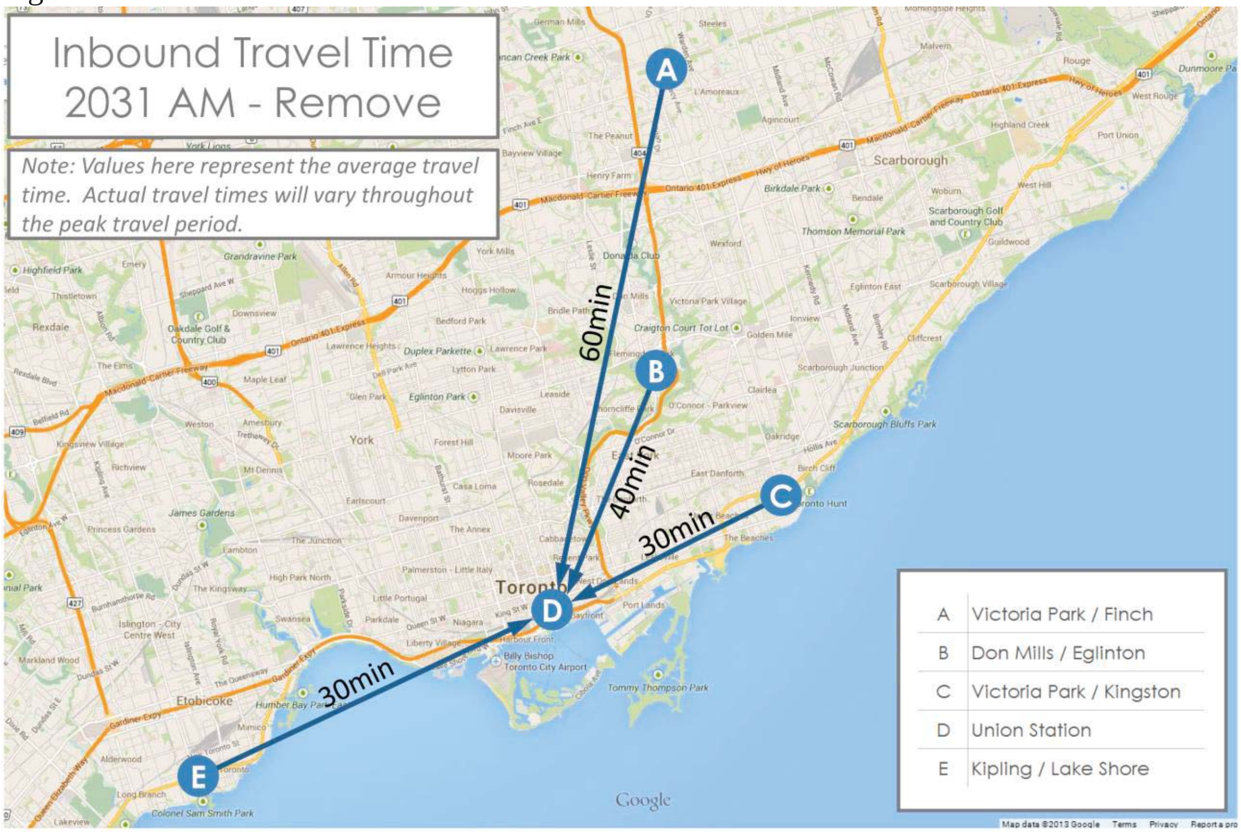

Inbound Travel Time
2031 AM - Remove
Note: Values here represent the average travel time. Actual travel times will vary throughout the peak travel period.
60min
40min
30min
30min
A Victoria Park / Finch
B Don Mills / Eglinton
C Victoria Park / Kingston
D Union Station
E Kipling / Lake Shore

Table 5 – Travel Time Stratification Results

Change in Travel Time for FGE Alternatives Compared to Maintain (considers all vehicles assigned by Paramics model to any route in any direction)								
Magnitude of Impact Alternative vs Maintain		Improve		Replace		Remove		
		%	vph	%	vph	%	vph	
No change	Less than 2 min	85%	59,500	80%	57,000	75%	48,000	
Minor Impact	2 min-7 min	15%	11,000	20%	13,500	20%	12,500	
Noticeable Impact	7 min-12 min					5%	2,500	
Total Volume Assigned *Note additional auto demand reduction under Remove Scenario due to TDM means that % shown are based on lower total auto volume*			70,500		70,500		63,000	

3.2. Transit

Impact on Surface Transit

The change in AM peak hour travel time for streetcars on key east-west corridors in the study area was measured to determine if the future road network conditions would result in slower travel times for surface transit (see **Table 6**). The Paramics model indicated that travel times would be lowest and essentially equal for the Maintain and Improve alternatives. Streetcar travel times were projected to increase by between one and four minutes (depending on the corridor and direction of travel) under the Replace and Remove alternatives.

Table 6 – Travel Times Along Key Transit Corridors

AM PEAK HOUR

Scenario	Queen EB	Queen WB	Dundas EB	Dundas WB	King EB	King WB
Maintain	0:15:13	0:15:44	0:13:55	0:12:59	0:07:46	0:08:57
Improve	0:15:11	0:16:04	0:14:11	0:13:05	0:07:53	0:09:36
Replace	0:15:17	0:17:36	0:16:42	0:14:14	0:08:55	0:13:18
Remove	0:15:28	0:18:44	0:16:30	0:16:12	0:09:18	0:13:05

Impact on Subway Service

None of the alternatives will impact subway service.

Ability to Accommodate Planned Transit Service

All of the alternatives will accommodate the major transit projects planned for the future – the Downtown Relief line, the Waterfront West LRT, the Cherry Street LRT and expansion of GO service and possibly facilities. The Remove alternative allows for greater flexibility in transit service planning east of the Don River due to the removal of the Gardiner Expressway infrastructure.

3.3. Pedestrian

Ability to Implement Standard Sidewalks North-South

Pedestrian movements across Lake Shore Boulevard will increase significantly in number with all of the planned development adjacent to the corridor. The number of people walking across the corridor to access transit north of the rail line in particular will increase sharply in the future. Adequate sidewalks on the north-south streets crossing Lake Shore Boulevard will be a key requirement.

The Maintain alternative does not allow for improvements to existing sub-standard sidewalks. The Improve alternative allows some of the crossings to be improved, but not all. The Replace and Remove alternatives are preferred as they allow for all north-south sidewalks to be improved to meet current City of Toronto standards.

Crossing Points

Existing pedestrian movements across Lake Shore Boulevard are physically impacted by the presence of columns and are interrupted by multiple medians at many crossings. These physical barriers are particularly impactful on persons with mobility challenges.

The Maintain alternative does not allow for removal of these barriers. The Improve alternative allows some of the crossings to be improved, but not all. The Replace and Remove alternatives are preferred as they allow for barriers to be removed.

North-South Crossing Distance

North-south crossing distance is a measure of the distance that must be traversed by pedestrians when crossing from the north curb to the south curb on Lake Shore Boulevard. Given the auto demands on Lake Shore Boulevard and the pressures that they place on traffic signal timing at the intersections, the longer the crossing distance the greater the likelihood that pedestrians will encounter long delays crossing Lake Shore Boulevard.

The Replace alternative has the shortest average crossing distance (26.1m), which is not surprising as Lake Shore Boulevard has a four lane cross-section in this alternative west of the Don River. The Remove and Improve alternatives have roughly equivalent average crossing distances (32.5 to 33.5m) that are higher than the Replace alternative. The Maintain alternative has the highest average crossing distance at almost 37m.

East-West Sidewalks

Modifications to Lake Shore Boulevard will create the opportunity to construct continuous east-west sidewalks in the Lake Shore Boulevard corridor. The length of continuous sidewalk varies by alternative, as the sidewalks are constrained or eliminated in places by the Gardiner Expressway infrastructure.

The Maintain alternative allows for almost 1,500 linear metres of new sidewalk, the Improve and Replace alternative allow for almost 4,000 linear metres of new sidewalk, and the Remove alternative allows for almost 4,400 linear metres of new sidewalk.

3.4. Cycling

East-West Movement

Modifications to Lake Shore Boulevard will create the opportunity to construct continuous east-west bicycle facilities in the Lake Shore Boulevard corridor. The length of continuous cycling facility varies by alternative, as the bike facility is constrained or eliminated in places by the Gardiner Expressway infrastructure.

The Maintain alternative allows for almost 2,200 linear metres of bikeway, the Improve and Replace alternative allows for almost 3,700 linear metres of bikeway and the Remove alternative allows for almost 4,200 linear metres of bikeway.

Connectivity to North-South Bicycle Facilities

Bicycle trips are typically longer distance trips (up to 10 km); therefore connectivity of Lake Shore Boulevard facilities to north-south facilities is a critical objective.

The Maintain and Improve alternatives do not allow for connection to an important north-south facility in the Yonge Street corridor, whereas the Replace and Remove alternatives allow connection to all existing and planned north-south cycling facilities.

3.5. Goods Movement

Vehicle Operations

Vehicle delays are particularly impactful to the freight industry. The economic impact of congestion on the goods movement industry is significant and translates directly to higher costs for the goods moved.

The model results show that the travel times are lowest for the Maintain Alternative, roughly equivalent and slightly higher for the Improve and Replace alternatives and highest for the Remove alternative.

Access Opportunity

The existing configuration of the Gardiner Expressway/ Gardiner Expressway ramps/ Lake Shore Blvd has a number of awkward intersections with offsets, poor angles of intersection for the side roads, or ramp conflicts at intersections. The result is turn prohibitions at intersections; at least one turning movement is prohibited at every major intersection on Lake Shore Boulevard. In total, there are twelve movements currently prohibited at five intersections.

The geometric changes proposed under the four alternative solutions reduce the prohibitions to six (Maintain), three (Improve), and zero (Replace and Remove) under the various alternatives. Given the improved simplicity and opportunity for circulation, the Replace and Remove alternatives are preferred, followed by the Improve alternative and the Maintain alternative.

3.6. Safety

Safety Risk for Pedestrians

The risk for pedestrian is highest when they are crossing the intersections along Lake Shore Boulevard. Even though the crossings are subject to traffic controls, pedestrians are exposed to the potential for driver error. Where there are more lanes of traffic that need to be crossed, the traffic volume to be crossed is higher, and the higher the risk to pedestrians.

The Replace alternative has the lowest pedestrian risk as it has the lowest number of Lake Shore Boulevard lanes to be crossed (four). The Maintain and Improve alternatives are equal and higher than Replace at six lanes; Remove results in the highest pedestrian risk at eight lanes.

Safety Risk for Pedestrian and Cyclists

There are a number of existing conflict points for pedestrians and cyclists in the Lake Shore Boulevard corridor where there are no traffic control measures (i.e. stops signs or traffic lights) – essentially the locations where both pedestrians and cyclists must cross free flow right turns and Gardiner Expressway ramp terminals.

The Remove alternative deletes all conflict points without control measures that pedestrians and cyclists need to cross. The Maintain, Improve, and Replace alternatives all have a similar and higher number of conflict points for pedestrians and cyclists.

Safety Risk for Cyclists and Motorists – Lake Shore Boulevard

There are a number of existing road segments and intersections on Lake Shore Boulevard that are performing poorly from a road safety perspective. Some elements, such as the Lake Shore Boulevard/ Jarvis Street intersection and Lake Shore Boulevard between Jarvis Street and Sherbourne Street, are in the top 20% of the City of Toronto's list of road elements in need of safety improvements. The modifications proposed by the alternative solutions address the existing safety concerns to a greater or lesser degree, depending on the design of the alternative.

The Replace and Remove alternatives completely modify the existing geometry of Lake Shore Boulevard between Jarvis Street and the Don Roadway and resolve many of the existing safety concerns. The Maintain and Improve alternatives improve some of the existing concerns, but do not measurably improve the existing design of the northwest quadrant of the Lake Shore Boulevard/ Sherbourne Street intersection.

Safety Risk for Motorists – Gardiner Expressway

The existing geometry of the Gardiner Expressway does not meet current design guidelines for this kind of facility. Most notably the Expressway does not provide shoulders, which provide clearance from the edge barriers and a safe refuge for disabled vehicles.

The Remove alternative eliminates the Gardiner Expressway, eliminating safety concerns with the Gardiner design. The Replace and Improve alternatives improve the Gardiner Expressway geometry and provides shoulders on the Expressway and Expressway ramps. The Maintain alternative does not significantly modify the existing design of the Gardiner Expressway and the safety concerns remain.

Appendix D
Transportation Demand Management Paper

TABLE OF CONTENTS

Page

1.0 Introduction

This memo outlines potential transportation demand management (TDM) measures that could affect traffic volumes in the downtown area, particularly as it relates to the modeling for the "remove" alternative in which capacity in the Gardiner / Lake Shore corridor would be substantially reduced from current levels. It is intended as a working document to stimulate discussion amongst the project team and to document assumptions.

2.0 Underlying context, principles and considerations

2.1 Destined vs. through traffic

The Gardiner / LSB corridor serves four different travel patterns:

- Inbound to downtown (peak direction)
- Outbound from downtown (counter-peak direction)
- Through (crosstown) traffic
- Local traffic (may be considered subset of inbound / outbound categories)

The greatest benefit to reducing overall demand in the corridor would be derived by reducing inbound and through traffic, although outbound (counter-peak) traffic has grown rapidly of late due to increased residential population commuting to suburban employment areas, where transit is unavailable or less attractive.

The Bluetooth survey found that less than one-quarter of vehicles approaching downtown on the Gardiner, Lake Shore and DVP is using those routes to travel through (rather than to) downtown.

- 20% of eastbound Gardiner traffic at Dufferin is destined to the DVP or east Lake Shore
- 15% of southbound DVP traffic north of Bayview/Bloor is destined to the Gardiner west of Spadina
- 25% of westbound Lake Shore traffic at Carlaw is destined to the Gardiner west of Spadina

However, in absolute terms, the through traffic on the Gardiner/Lake Shore is substantial, especially when measured against arterial lane capacity.

- 1,600 vph westbound
- 1,250 vph eastbound

The majority of through traffic is not traveling the full distance of the Gardiner and DVP (e.g., not motorists traveling from south Mississauga to Durham and deciding whether to cross Toronto via the 427 / 401 or the Gardiner / DVP).

Distinction between downtown and crosstown traffic may be important. Some solutions may be more feasible than others depending on the nature of the trip.

2.2 Why people change their travel behaviour

A review of Cairns et al[1] highlights a number of points listed below.

A transportation model is based on decisions being broadly stable in aggregate, but this stability masks many underlying changes that constantly occur and sometimes cancel each other out. For example, one person retires from the workforce while another enters; one person moves to a different home or job, but is replaced by another. Normally this would cancel out and no net change would be observed in aggregate. In some cases the change from one cohort to another is substantial enough that it gradually impacts overall results (e.g., downward trends in vehicle ownership, % of adults with driver's licenses, increased propensity to use transit).

Major life events occurring from time to time that could influence study area travel:

- Place of residence:
  - Move within Toronto (local)
  - Move within GTA
  - Move to / from outside GTA
  - New residence
- Place of employment
  - Change place of employment
  - Enter workforce
  - Leave workforce (retire / unemployed)
  - Change in nature of job (hours, position, responsibility)
- Demographic changes
  - Marriage
  - Birth of dependent (or new dependent – e.g. elders)
  - Death
  - Other change in home responsibilities

[1] Sally Cairns, Carmen Hass-Klau and Phil Goodwin. *Traffic Impact of Highway Capacity Reductions: Assessment of the Evidence.* Landor Publishing, March 1998.

- Transportation changes
  - Increase or decrease number of cars in household
  - Obtain driver's license

When making transportation choices, one is generally more amenable to changing behaviour when it occurs in conjunction with other life changes ("starting fresh")

In life changes involving choice / options (e.g., decision to move), the decision considers many different factors; the prevailing transportation context can be a major factor. If the prevailing transportation context is different, it may result in a different decision for some people. (e.g., people may buy a home that will result in them commuting across town with the perception that the Gardiner will allow them to travel "against traffic" most of the way; people make different activity and travel choices when they know that the Gardiner is closed for the weekend).

Each of these thousands of individual changes is based on a variety of factors, including transportation. People consider the transportation network when they decide where to move, where to work, what travel mode and route to choose; and when to travel. If the transportation network changes, this may result in different choices.

Response to capacity reductions is comprised of two subsets of users:

- Response by stable population of individuals (no change in place of residence, work, etc.) – change will occur to the extent that change is desirable and reasonably feasible. May be some initial changes ("low-hanging fruit"), but generally slow for the majority. This group has developed existing habits in their travel patterns; habits can be difficult to break.
- Response due to ongoing changes in the population using the road – some people would have automatically left the road regardless due to underlying life changes; they would normally be backfilled by new arrivals making generally similar choices, but if the context is different, the new arrivals may make different choices or may not arrive.

It is easy to focus on the first category – "how do we get people to change?", but the second category may lead to greater opportunity.

How to quantify? Cairns et al have UK examples of life changes over time (e.g. % moving over the past *x* years). An important subset may be new development in the waterfront area since it will be populated exclusively by new residents each of whom will be making certain transportation choices (O/D and mode). We can follow a "transit first" principle, although note political / financial challenges in implementing east waterfront LRT… will a transit habit develop if the underlying transit network is not in place?

Change will occur on a spectrum. Some users may need little further incentive to change; others may have no flexibility and are unlikely to change.

2.3 Potential data sources

- EMME model:
  - Trip matrices (person, auto, transit)
  - Select link analyses (Gardiner, LSB, Richmond/Adelaide/Eastern)
  - Others tabulations
- TTS:
  - Modal split (CBD-oriented trips – inbound and outbound) – percentages; dot density plots
  - Modal split (through trips – e.g., from PDxx [east of downtown] to planning districts in west Toronto, Mississauga, Brampton) – percentages; dot density plots
  - Trip purpose breakdown (work-based vs. discretionary)
  - Trends from 1986 through 2006
  - Other tabulations
- Bluetooth O/D survey
  - Through vs. local traffic breakdown
- Cordon count
  - Trends (auto occupancy, etc.)
  - Impact during Gardiner construction
- Census data
- City traffic data (permanent count stations)
  - Traffic volume changes during major construction projects
- Case studies from other jurisdictions
  - Sally Cairns et al – *Traffic Impact of Highway Capacity Reductions: Assessment of the Evidence* (March 1998 report); Victoria Transport Policy Institute; others?
  - Case study may not be directly comparable – different transportation, land use, attitudinal contexts
  - May quantify the overall traffic reduction effects, but may not quantify the range or nature of the changes (e.g. xx% of people moved into the city so that they would not have to drive in)

Select link analyses:

- Where are the problems?
- How substantial is the problem?
- Where are these opportunities?
- E.g. if a lot of traffic coming from one particular area, is there a gap in transit service?

2.4 Smaller-scale or temporary capacity reductions in Toronto

Effects can be reviewed in Toronto by reviewing impacts of construction or other smaller capacity reductions:

- Streetcar track reconstruction
- Gardiner / DVP closures
- West Don Lands closure of Bayview south of Queen
- Road lane reallocation for bike lanes (road diet)
- Pedestrian scramble phase at Yonge / Dundas
- Planned subway closures (transit ridership) – e.g. recent closure of downtown "U"

Would likely see a combination of reduced volumes (ridership) and increased congestion (e.g. when the Gardiner is closed, the Lake Shore is severely congested, but traffic demand is also likely lower)

This approach might give end results, but may not explain why the change (quantifiably).

It was initially hypothesized that the removal of the eastern stub of the Gardiner could be a case study. However, it actually represented a capacity increase, because it eliminated a previously existing bottleneck at the single-lane ramps to/from Leslie. Net result was a shift in traffic from Lake Shore (overflow traffic) to the Gardiner.

2.5 Model variability and risk management

There will be close scrutiny of the model results (volumes and Measures of Effectiveness MOEs)). Members of the public, media, and Council will be likely to interpret results literally, whereas in practice the model is at best an estimate and requires considerable judgement in interpreting. We need to manage expectations of what the model can and cannot accomplish; it is at best an estimate of operations under a certain set of conditions and assumptions, but traffic volumes (and results) are not likely to materialize as modeled, even under the "retain" solution. There are numerous sources of error in traffic modeling that would impact the results:

- Natural day-to-day traffic fluctuations

- Increased traffic due to special events
- Temporary closures or lane reductions due to construction, collisions / emergency response, or special events
- Unanticipated transportation network changes not accounted for in the model
- Unanticipated development proposals or changes to currently anticipated development proposals
- Demographic trends leading to changes in attitudes / preferences (e.g., younger cohort obtaining driver's license / purchasing vehicles at a later age or not at all; differing live/work location preferences)
- Technological changes leading to changes in attitudes / preferences (e.g., telecommuting, smartphones)
- Policy changes resulting from shift in political environment
- Changes in activity beyond 20-year model horizon
- Model calibration may be off (O/D pairings, trip rates, modal splits, specific assignments etc.)
- PARAMICS parameters may be off (e.g. pedestrian interaction; centroid connectors)

At best, the model helps us understand - given a certain set of conditions, would this particular transportation network work?

We make our best estimates, and build in flexibility where possible to address unanticipated fluctuation and deviation. Our challenge is how to define that set of conditions, including making our best estimate of changes that we would expect to happen that the model cannot adequately capture.

Risk assessment:

- How certain can we be of a particular shift occurring?
- If we are unsure, are there other measures/changes that we can better rely on?
- What is the backup plan in case the shift does not come to fruition?
- Identify policies and infrastructure to encourage the desired shifts in behavior, but also identify changes to mitigate congestion for transit and determine which links/movements should be prioritized (e.g., metering traffic access to the network sensitive portions of the network) in the event that the shifts do not materialize

3.0 Categories of Vehicle Trip Reductions

The body of research suggests a variety of ways that traffic may respond to capacity reductions. The magnitude of the response varies depending on the severity of the impacts of the capacity reduction. If capacity constraints are limited to shorter periods during the day or specific routes, motorists may only make minor adjustments to their departure time or may make routing adjustments. As capacity constraints become more geographically widespread, more severe, or of longer duration, motorists begin to make more substantial shifts.

Generally from easiest to most difficult to quantify or perhaps shorter term response to longer term response:

- Shift of trips to alternate routes (local or regional)
- Shift of auto driver trips to alternate modes (TTC/GO; walking/cycling)
- Increased auto occupancy
- Shift of trips to other times of the day (either outside the peak hour, or outside the peak period)
- Reduced frequency of trip-making (including alternate work arrangements such as telecommuting, conference calling or compressed work week)
- Changing origin/destination patterns (increased downtown population and employment enabling increased non-auto commuting; residents move to opposite side of the city to avoid having to commute crosstown).
- Discretionary trips just don’t happen (e.g. shopping more locally instead of downtown or crosstown), a particular trip is not worth the effort of traveling through congested area, or trips consolidated to occur less frequently

For each of the categories above, consider a number of questions:

- Do the EMME or PARAMICS models account for this type of shift?
    - ➢ Is the change sufficient or is it possible that the model is understating the magnitude of the change?
- Is there evidence of this change already happening?
- If not, how likely is it to occur? Is this a reasonable assumption?
- What is the potential for growth in behaviour that will reduce vehicular demand?
- Would the shift happen organically, or would there need to be specific infrastructure, initiatives and/or policies in order to encourage the shift and reach the desired targets? (What would be required for the assumption to be true or to push the boundaries?)
- How to quantify the baseline and the likely maximum shift?

- If additional adjustment required, how to accommodate in the model(s)?
- Should the adjustment be made globally or targeted to specific links, zones, O/D pairs? Or to one particular classification of trip (e.g., telecommuting only applicable for office work).

3.1 Trip Reassignment

EMME accounts for this in regional trip assignment (macro level) and PARAMICS accounts for this in local trip assignment within the study area (micro level). The results are limited by underlying assumptions and parameters within the models.

Considerations:

The traversal matrices for "maintain" and "remove" indicate EMME is modeling a reduction of 856 trips (1.7% of trips in study area). The majority of the reduction has been at the gateways; the internal study area zones only experienced a reduction of 65 trips. This suggests that most of the modeled change is due to traffic rerouting away from the study area.

In the Gardiner survey, 24% of drivers said that they were likely or somewhat likely to select an alternate route if travel time on the Gardiner / Lake Shore increased. This could be a different route within the study area (as modeled by PARAMICS).

Initial Suggestion:
Assume that the models have addressed this measure as much as practical and make no further changes.

Outcome:
Assume that the models have addressed this measure as much as practical and make no further changes.

3.2 Mode Shift

The EMME model divides person trips into auto, transit and "other" (walking and cycling) trips based on factors such as travel time, trip purpose, traveler demographics (including auto ownership), and historical traveler attitudes and characteristics. In theory, then, if road capacity is reduced such that auto delays increase substantially, the model should show a shift to transit ridership to the extent that there is an attractive transit alternative available for that particular trip.

<u>Considerations</u>

In the Gardiner survey, 11% said it was likely or somewhat likely that they would respond to increased congestion by switching to GO (5%) or TTC (6%), and 6% said they might switch to walking or cycling.

Downtown-oriented trips:

Already occurring in peak direction for downtown-oriented trips:

- auto driver mode typically around 25% for inbound AM peak period trips originating both in 416 and 905
- most of the rest is on TTC (416) or GO (905)
- Walking trips mostly internal to PD1 (targeted adjustment)
- Cycling trips to PD1 mostly from zones immediately surrounding PD1 ("inner ring")
  - ➢ During the winter, cycling activity decreases by ~90%. Is increased cycling as a TDM measure contingent on it continuing through the winter?
- Auto modal split in 2001 model appears to be somewhat higher than TTS data (37% in model vs. 31% in TTS). Areas not exactly the same (TTS = PD1; EMME = EA study area). If focusing on EA study area, might expect TTS auto modal split to be lower.

Surveyed vs. Modeled Modal Split – AM Peak Period Inbound Trips

	Driver	Passenger	TTC	GO	Walking	Cycling
Inbound trips to PD1 (2006 TTS)						
From 416	25%	6%	54%	3%	9%	2%
From 905	27%	5%	19%	48%	0%	0%
From all GTA	26%	5%	43%	17%	6%	2%
Inbound trips to EA study area (2001 and 2031 EMME models)						
EMME 2001	37%		58%		5%	
EMME 2031	28%		66%		6%	

(see also dot density maps)

- Is there any more room for driver % to come down or is it already at its lowest level?
- Would it be reasonable to bring auto driver down to say 20%, and distribute the remainder according to external trip end characteristics? (i.e., trips from 905 largely

shifting to GO; trips from 416 shifting to TTC, with additional walking / cycling depending on distance from downtown)

2008 Kings Travel Survey modal split data were compared against 2006 TTS data. The auto modal split is reasonably close (23% KTS; 25% TTS), although there has been a substantial reduction compared to the 2001 KTS (35%). If the model is calibrated to 2001 TTS data, there may be an overstatement of vehicle trips generated in those areas, as well as similar high-density precincts in the downtown area (CityPlace; new waterfront precincts).

Crosstown and counter-peak trips:

Auto mode share is much higher for counter-peak and "through" trips that are not as well served by transit (either for entire trip or at external trip end; e.g., outbound congestion on Gardiner / DVP with increased downtown population commuting to suburban auto-oriented employment areas along 427 and 404)

Opportunities for mode shift may be more limited depending on

- Specific o/d pairings
- Transit improvements (esp. GO counter-peak service and local service levels at destination end / "last mile")

Probably not appropriate to apply global reductions – any adjustments should be more targeted to geography, trip purpose, O/D pairings, if possible.

Assessment of opportunities may be more challenging due to more widely dispersed o/d patterns (many-to-many vs. many-to-one).

Opportunities limited to transit (GO and local); travel distances likely too great to accommodate via walking / cycling. Counter-peak trips via GO also limited by GO schedule and by transit availability / attractiveness at the outlying GO station.

Initial suggestion:
Review model runs (O/D matrices) to determine if there is any discernible difference in modal split between "retain" and "remove" alternatives. If the shift is commensurate with expectations, accept and take no further action. If not, or if walking and cycling are underrepresented, then further analysis is required and possible post EMME model adjustments to the PARAMICS traversal matrix.

Outcome:

Post-modelling adjustment is required

- EMME model includes a module (known as a logit model) that distributes trips between auto, transit, and other modes (cycling and walking)
- Modal assignment relies on:
  - transit service
  - travel times for various modes
  - trip purpose; traveller demographics
  - historical traveller attitudes and characteristics
- Numerous changes to the transportation environment are expected that will make transit and cycling/walking generally more attractive than it has been historically
  - Policies governing land use patterns (mixed-use developments, smart growth) and site design (transit-oriented design) are promoting developments with higher density, increased proximity of employment and amenities to residents, and more street orientation, particularly in areas well served by high-frequency or higher-order transit
  - Non-auto modes are being promoted through education programs, implementation of better on-street amenities, better access to transit passes, and tax incentives
  - Generation Y is personally less inclined to drive than Generation X/Baby Boomers
  - Integration and cooperation between GTA transit authorities is improving (most relevant for cross-boundary trips, primarily counter-peak direction)
- The EMME model will account for some of the factors (such as transit service and facilities), but will not account for all of the factors
- GTA transportation planning exercises (Metrolinx Transportation Master Plan) have assumed 2% global reductions post-modelling and an additional 5% reductions post-modelling for trips less than 10 km long for this factor. This factor is GTA wide and it is likely that a higher number is supportable in the study area.

Suggested reduction:

- 5-7% reduction in auto trips – shift to transit
- Further 5-7% reduction in auto trips for internal trips (under 5 km) – shift to walking and cycling

3.3 Auto Occupancy

Increased auto occupancy and carpooling is frequently identified as a policy goal, with some measures in place to encourage this (e.g. HOV lanes, preferred parking).

Considerations

TTS and cordon count data both indicate a trend toward lower auto occupancy levels. What is the likelihood of this trend being reversed and reversed substantially enough to have a noticeable impact on model results? What specific measures would need to be enacted that are not already in place (since the status quo is resulting in a decrease in auto occupancy)?

Cairns et al indicate that ridesharing is a rare response to capacity reductions. As well, the Gardiner survey indicated that only 5% of respondents were likely or somewhat likely to switch to carpooling in response to increasing congestion in the corridor.

There are some cities with stronger ridesharing (e.g. "slugging" in Washington – certain highways into the city are reserved for HOVs only during rush hour). There are suggestions that carpoolers are taken from transit rather than single-occupant vehicles (or more prevalent where transit options are limited). Suggestion that carpooling incentive is predominantly based on time savings compared to general traffic rather than financial or altruistic incentives (i.e., can I use the HOV lanes to get around congestion in the general traffic lanes).

Initial Suggestion:
Increased auto occupancy is not likely without aggressive policy direction and measures to encourage HOVs. This would only be of benefit if new passengers were taken from existing drivers rather than existing transit riders. Suggestion here is to assume existing auto occupancy levels for modeling purposes.

Outcome:

- Post-modelling adjustment is not required
- TTS and cordon count data both indicate a trend toward lower auto occupancy levels
- There are suggestions that carpoolers are taken from transit rather than single-occupant vehicle
- Increased auto occupancy and carpooling is frequently identified as a policy goal, with some measures in place to encourage (HOV lanes, preferred parking), but ability to affect auto occupancy globally or within the FGE/LSB corridor is unproven

- GTA transportation planning exercises (Metrolinx TMP) have assumed 4% global reductions post-modelling for this factor. While this suggests there may be some room GTA wide, we will not make adjustment for this to/from the study area.

3.4 Peak Spreading

Potential data sources:

- Permanent count station data / cordon count data (for baseline)
- TTS data (discretionary vs. work trips)
- EMME modeling

Considerations:

- How much capacity is available in the shoulders of peak hour? Peak hour volumes on major corridors are experienced for nearly entire duration of AM and PM peak periods (model assumes 3-hour peak periods)
- How much capacity is available in the off-peak? (mid-day; mid-evening)
- What is the tolerance for users to shift to other times? Already evidence that this is occurring (anecdotal; hourly traffic profiles); is there more willingness to spread trips further? Impact on scheduling (meetings / work), convenience (start or end trip at intolerable time). Shift high-tolerance users first to make room for low-tolerance users
- Gardiner survey: 14% of drivers said that it was likely or somewhat likely that they would make the trip at a different time, if congestion increased in the corridor. This was the second highest response (after choosing an alternate route at 24%).
- The EMME model includes an auto peak period to peak hour factor of 0.405 and a similar transit factor of 0.55. This suggests there is room to shift within the peak period as a fully balanced peak period factor would be 0.333.
- Shifting trips outside the peak period to mid-day or the weekend would be over and above shifts within the peak period

Initial Suggestion:

Examine trends and available data and estimate. A global adjustment within PARAMICS is likely required.

Outcome:

- Post-modelling adjustment is required
- Capacity of the system is a hard cap and will ultimately restrict the volume served in the peak hour

- Demand that is above capacity will be forced out of the commuter peak hour into shoulders (i.e., the hours before and after the peak hour) – this despite the fact that the volume served in shoulders is also approaching capacity
- If the hours immediately before and after the peak hour are also nearly saturated, there may be some further spreading of demand outside the conventional three-hour peak period
- Gardiner survey: 14% of drivers said that it was likely or somewhat likely that they would make the trip at a different time, if congestion increased in the corridor.
- GTA transportation planning exercises (Metrolinx TMP) have not included post-modelling reductions for this factor. This may be appropriate across the GTA, but in the capacity constrained downtown shifting is quite likely.

Suggested reduction:
- 3-7% reduction in auto trips – global adjustment

3.5 Trip Reassignment

Could encompass two broad categories:
- Longer-term changes to population and employment locations and O/D pairings (increased downtown population and employment enabling increased non-auto commuting; residents move to opposite side of the city to avoid having to commute crosstown)
- Shorter-term decisions on discretionary trips (e.g., shopping, entertainment)
    - Trips made to a different generator (e.g. shopping more locally instead of downtown or crosstown)
    - Trip purpose fulfilled at a different location that eliminates the need to travel through the congested area.

Potential data sources:
- Baseline conditions – TTS; Bluetooth; EMME select link analysis
- Is this captured in the EMME modeling (i.e., would the person O/D tables be different between “retain” and “remove”)?
- Can the EMME model differentiate between work-based trips and other more discretionary trips? EMME model is AM – fewer discretionary trips than during the PM or on weekends.
- TTS: number of auto trips to PD1 by type and by PD; number of auto trips by PD1 residents (dot density map) by non-work trip type – AM and overall

- Kings Travel Survey: 11% of AM peak period trips appear to be discretionary (all modes)

Considerations:

Longer-term O/D pattern changes

- Would be less feasible for households where there are two people commuting to opposite sides of the city.
- Longer-term change – you would keep it in mind as a factor if you were planning to move or take a job, but it is not applicable if you are remaining in your current residence / place of employment for the foreseeable future. In the first instance you can avoid impact if desired, but in the second instance you would be impacted.
- The change could start to happen before the capacity reduction takes effect. If the City announced tomorrow that the Gardiner was to be removed, any subsequent decisions by individuals would take those plans into consideration even though the actual road network change would not have occurred yet.
- People already choose to live and work in certain places in part because they can travel on the subway or the GO train, or because they can use 400-series highways.
- 2008 Kings Travel Survey reveals an increasing trend toward live-work downtown (59% of Kings residents worked in PD1 in 2001, vs. 66% in 2008).

Shorter-term discretionary trip changes

- Could have a variety of impacts:
  - Trips currently made to downtown, instead made to similar facilities outside downtown
  - Trips currently made from downtown to facilities outside downtown, instead made to more local facilities
  - Trips currently made to facilities on the opposite side of the city (e.g., east end residents shopping at Sherway Gardens) now made more locally to avoid traveling through downtown
  - Trip purpose fulfilled electronically (e.g. internet shopping)
- Generally easier to make this change because more transient, although some destinations not available elsewhere (e.g. ferry to islands, major attractions etc.)

Initial suggestion:

EMME model should capture longer-term O/D changes based on current trip distribution stage in the model (Gravity model). Is it sensitive enough to other trip-making behaviour, or do we need to make an adjustment? If we need to adjust, we need to consider how and whether PARAMICS is the best model to do that.

For discretionary trips, assess available information and make an adjustment in PARAMICS. Consider whether this should be targeted to gateway study area zones.

Outcome:

- EMME model establishes broad relationships between Origin and Destination pairs and makes broad assignments of trips to corridors based on system performance and travel times
- There is some question as to whether or not the EMME model sufficiently accounts for the increasing number of people who both live and work downtown – a relationship that promotes transit, cycling, and walking as preferred modes of travel
- It was initially assumed for this exercise that EMME sufficiently accounts for this phenomenon
- Subsequent review of EMME output indicates that O/D pairings do not appear to change substantially between 2031 "base" and 2031 "remove" (only the specific route choices between those zones)
- If the EMME model does not account for different O/D choices under "remove", this may be one area where additional reduction above baseline levels can be justified (but would need to be quantified).

Suggested reduction:

- 0% reduction in auto trips – under the assumption that this is handled by the EMME model
- Additional reduction may be justifiable under "remove", but we have made mode choice adjustments that may in part offset this.

3.6 Trip Reduction

This covers a situation in which fewer total trips are made within the study area:

- Reduced frequency of trip-making (including alternate work arrangements such as telecommuting, conference calling for business travel or compressed work week)

Potential data sources:

- TTS data? Probably not.
- Other travel surveys? (Smart Commute? VTPI?)

- Census data?
- Permanent count station data (day-to-day fluctuation)
- Others?

Considerations:

- There has been a shift toward increasing telecommuting/teleconferencing with recent technological changes. Is there willingness amongst employers and employees for additional telecommuting or have we reached a threshold? (similar for growth of e-commerce – internet shopping etc.). While some of this has occurred, there is likely room for some more of this.
- How much is occurring now? How much more?
- 2006 commuter survey:
  - Of motorists that expressed willingness to switch from auto at least one day a week (unknown %), 44% expressed a willingness to telework at least one day a week. This statistic may not be directly comparable, since it is on an unknown baseline percentage and applies to all commuters living in Toronto (regardless of O/D pairings).
  - 34% to 45% of respondents (unknown) said that teleworking was "an option" but did not specify how many days per week.
- Assume to apply increase (if any) globally to work trips, perhaps limited to certain employment sectors
- Would any additional work trip reductions occur uniformly throughout the week or would they be weighted toward Monday/Friday? (reduced benefit if still have to accommodate higher traffic Tues-Thurs)
- Would currently unforeseen technological advances make this type of reduction more feasible? (Substantially better than today?) Can we rely on the hope that this type of unknown technological advancement will materialize?

Outcome:

- Post-modelling adjustment is required
- Home-based work is increasing as a percentage of the employment base
- Teleworking is increasing as the supporting infrastructure improves and the proportion of information-based jobs increases
- Teleconferencing is an accepted method of business interaction with an increasing trend
- E-commerce is increasing in popularity, reducing discretionary shopping trips
- E-learning is increasing in popularity, reducing school-related trips
- Baby boomers retiring and travelling less as a demographic group

- GTA transportation planning exercises (Metrolinx TMP, Halton TMP) have assumed between 2.7% and 8% reductions post-modelling for this factor

Suggested reductions:

- Trip reduction *(trips are reduced due to telework, compressed work week, etc.)*:
    - 2-4% reduction in auto trips – global adjustment

3.7 Trip Elimination

"Trip just doesn't happen" – discretionary trip not worth the effort of traveling through congested area, or trips consolidated to occur less frequently.

Potential data sources:

- TTS, EMME model? — discretionary vs. non-discretionary trips
- Cairns et al list case studies with a wide range of net traffic impacts, but they predominantly refer to the net trip reduction without categorizing into where (if anywhere) the eliminated trips went.
- Some examples:
    - Embarcadero closure: "42% of drivers found alternate routes within six weeks of the earthquake, remainder reduced discretionary trips or switched to transit)"
    - Central Freeway closure: "A survey mailed to 8,000 drivers whose license plates had been recorded on the freeway prior to the closure revealed that 66% had shifted to another freeway, 11% used city streets for their entire trips, 2.2% switched to public transit, and 2.8% said they no longer made the trip previously made on the freeway. The survey also found that 19.8% of survey respondents stated they made fewer trips since the freeway closure. Most were discretionary trips, such as for recreation."
- Gardiner survey: 7% of drivers said they would likely not make the trip if congestion increased in the corridor

Initial suggestion:

- The data are limited in this category, typically documenting the overall reduction and not how it was accommodated. Often "trips not made" are captured by one of the other categories of trip reduction mentioned above. Some trip elimination of discretionary trips is expected, but it is difficult to quantify.

Suggested reductions:

- Trip elimination *(trip is completely eliminated)*:
  - 1-2% reduction in auto trips – global adjustment

3.8 Summary

The following table summarizes the trip reduction demand adjustments contemplated. It also includes how the change is expected to be accomplished from a modelling perspective.

Recommended Post-EMME Modelling Adjustments to Auto Demand Forecasts		
Areas for Adjustment to Forecasted Peak Hour Auto Trip Generation	**Magnitude of Adjustment***	**Trip Forecasts Requiring Adjustment**
Trip Reassignment *Trip shifts to alternate route, but not within the FGE/LSB corridor*	0%	Handled by EMME model, no additional change
Mode Shift *Trip occurs, but not as auto driver* • Transit Mode Share increase • Cycling and Walking Mode Share increase	5 - 7% 5 - 7%	Global reduction to Study Area Demand Primarily applied to shorter, internal trips (under 5 km)
Auto Occupancy	0%	No substantive change expected
Peak Spreading *Trip occurs, but not in peak commuter hour/period*	3 - 7%	Global reduction
Trip Redistribution *Origin and/or destination of trip is changed*	0%	Handled by EMME model, no additional change
Trip Reduction *Trips are reduced due to telework, teleconferencing, compressed work week, etc.*	2 - 4%	Global reduction
Trip Elimination *Trip is completely eliminated*	1 - 2%	Global reduction
Overall	**16 - 27%**	
** Note the term "adjustment" in this case refers to reductions to peak hour auto trip generation rate*		

Appendix E
Construction Staging Summary

Introduction

Project team for the F.G. Gardiner Expressway (FGE) and Lakeshore Boulevard (LSB) Reconfiguration Environmental and Urban Study for the section of the corridor east of Jarvis Avenue has identified and consolidated a total of 4 alternatives to be brought forth to the next stage of evaluation.

These alternatives include:

Maintain Alternative – as exhibited at PIC#2, the Maintain option is to represent the base case (2031) or "do nothing" alternative, as presented by the City to include full deck replacement and rehabilitation of the Gardiner but does not include a re-aligned LSB through Keating for the time being.

Improve Alternative – This includes the "Improve Lite" alternative which will involve the replacement of the deck of the FGE, similar to the Maintain Alternative but with a narrower deck to carry only 4 lanes generally instead of 6, the replacement of a total of 10 supporting bents, as well as some modifications to the current lane configuration of the LSB including the removal of one eastbound lane from Jarvis to Bonnycastle, as well as some new urban design features along the modified LSB.

Replace Alternative – This will involve the reconstruction of the elevated FGE at a higher elevation to replace the existing aging structure, and realignment of the LSB underneath.

Remove Alternative – The corridor will be converted into an at-grade, 8-lane boulevard.

In addition to providing a conceptual recommended construction staging plan, these notes discuss potential construction traffic management and staging issues for each of the 4 main alternatives identified in this study. The concept of <u>ONE</u> workable option for each alternative has been presented. The following should be noted:

1. The concepts offer some estimate of lanes available at each construction stage. These temporary lanes will be connected to the road system outside the limits of this study at various locations. The efficiency and impact of this will be evaluated in subsequent studies.

2. There are opportunities to create additional stages along the Elevated Gardiner (FGE) (longitudinal staging) as this is a very long site (over 3km), by isolating the structure at some "on-" and "off-" ramp locations. These can be further evaluated when more information are available, e.g. requirement to reduce traffic impacts, funding limitation, and the like. This review assumes that the entire work limit will be made available for construction all at once.

3. The use of Railway lands next to the Toronto Rail Corridor on the south side has not been identified based on Metrolinx's response to the request regarding the possible use of their lands. If these lands become available in the future, they could provide the opportunity for additional road capacity and will be beneficial to all staging schemes.

Remove Alternative

Key Features of the Scheme:

1. General

   Reference should be made to the concept layout drawings prepared for the Remove Alternative, the proposed new alignment of the new Lakeshore Boulevard, and its east connection with the DVP/East Lake Shore and the west connection with the remaining elevated FGE and at-grade LSB.

   a. The "Remove Alternative" will eliminate the elevated section of the FGE between DVP and Yonge, including the high-level ramps connecting DVP to FGE, and with the LSB converted into a wide, 8-lane boulevard carrying all traffic within the corridor. The LSB will be realigned northwards west of the Don to Cherry, and necessitating new low level crossings (both EB and WB) over the river. Elsewhere the new LSB will more or less follow the existing alignment of LSB.

   b. The New LSB is expected to provide 4 mainline lanes in each direction, with at-grade intersections at each major crossing with arterials controlled by signals, and ancillary lanes and bike lanes provided as required.

   c. New structures will also be required on the west limit to bring some of the LSB traffic back onto the remaining elevated portion of the FGE. These ramps will generally be 2-3 lane structures ramping up at around 4% grade, around 200m long, for both WB and EB traffic, primarily between Yonge and Jarvis. Although the alignment of these ramps have yet to be finalized, considerations should be given to:

      i. For the WB on ramp onto FGE, utilize the existing WB Jarvis on-ramp potentially widening it to accommodate 2 lanes, i.e. the 4 mainline lanes on the new LSB will be split into 2 mainline lanes to continue onto the existing LSB, one "either or" lane to FGE and LSB and one ramp lane onto FGE. FGE will have 2 WB lanes from here which become 3 lanes west of Yonge when the York On-ramp will be combined. This configuration may change based on recommendations from the Lower Yonge Precinct planning work that is currently ongoing.

      ii. For the EB off ramp, depending on the future of the York-Bay-Yonge (YBY) off ramp, traffic will be let off at this ramp, the rest of the traffic will descend onto the new LSB via the existing Jarvis off ramp which can again be widened to accommodate 2 lanes, and a brand new ramp structure may not be required. Similar to the above, this ramp will be influenced by the pending recommendations of the Lower Yonge Precinct Plan, where the current EB Jarvis off ramp may be shortened to end at Yonge Street instead.

Nevertheless the final configurations of these ramps would not likely affect the construction approach as described in this document. Where necessary this document will be updated to address any resulting impact when the precinct plan has been finalized.

d. All pedestrian sidewalks and crossings of the boulevard will be at-grade.

<u>Constructability review and recommendation for Remove Alternative:</u>

1. For this Alternative the entire elevated FGE will be removed. Understandably the number of lanes in the FGE/LSB corridor will be reduced during construction due to the need to provide sufficient working areas for the new construction works, contractor accesses, as well as laydown areas and prefabrication yards. Additionally, safety considerations will likely preclude the removal of major deck panels and substructure components over live traffic or public / inhabited areas due to the significance of this operation, for both superstructure and substructures, and the danger / hazard entailed.

2. As described below, the team identified the opportunity that removal can be staged to allow FGE to be partly operational during the removal, but there would be costs associated with temporary strengthening of the substructure (likely by the use of temporary additional columns). This approach involving FGE removal on a per direction basis while keeping one direction open on the viaduct, has been adopted in this study.

3. Management of Traffic during construction for this Alternative would involve the following:

    a. Utilizing the existing Queens Quay (QQ) between Yonge and Small Street, a new Parliament Slip encroachment/crossing east of Small and a new roadway, which can be used as permanent road in future development of the Lower Don area (which is assumed to be available for the construction of this project) that can be reconnected into the existing LSB east of DVP.

       (Note: action for protection of the ROW to allow this to happen should be done as soon as possible).

    b. Utilizing Commissioners Street (Carlaw/Commissioners/Cherry) to detour LSB traffic around the Gardiner East Ramp structures and the Don Roadway/LSB Intersection to facilitate the construction of this major intersection. Due to the condition and limited capacity of the existing Cherry Street Bascule bridge, this detour would require a new 4-lane crossing of the Keating Channel at or near the existing Cherry Street Crossing. This detour was successfully used in the 2001 Gardiner East Demolition contract to re-route LSB traffic east and west of the DVP during demolition work. Reference is made to the Waterfront Toronto's "Keating Channel Precinct Environmental Study Report (2010)" where a new fixed crossing over the Keating Channel is proposed located approximately

50m west of the existing Cherry Street Bridge. This new fixed link will carry 4 lanes of traffic, 2 in each NB and SB direction, as well as transit, pedestrian and cycling facilities. The Project Team recognized that timely provision of this structure would facilitate the traffic planning for the Gardiner Project, otherwise a temporary bailey structure would be required in place to complete the Commissioners detour route. Either way the new fixed link or the temporary crossing will be constructed at a higher elevation than the existing Cherry Street Bascule Bridge, to provide the necessary vertical headroom for vessels that continue operating in the area, such as the dredgers.

c. Additional opportunity for diverting traffic can be provided by temporary connecting Esplanade north of FGE corridor with Mill Street thus allowing vehicles to bypass the work zone via a Cherry Street connection. The efficiency of this route has not been fully evaluated, as these are narrower and busier streets and the connection will involve a number of left turning movements.

d. Additional temporary / permanent lanes may be proposed or considered along the south edge of LSB to enhance capacities during construction. For construction purposes, it is assumed that a physical separation of 5m be maintained between the construction zone and the operating highways / roads. A more detail analysis of this opportunity will be completed when sufficient surveying and preliminary design data are available.

e. The remaining opportunities will be provided by staging within the work zone by taking out lanes sequentially but will still observe efficiency and safety requirement as stated above.

4. Potential Staging Alternative:

a. Pre-Works (these works will proceed with negligible or no impact on the FGE/LSB traffic as they will be constructed away from the work zone). This will include:

i. Pre-stage 1:

1. Maximize width of the LSB between Yonge and Parliament during construction by widening to the south. Due to the first stage work on the north side of the FGE, as described below, as well as the proximity to railway lands, opportunity to utilize lands north of the corridor for detouring was assumed not available.

2. Widen / Reconstruct / Extend Queens Quay to a potential 5 to 6 lane arterial to carry the bulk of the traffic during construction works. This is a key temporary route for most of other Alternatives of this study. Through this, a bypass route will be created that will convey traffic off

the busy work zone area. The east end of the QQ extension will be turned northward and connected to the new section of the LSB constructed under pre-stage 2 (below), or southward to connect to the new Don Roadway interchange area for accessing the DVP at certain construction stages.

ii. Pre-stage 2: To construct the section of new widened LSB Boulevard east of Cherry including:

1. Section of the permanent LSB east of Cherry, including the new WB Don River Crossing. Both new Don crossings have been realigned and will be positioned outside the shadows of the existing group of structures to allow them to be pre-built. The construction of the first of these 2 bridges, each as a 2-lane structure, is potentially the most time consuming item in this pre-work stage and can be seen as a standalone work. The other ramp structure is not considered essential at this time, but can be built as well if so desired.

2. With the implementation of the Commissioners Detour, complete temporary connections between the QQ detour and the other detour routes in preparation of Stage 1 work. During this stage, the new intersection of the LSB east and Don Roadway, as well as the demolition of the LSB to FGE Ramps can be constructed first as this section is primarily located away from the busy traffic. The NB and SB Don Roadway traffic will have to be staged to maintain capacity and connections. Note that the Commissioner detour may include a new 4 lane crossing of the Keating Channel as indicated above.

iii. Pre-Stage 3: Temporary Supporting Columns for identified FGE bents in preparation for the staged demolition of the FGE. Notably, for example, if the bent contains only 2 columns, a temporary centre column will be required to maintain stability of the elevated FGE when half of the bent, and one column as well as the deck, is being removed. Some traffic restrictions on LSB may be required.

iv. Pre-Stage 4: Other works that may proceed early include the WB Jarvis On-Ramp Widening, and the reconstruction of the EB Jarvis Off Ramp as per the Lower Yonge Precinct Plan, which may be able to carry some traffic from arterials back onto the FGE during stage 1 of the work (see below).

b. Stage 1 Work: Demolition of WB FGE

i. At this time the permanent crossing and part of the realigned LSB east of Cherry will be operational, as well as other detour routes such as the QQ extension and its connection to the new LSB. These detours will be a major route to carry the WB traffic during the first stage removal of the FGE, and accommodate all connecting traffic with arterials and existing ramp traffic, which will no longer have access onto the WB FGE. Additionally any required temporary substructure work would have been in place to support partially removed bridge. Traffic will re-access the WB FGE via on-ramps at Jarvis and York.

ii. EB FGE will continue to operate together with the ramps and the E-N DVP ramp in place. How the available lanes on the still operational EB FGE/LSB corridor, and the detour route via QQ etc. will be utilized and signed, will have to be decided later during subsequent design stages.

iii. The N-W DVP Ramp and the north half of the FGE (WB direction lanes) will be removed. Sections of LSB directly under the elevated FGE here will be closed for safety reasons. In considering the impact to N-S traffic (such as Jarvis, Sherburne, Parliament and Cherry), works at the LSB for construction of the new LSB will have to be staged to maintain access of these arterial N-S roads with the LSB, with at least one lane available in each direction. Demolition work will have to be staged to occur at pre-arranged night-time or weekend closure to ensure safety to the public for the FGE sections at these intersections.

iv. The West Limit on ramps at Jarvis and Yonge, as discussed above, if not already built as discussed in the pre-stage works, will be constructed along with any required ramp improvement interacting with the existing Jarvis On-Ramp. Construction of these works is not expected to be problematic as the LSB here is closed.

v. The new LSB WB lanes west of Cherry will be built including part of the intersections with major arterials, thus completing the new WB new LSB.

c. Stage 2 Work: Demolition of EB FGE.

i. At this time the WB traffic will be using the WB lanes of the new LSB and connections back onto the FGE or continue on LSB WB beyond Yonge as per existing, and with other detour routes still fully operational.

ii. EB traffic will be led off the FGE via ramps prior to Yonge such as the York-Bay-Yonge Ramp and perhaps the Jarvis Ramp depending on the final configuration agreed. Traffic will be led onto the QQ detour, or other potential routes as identified. The LSB directly under the EB structure will be fully closed to traffic.

iii. The remaining elevated structure of the FGE east of Yonge will be demolished, along with the high level DVP Ramp connection. As this ramp goes over live traffic at some locations, the demolition may have to be carried out during pre-arranged weekend closures of the entire corridor.

iv. The new EB Ramp at the west end will be built. As discussed above, this can be combined with the existing Jarvis off-ramp by rebuilding this ramp into a 2-3 lane structure and bringing FGE traffic down onto the new LSB and reconfiguring the signaled intersection here to optimize the capacity of the new corridor, or as a shorter ramp ending at Yonge as per the Lower Yonge Plan. Again, the future of the YBY Off Ramp has to be confirmed in due course and is not part of this project.

v. The LSB EB – NB DVP ramp over the Don will be completed in this stage, if not already built in previous and pre-stages.

d. Stage 3 Work: Final Configuration of the LSB, New DVP Crossings, and Removal of the Detours.

i. After the demolition work the remaining portions of the new LSB wide boulevard can be constructed, along with all urban features such as bike lanes and leisure areas.

ii. All intersections will be finalized, all signals and crossing completed.

Replace Alternative

Key Features of the scheme:

1. General

   This Alternative will replace the existing FGE elevated structure with a new modern structure between the DVP and Jarvis Street. As well, the LSB will be reconstructed.

2. To make use of this opportunity to open up the Waterfront area and make the area more attractive and lively, the new structure will tower above the newly realigned LSB below by placing this structure approximately 5m above the existing deck, i.e. around 15m above LSB. This will allow a brighter and less enclosed LSB which will be equipped with newer features to address the urban design component of this study.

   (As per the project team's discussion in late November, there is a possibility of raising this new structure by another 3 meters to allow additional lane of traffic on the existing FGE, but since this option involves much longer ramps (around 100m additional length each), the final details has to be established to ensure this approach is feasible.)

3. The new structure will generally be 2 lanes in each WB and EB directions. For practical reasons due to the new height of the elevated FGW, fewer connections via much longer ramps will be provided with arterials and the LSB.

4. As a result of this, new structural ramps will be required as follows:

   - On the east limit, EB and WB DVP Ramps over the Don River to climb to the new elevations of the proposed structure;
   - Also on the east limit, EB and WB LSB Ramps to connect to the LSB east of the Don River;
   - WB Sherburne Off Ramp and the WB Yonge Off-Ramp;
   - Consideration of keeping the existing York WB On-Ramp will be reviewed in subsequent design stages to confirm its feasibility and validity, similarly for the EB Jarvis Off-Ramp, to see whether new ramps will be more economical considering life cycle costs. Reference is also made to the Lower Yonge Precinct Plans and its discussions regarding these ramp structures, as mentioned in the "Remove" Alternative above;
   - A new EB Jarvis On-Ramp will be provided; and
   - At the West limit of the new FGE, 2 new ramps (for both EB and WB traffic) will be required to bring the FGE back down to join with the existing, remaining portion of the FGE before Yonge.

5. The LSB will also be reconstructed to a new alignment, with the east end west of the Don River moved northwards and the rest of the LSB tucked below the new FGE. The median of the LSB will become the location where the single column of the new FGE will be located. All other urban design elements/features will be incorporated into the new LSB.

6. Preliminary considerations for the new bridge cross-section and aesthetic appearance, as well as the relative position with the existing FGE and LSB have been prepared conceptually. It is understood that one section may not represent the full picture of the dimensional relationship but this can only be finalized in future designs.

   The new elevated FGE is around 21m in total width, while this section of the existing FGE is between 27 and 29m. A typical section is attached to these notes at the appendices. As the area below the new FGE cannot accommodate any traffic lanes, only the outside of the existing FGE can be used to convey traffic during construction of the new bridge, and this is possible with some minor widening of the existing FGE but this is considered doable.

<u>Constructability review and recommendation – Replace Alternative:</u>

1. With the existing FGE able to provide only one single lane during construction in each direction, it is understood that the number of lanes in the FGE/LSB corridor will be significantly reduced during construction and the ability to detour traffic away from the corridor is a key element to maintain adequate E-W traffic across the lake shore of the City.

2. Additionally, it must be pointed out that to construct a 3km elevated viaduct a large amount of prefabricated components and complex machinery will be needed during the entire construction period. This may imply, for precast works, a large quantity of precast girders, or for incremental launching or balance cantilever construction, sophisticated formwork and traveling systems. These notes will only deal with the traffic planning and construction staging issues and have not looked into the availability of large precasting facilities as well as equipment storage and maintenance locations, which have to be investigated in detail in the future design stages.

3. Again, safety consideration will preclude the removal of major deck panels and substructure components over live traffic or public / inhabited areas due to the significance of this operation, for both superstructures and substructures, and the danger entailed.

4. As described below, the team found that some potential of staged construction to allow FGE and LSB partly operational during the removal, but some costs for temporary widening will be required.

   Additionally there are concerns of “single lane” viaduct during emergencies and inefficiencies with ramp traffics. This is not evaluated here but consideration should be made in future design stages to see whether these lanes should be allowed to operate during construction stages.

5. For the LSB, at least one lane in each direction will be disabled during the construction of the piers for the future FGE structure.

6. Similar to Remove Alternative, management of Traffic under this Alternative will have to look into the opportunities provided by the following:

    a. Similar to the Remove Alternatives, utilize existing QQ between Yonge and Small Street, construct a new Parliament Slip crossing east of Small and a new roadway to the east, which can be used as permanent road in future development of the Lower Don area (which is assumed to be available for the construction of this project) that can be reconnected into the existing LSB east of DVP.

    (Note 1: action for protection of the ROW to allow this to happen should be done as soon as possible, to ensure the developments here, if going ahead before this project, the detour routes will still be available, perhaps as part of the future municipal road system)

    (Note 2: as described above, the City should identify a significant size workshop and precasting area in the vicinity of the site for this Alternative and has it protected from developments until the conclusion of the work).

    b. Also the Commissioners Detour including a new or temporary 4 lane crossing of the Keating Channel, instead of utilizing the existing Cherry Street Bascule, should be implemented to lead traffic away from the Gardiner East and Don Roadway intersection to allow removal of the ramps and upgrading of the intersection to be completed with minimal traffic impact to the users.

    c. Similarly, additional opportunity for diverting traffic can be provided by temporarily connecting the Esplanade north of FGE corridor with Mill Street thus allowing vehicles to bypass the work zone via a Cherry Street connection. The efficiency of this route has not been fully evaluated, as these are narrower and busier streets and the connection will involve a number of left turning movements.

    d. The remaining opportunities will be provided by staging within the work zone by taking out lanes sequentially but will still observe efficiency and safety requirements as stated above.

    5. Potential Staging Alternative:

        a. Pre-Works (these works will proceed with negligible or no impact on the FGE/LSB traffic as they will be constructed away from the work zone). These will include:

            i. Pre-stage 1:

- Maximize space for the LSB between Yonge to Parliament for any requirement for lanes on LSB during construction. Due to the proximity to railway lands, opportunity to utilize lands north of the corridor for detouring may not be available.

- Widen / Reconstruct / Extend Queens Quay to a potential 5 to 6 lane arterial to carry the bulk of the traffic during construction works. This is a key temporary route for most Alternatives of this study. Through this, a bypass route will be created that will convey traffic off the busy work zone area. The east end of the QQ extension will be turned northward and connected to the new section of the LSB constructed under pre-stage 2 (below), or southward to connect to the new Don Roadway interchange area for accessing the DVP at certain construction stages..

- Modify the Commissioners Street and construct the permanent / fixed link crossing of the Keating Channel, as described under the "Remove" Alternative, to complete the Commissioners Detour to facilitate the demolition of the FGE East section.

ii. Pre-stage 2: Section of new widened LSB Boulevard east of Cherry including temporary connections with the existing LSB east of DVP can be built first as this section is primarily located in virgin ground. Works under this pre-stage also include:

- Two temporary crossing over the Don to allow DVP traffic to reach the new LSB as the existing ramps will be demolished and advance construction of the new ramps onto the higher new FGE cannot be completed as they overlap partly with the existing ramps. The tighter curve of these crossings will only permit traffic at a lower speed but is considered acceptable. An alternative exists to lead all traffic down Don Roadway to access existing LSB, but this would not be able to meet the demand and is likely jamming up the entire corridor.

- The new LSB here will be connected to the QQ detour as mentioned above and will become one of the major relieve for the traffic during construction. LSB will continue to operate with limited capacity having to give up at least one lane for the construction of the new LSB median and substructures of the new FGE elevated viaduct.

- The portion of the new FGE outside the shadow of the existing FGE and the 2 new LSB to FGE ramps can also be built as long as they are not interfering with the existing traffic. This connection may become important during stage 3, when the 3 existing FGE-DVP ramps are being demolished and the new ramps being built.

iii. Pre-Stage 3 will construct the Don Roadway and demolish the LSB-FGE ramps using the Commissioners Detour, as in the Remove Alternative.

iv. Pre-Stage 4: Local widening of the FGE both EB and WB to provide sufficient space to permit one lane of traffic in each direction on the FGE during construction of the new bridge, as mentioned above. At this time it is not expected that such a minor widening will entail substructure work.

v. Pre-Stage 4: Other works that may proceed early may include the major intersection at the LSB, and any other works such as connecting roadways outside the shadow of the existing FGE/LSB corridor.

e. Stage 1 Work: Construction of the Substructure of the new FGE

i. All detours and temporary crossing will have already been in place for traffic purposes. This will involve the closing of the existing FGE down to 2 lanes in each direction by opening up the median portion of the entire deck including the removal of the girders to allow the new pier to punch through. At the east end due to the off-alignment of the new and old FGE, the situation may be more complicated as the 2 structures cross each other instead of one overlapping the other, and has to be reviewed more carefully during future design stages.

ii. Lakeshore will also be reduced by one lane in each direction generally depending on the location. Sections of the LSB located outside the shadow of the FGE will be less affected.

f. Stage 2 Works: Construction of the Superstructure of the new FGE

i. The existing FGE will be limited to one outside lane in each direction continue to operate while the bulk of the middle portion will be closed for the construction of the pier cap, the bearings and the superstructure. As discussed above, the operation of single lane highway has to be carefully reviewed on safety (accidents) and operational (ramps) reasons. As the new deck will be an aesthetically pleasing deck, in-situ, or match-casting segmental construction will likely be required, and will occupy the entire area until the completion of the new deck ready for traffic.

ii. Both West connecting ramps will be constructed as part of the new viaduct as the lanes are already closed here.

iii. LSB may be fully reopened at this stage as per existing condition depending on the final layout of the LSB median. Majority of the DVP traffic will be using the QQ detour route.

iv. The new on and off ramps for the new elevated FGE has to be constructed with due consideration of the outside lane traffic on the FGE. At this time it is considered feasible to leave one span of each of these ramps open to keep traffic on the existing FGE as long as possible, and fill in the gap after the new FGE traffic is flowing.

At the completion of Stage 2 the new FGE decks have been built from the West connection to the LSB on the east, except the connections with the DVP, hence allowing traffic to use it during Stages 3 for the relieve of traffic.

g. Stage 3 Work: The new DVP Ramps and Completion of the On and Off Ramps.

i. The DVP ramps will be constructed when the new FGE has been substantially complete and ready to convey traffic except for the new on and off ramps to DVP. This is because during the construction of the DVP ramps, the entire DVP to FGE connection will be totally shut down. Traffic down DVP will be entirely relying on the QQ detour and the temporary crossings onto the pre-built part of the LSB. Traffic on the new LSB will be able to access the new FGE from the new ramps and use the FGE to relieve the traffic.

ii. The existing DVP ramps will be demolished and the new ramps will be built to connect to the new FGE (at a higher elevation). Once the connection is complete traffic can be routed onto the new FGE although not all the ramps are fully operational.

iii. The incomplete on and off ramps will now be complete now that traffic on the existing FGE is removed.

h. Stage 4 Work: Demolition of the existing FGE.

i. Although this may be a quicker stage, but as this involves the demolition of both the superstructure and substructure of the FGE, the entire LSB will have to be closed, except those sections of LSB which lie outside the shadow of the existing FGE and those widened portions at the pre-stages for detouring purposes.

ii. Protection to the new substructures for the FGE from being damaged by the demolition is a key requirement of this stage.

iii. In considering the impact to N-S traffic (such as Jarvis, Sherburne, Parliament and Cherry), demolition work will have to be staged to occur at pre-arranged night-time or weekend closure to ensure safety to the public for the FGE sections at these intersections.

i. Stage 5 Works: Final Configuration of the LSB, and Removal of the Detours.

   i. After the demolition work the remaining portions of the new LSB can be constructed, along with all urban features such as bike lanes and leisure areas.

   ii. All intersections at LSB will be finalized, including the intersection with LSB east of Don and the Don Roadway connection.

Improve Alternative

Key Feature of the scheme:

2. General

- Reference shall be made to the Project Drawing depicting the proposal scheme and new alignments of the Gardiner / Lakeshore corridor. This is a "lite" version of the original scheme as provided to the engineers in a memo dated November 18, 2013. The work is very similar to the "Maintain" Alternative as described below. Subsequent revisions to the Improve Alternative may include other work on LSB but these work is not expected to have significant impact on the construction approach for this Alternative.

- This section of elevated Gardiner (FGE) will remain at its longitudinal and vertical alignments but the number of lanes and/or the width of the deck reduced to a narrower structure, but with proper shoulders (median and curb). All lanes will be tucked towards the north side of the existing bridge, thus opening up the south side with better light onto the LSB below. This will be achieved via a full deck replacement and as well as removal of girders on the south side that no longer support a deck.

- A total of 10 bents will need to be reconstructed to agree with the urban design details below the deck on LSB.

- The existing LSB will be modified including the removal of one EB lane from Jarvis to Bonnycastle. There are other potential opportunities here to reconfigure the LSB, but since it does not affect overall traffic planning, it will not be discussed in detail in this section.

- FGE Ramps, including the DVP ramps which are re-decked in 1993, will generally remain the same, or, some can be removed if desired, particularly those that are currently carrying very low traffic volume. Again as the ramp removal will unlikely affect the overall traffic planning of the corridor, it will not be discussed here in details.

Constructability review and recommendation for Improve Alternative:

1. Management of Traffic under this Alternative will be similar to a Maintain Alternative, when the deck will be replaced in full. The major difference is that for the Improve Alternative, during stage 2 of the work, only part of the removed deck will be reinstated opening up the median as per the above discussions. At any one time, 2 lanes will be provided during construction, and 2 lanes will be provided at the ultimate bridge configuration.

2. Potential Staging Alternative:

a. Pre-Works (these works will proceed with negligible or no impact on the FGE/LSB traffic as they will be constructed away from the work zone). For this alternative, this will include the pre-construction of all replacement bents as identified which need to be reconstructed.

b. Stage 1 Work: Construction of the Median lanes

   i. At this stage, all traffic will be routed to the outside, 2 lanes will be provided at each direction, while the median lanes will be built.

   ii. To allow the ramp traffic and connection to the FGE East (of Don), 2 sub-stages will be required to manage traffic between Cherry and Leslie, namely Stages 1A and 1B.

   iii. Ramps will remain open under this stage.

c. Stage 2 Reconstruction of the Outside Lanes:

   i. Traffic will now be using the newly constructed median lanes. Due to the need to stage traffic, provide work zone overlaps and TCB's lane widths provided may be slightly substandard but is acceptable.

   ii. All ramps will be closed at this stage.

   iii. The outside decks (original WB direction, on the north side) will be replaced, to complete the deck, while the deck and girders on the south side no longer required will be removed and the remaining new deck constructed at Stage 2 will be configured with the Stage 1 deck to provide proper lane and shoulder widths for the permanent layout.

   iv. Similar to Stage 2, 2 sub-stages, 2A and 2B, will be required to manage the traffic to and from DVP and the split elevations of the deck east of Cherry.

d. . Stage 3 Work: Miscellaneous Works.

   i. This will include the LSB upgrade if necessary, to accommodate the new intersections, substructure repairs, and the like.

Maintain Alternative

Key Features of the scheme:

1. General

- The Maintain Alternative is to continue the City's plans to rehabilitate the FGE using conventional methodology. Currently the City has adopted the use of full deck replacement, with due consideration of replacing the girder if a faster schedule can be accomplished in this manner.

- Any improvement to LSB will be extra to this Alternative and will not be reviewed.

Constructability review and recommendation for Maintain Alternative:

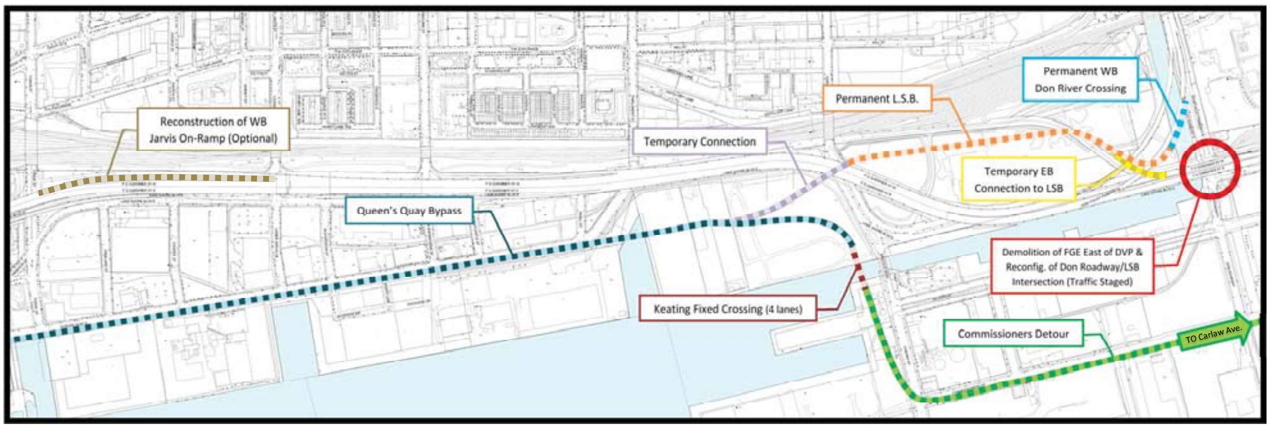
Staging Alternative: 2 stage of construction will be adopted also in consideration of the operation of the DVP ramps, LSB is not affected. Due to the fact that the full deck will be reinstated, it is considered better to start with the work on the outside lanes first, as compared with the Improve Alternative.

1. Stage 1 Work: Outside Lanes, maintaining 2 lanes of traffic in each direction, Ramp closed, Stages 1A and 1B for deck work east of Cherry.

2. Stage 2 Work: Median Lanes, also maintaining 2 lanes of traffic in each direction, Ramps reopened, Stages 2A and 2B for deck work east of Cherry.

Sketches

Remove



Pre-Work

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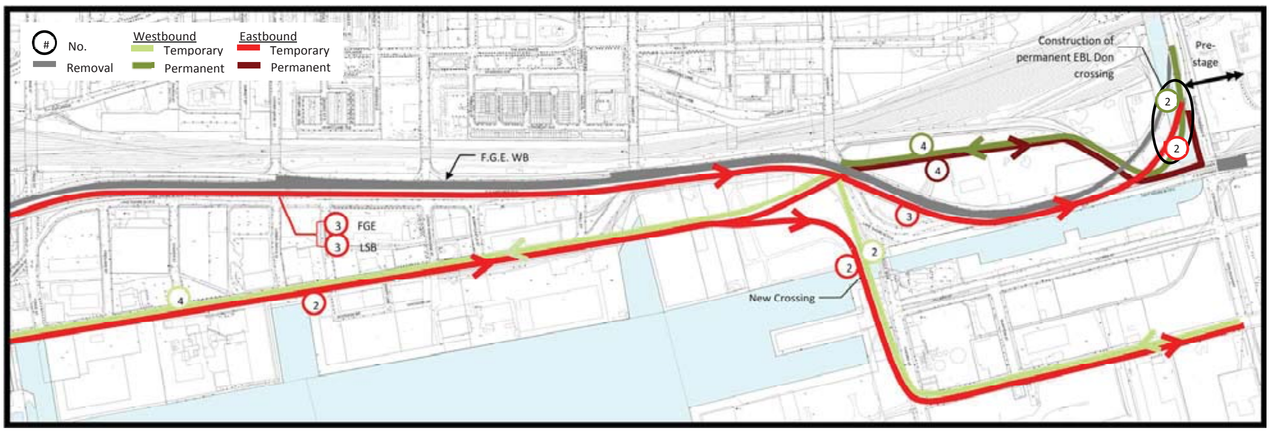
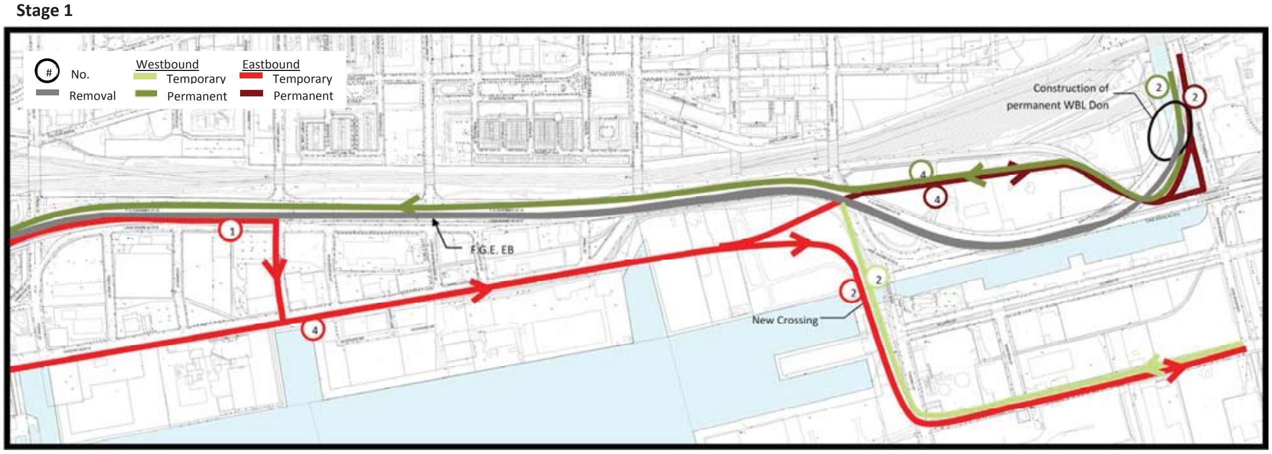


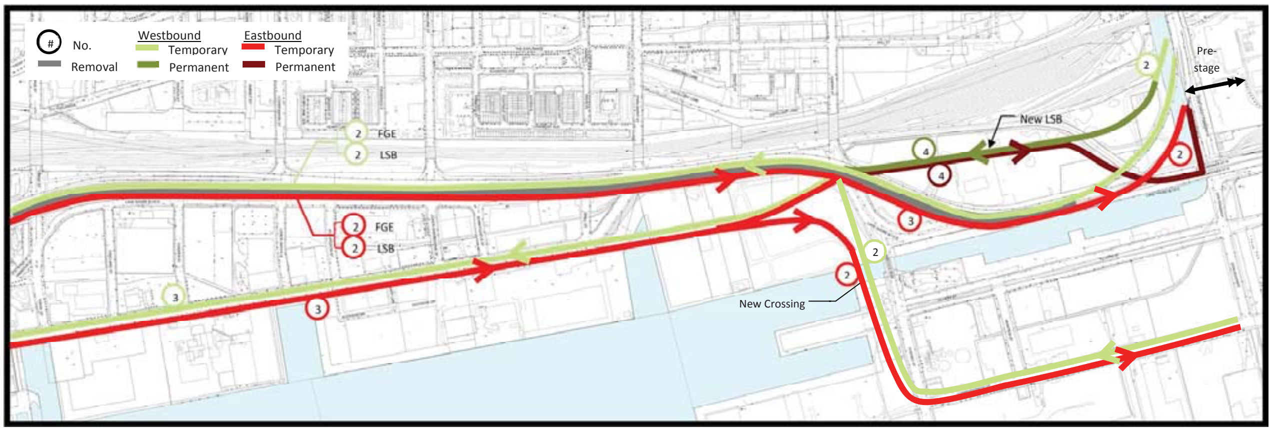
Stage 1



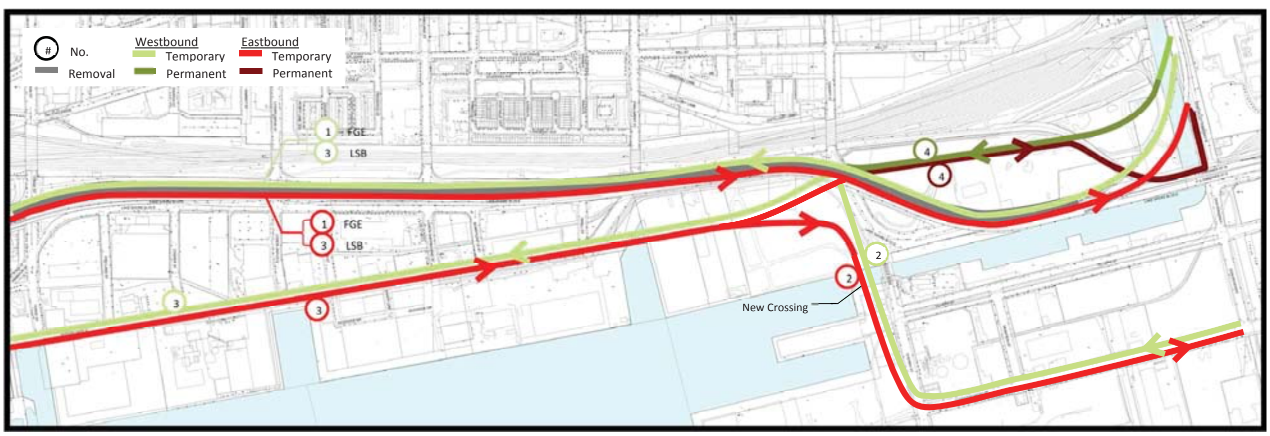
Stage 2

Stage 3: Completion of LSB and removal of detour not shown

Replace

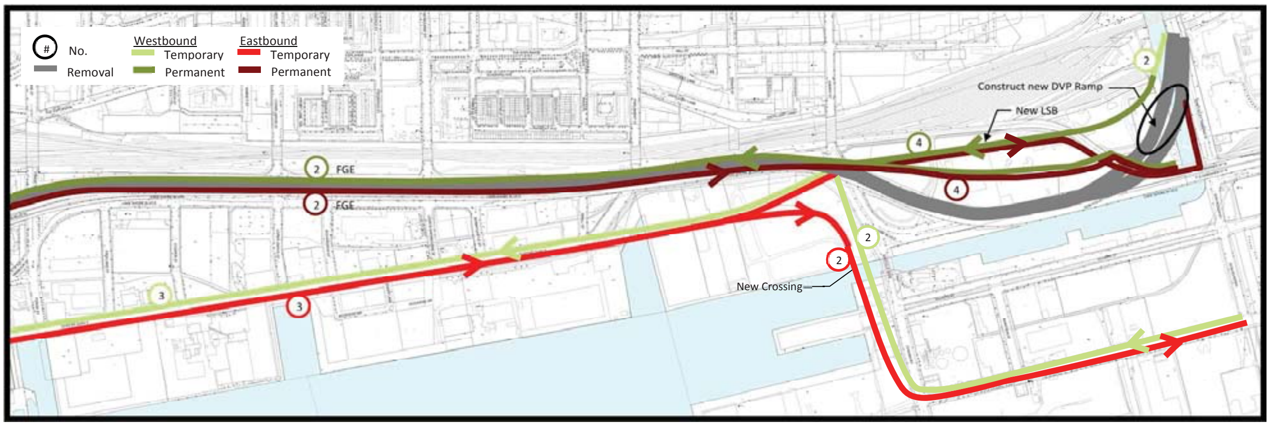


Stage 1 (Pier)

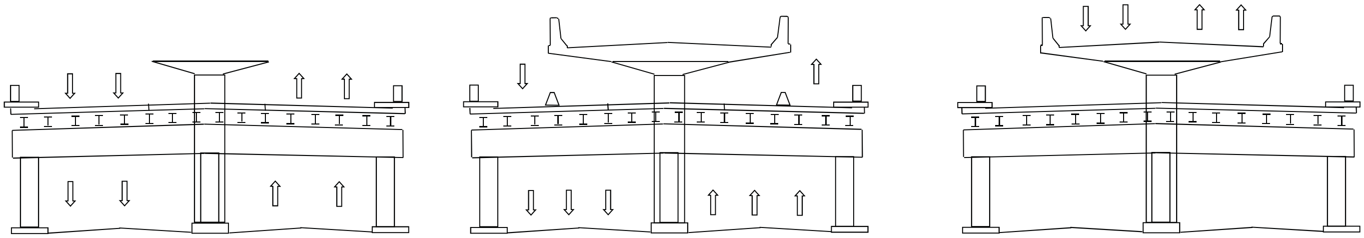


Stage 2 (Deck)

Replace

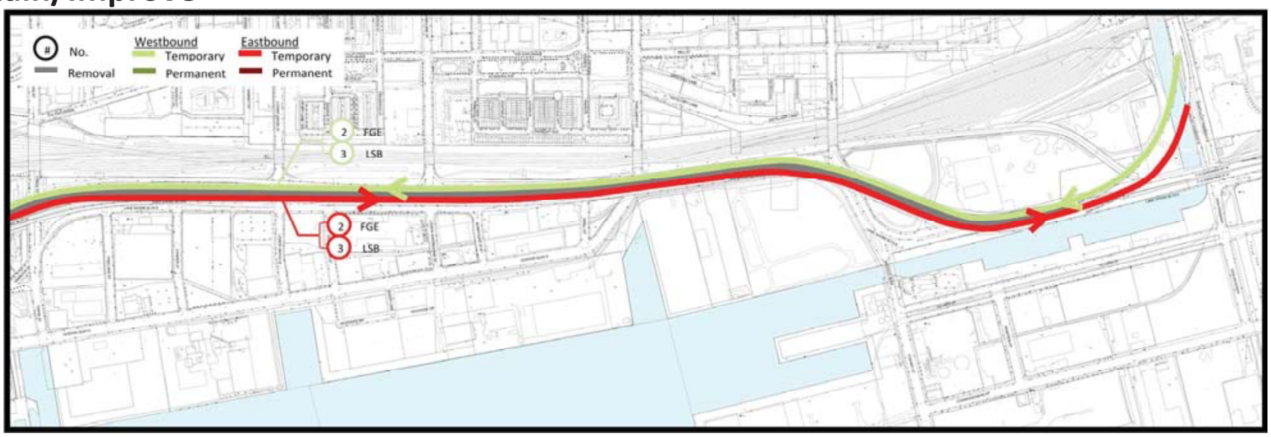


Stage 3 (DVP Ramp and Demolition)

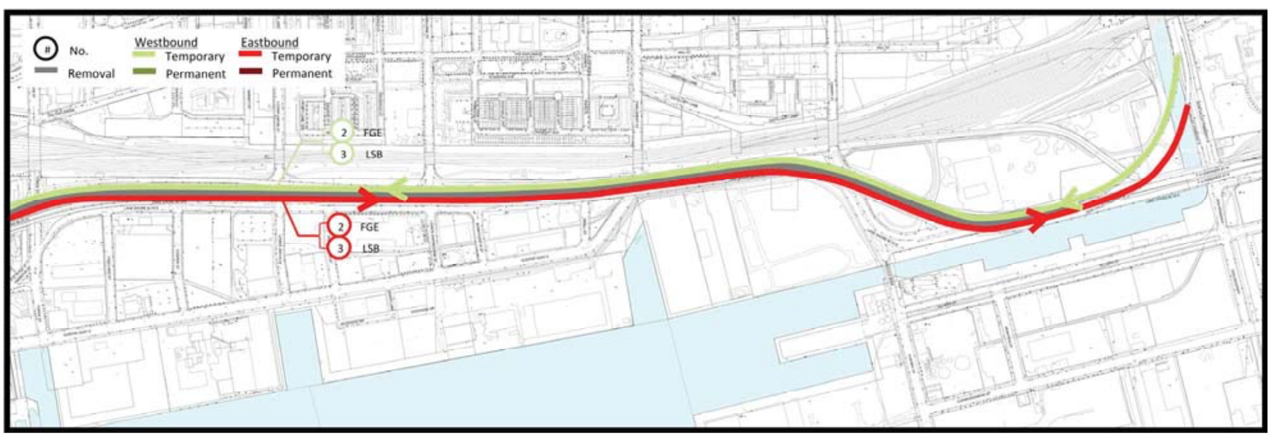


Stage 1 (Pier) **Stage 2 (Deck)** **Stage 3 (DVP Ramp and Demolition)**

Maintain/Improve



Stage 1



Stage 2

Appendix F
Air Quality Assessment Summary

TABLE OF CONTENTS

Page No.

LIST OF TABLES

LIST OF FIGURES

1 INTRODUCTION

On November 30, 2009, the Ministry of the Environment (MOE) approved the Terms of Reference (ToR) for the Gardiner Expressway and Lake Shore Boulevard East Reconfiguration Environmental Assessment (EA) that was submitted jointly by Waterfront Toronto and the City of Toronto. The approved ToR includes a high-level work plan for the Air Quality component of the EA (i.e., the Air Quality Impact Assessment (AQIA)). As a part of the AQIA, Dillon established the background ambient air quality levels for use in the EA, using an approach and data sources approved by the MOE.

The air quality and greenhouse gas (GHG) impact assessment followed the methodologies described within the Ontario Ministry of Transportation's document "*Environmental Guide for Assessing and Mitigating the Air Quality Impacts and Greenhouse Gas Emissions of Provincial Transportation Projects*" (January 2012) [the Guide]. The assessment includes a regional air quality and GHG emissions impact evaluation based on a burden analysis, and a local air quality impact evaluation using atmospheric dispersion modelling. This document describes how the four alternative solutions (Maintain, Improve, Replace and Remove) were evaluated.

2 ALTERNATIVE SOLUTIONS

The alternative solutions evaluated were Maintain, Improve, Replace and Remove as described below.

Maintain –the Maintain alternative represents the future base case (2031) or "do nothing" alternative. As this is a 2031 base case, the alternative also includes:

- [1] Full deck replacement and rehabilitation of the Gardiner as per the City's current rehab plans.
- [2] Build out of the current approved development applications within the study area (as per City's planning information), and the build out of West Don Lands, East Bayfront and Lower Don Lands as per the current precinct plans.
- [3] The realignment of Lake Shore Boulevard (LSB) between the Don River and Cherry Street as per the Keating Precinct Plan.

Improve – the Improve alternative is to improve the Gardiner and Lake Shore Blvd between Lower Jarvis Street and approximately Leslie Street and includes:

- [1] Rehabilitate the Gardiner and reduce the deck to 4 lanes.
- [2] Reduce LSB by taking out the southern eastbound lane east of Lower Jarvis Street.
- [3] Reconfigure intersections to simplify road geometry and connections to and from Gardiner ramps
- [4] Assume realignment of LSB between Don River and Cheery Street as per the Keating Plan.

Replace – the Replace alternative defines a scenario whereby the Gardiner between Yonge Street and DVP is replaced with another elevated expressway. This alternative includes:

- [1] Elevate the Gardiner by 5 m from Lower Jarvis to the DVP.
- [2] Shift Gardiner between Don River and Cherry Street to the realigned LSB as per the Keating Precinct Plan.

[3] Build a transitional section between Yonge Street and Jarvis Street.

Remove – the Remove alternative incorporates the removal of the Gardiner between lower Jarvis Street and the DVP and expands the LSB to 4-lanes in both directions.

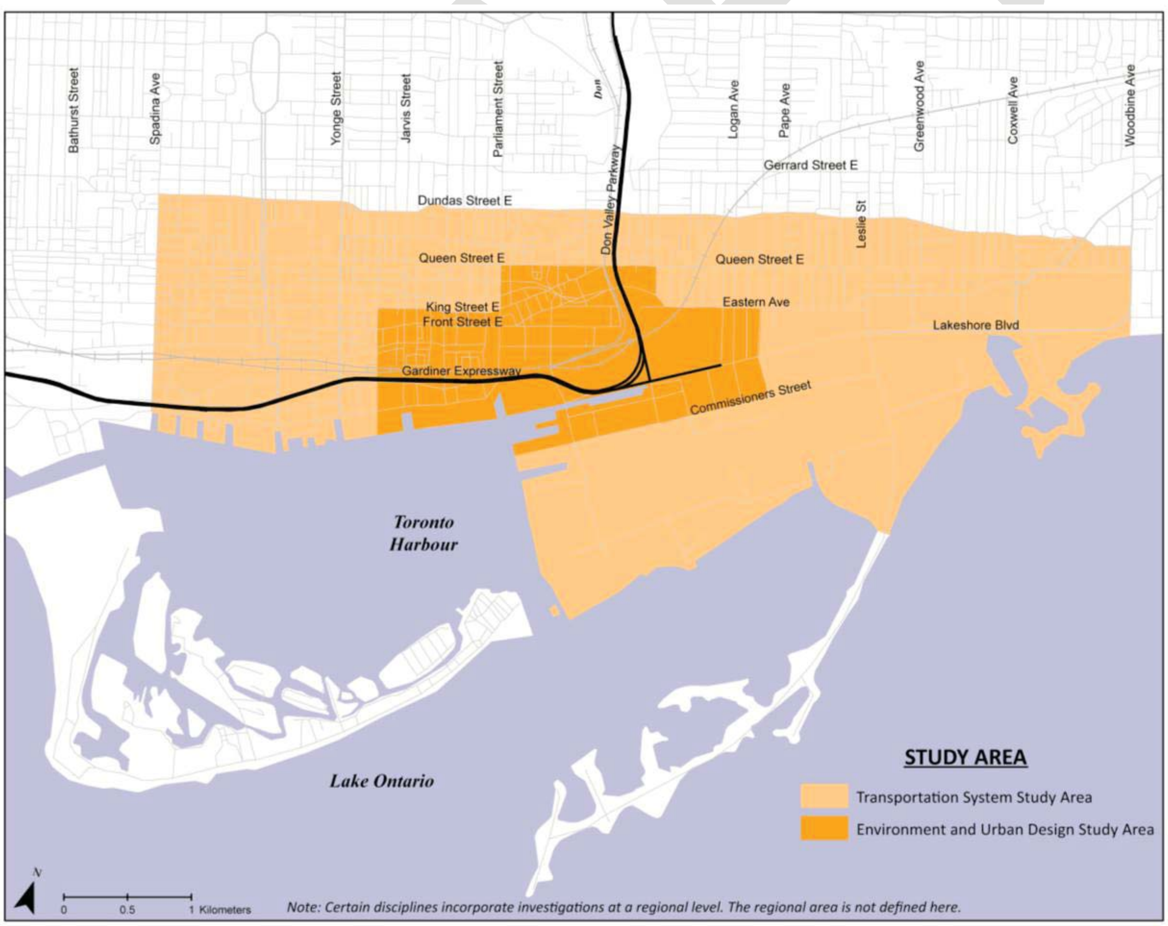
2.1 STUDY AREA AND RECEPTORS

Two study areas have been specified in the EA ToR, as shown in Figure 1:

- Environment and Urban Design Study Area – including lands south of King Street to the waterfront, and from Lower Jarvis Street to Logan Avenue.
- Transportation System Study Area – including lands extending from Dundas Street to Lake Ontario and from Spadina Avenue to Woodbine Avenue.

The section of the Gardiner and LSB that has been examined for reconfiguration is approximately 2.4 km and extends from just west of Lower Jarvis Street to just east of the DVP at Logan Avenue.

Figure 1: Terms of Reference Study Areas for GELBR



As described above, this assessment includes a regional air quality and GHG emissions impact assessment, and a local air quality impact assessment. In order to maintain consistency with the ToR study areas and to allow for consideration of the unique features of AQIA the study areas that have been identified for the AQIA include:

[1] Regional Study Area (RSA): for the regional air quality assessment and GHG emissions impact evaluation.
[2] Local Study Area (LSA): for the local air quality evaluation.

The RSA is defined as the Transportation System Study Area which are the lands extending from Dundas Street to Lake Ontario and from Spadina Avenue to Woodbine Avenue.

The LSA is designated as the study area bounded by King Street in the north, the lakefront in the south, Spadina Avenue in the west and Woodbine Avenue in the east.

Traffic data from the Expressway, arterial roads and collector roads have been included in the AQIA and so these roads have been defined within the RSA and LSA.

2.2 RECEPTORS

Receptors need to be defined for the local air quality assessment. The Guide recommends that the local air quality impacts be studied within a distance of 500 m from the transportation facility, in each direction and at both sensitive (residences) and critical receptors (hospitals, retirement homes, childcare centers, etc.). For this evaluation, the receptors include:

[1] Uniform Cartesian receptor grid with 100-m spacing within LSA at a default height of 1.8 m above ground, with receptors on railways and water removed;
[2] Critical receptors at a default height of 1.8 m above ground, identified based on current land use as provided by the City;
[3] Elevated receptors at heights of 1.8, 6 and 10 m above ground on both sides of the Gardiner with a spacing of 20 m between Yonge Street and DVP and 50 m between Yonge Street and Spadina Avenue.

Vehicular emissions are typically emitted close to ground level and modeling of transportation corridors generally yields maximum concentrations at ground level. However, some of the existing Gardiner sections are elevated. Therefore elevated receptors were also placed on both sides of the Gardiner. As the CAL3QHC/CAL3QHCR model allows the maximum release height of 10 m, the elevated receptors were placed at 10 m above the ground.

3 BACKGROUND AIR QUALITY

The Contaminants of Concern (COCs) evaluated in the air quality component of this assessment are listed below and were identified in consultation with the MOE (Dillon technical memo dated August 22nd, 2013). Table 1 identifies the background concentrations used for each COC in the air quality component of this assessment.

- Carbon monoxide (CO);
- Nitrogen oxides (NO_X (focus on NO and NO_2));

- Total suspended particulate (TSP);
- Particulate matter with aerodynamic diameter <10µm (PM_{10});
- Particulate matter with aerodynamic diameter <2.5µm ($PM_{2.5}$);
- Benzene;
- 1,3-Butadiene;
- Formaldehyde;
- Acetaldehyde;
- Acrolein; and,
- Benzo(a)pyrene (BaP).

As shown in Table 1, all of the background concentrations at both 70^{th} percentile and 90^{th} percentile were below their respective criteria except Benzene and BaP. For Benzene, the 90^{th} percentile annual concentration was 153% of its criterion. The 90^{th} percentile concentrations for BaP were 186% and 800% of its corresponding 24-hour and annual criteria. Therefore, Benzene and BaP are the two limiting factors to be considered in the evaluation.

Table 1: Background Concentrations for AQIA

Pollutant	Averaging Period	Data Period	70th Percentile ($\mu g/m^3$)	90th Percentile ($\mu g/m^3$)	Criteria ($\mu g/m^3$)	
$PM_{2.5}$	24-hour	2010-2012	7	12	30	Canada-Wide Standard; Ontario AAQC
PM_{10}	24-hour	2010-2012	12	21	50	Ontario AAQC
NO_2	24-hour	2010-2012	32	43	200	Ontario AAQC
	1-hour	2010-2012	32	51	400	Ontario AAQC
CO	8-hour	2008-2010	259	356	15700	Ontario AAQC
	1-hour	2008-2010	252	366	36200	Ontario AAQC
Benzene	Annual	2009-2012	0.69	0.69	0.45	Ontario AAQC
	24-hour	2009-2012	0.80	1.08	2.3	Ontario AAQC
Acrolein	24-hour	2008-2010	0.04	0.07	0.4	Ontario AAQC
	1-hour	2008-2010	0.10	0.18	4.5	Ontario AAQC
1,3 Butadiene	Annual	2009-2012	0.07	0.07	2	Ontario AAQC
	24-hour	2009-2012	0.08	0.12	10	Ontario AAQC
Formaldehyde	24-hour	2008-2010	1.46	2.51	65	Ontario AAQC
Acetaldehyde	24-hour	2008-2010	3.48	5.12	500	Ontario AAQC
	½ hour	2008-2010	10.31	15.16	500	Ontario AAQC
BaP	Annual	2008-2010	0.000088	0.000089	0.00001	Ontario AAQC
	24-hour	2008-2010	0.000093	0.000153	0.00005	Ontario AAQC

4 EMISSION FACTOR DEVELOPMENT

The air quality and GHG emissions assessments require that emissions (mass per unit of distance or time) of the COCs mentioned above as well as carbon dioxide equivalents (CO_2e) be estimated. Emissions are typically estimated by multiplying established emission factors by corresponding vehicle fleet size and kilometers of distanced travelled or idling durations. The most common emission factor model for mobile source emissions is the US EPA's MOBILE 6.2 model. This model predicts fleet-average emission factors. For this assessment, the Canadian version of the MOBILE 6.2 model (MOBILE6.2C, Version 6.2.3), which integrates the unique Canadian climate and fuel compositions, has be used.

Inputs and assumptions used within the MOBILE6.2C model followed the methodology recommended within the Guide and included use of:

- the month of July for the evaluation;
- diurnal patterns in temperature and relative humidity that were derived using measured data at Environment Canada's Toronto Island Airport station from 2008 – 2012 as inputs to MOBILE6.2C;
- the default vehicle characteristics (age distribution, annual mileage accumulation rates, and diesel fractions for the 16 vehicle classes) built into MOBILE6.2C;
- vehicle miles travelled (VMT) fractions by vehicle class that are derived from the field vehicle counts;
- VMT fractions by hour that are created based on the diurnal pattern in traffic volumes field counts;
- Ontario's drive clean program limit for the sulphur content of diesel of 15 ppm(note, the emission reductions due to Ontario's Emissions Inspection and Maintenance (I/M) Program have not been considered and this represents conservatism within the assessment);
- the road types: Freeway, Ramp and Arterial to simulate the average speeds that were used; and
- fuel composition and properties that are representative of those used in Ontario.

As all traffic volumes for the four alternative solutions are projected to 2031, the emissions were estimated for 2031. The emission factors used were calculated by MOBILE6.2C for NO_x, $PM_{2.5}$, volatile organic compounds (VOCs, a surrogate of air toxics) and carbon dioxide equivalent (CO_2e). The MOBILE6.2C output emission factors are shown in Tables 2 – 5.

In addition to exhaust, tire wear, brake and evaporative emissions, the re-entrainment of road dust is considered as a particulate matter emission source from vehicles travelling over a paved road. Emissions resulting from travel on paved roads were quantified using the US EPA AP-42 data (Chapter 13.2.1), as shown in Table 9. This is the recommended method within the Guide for the prediction of road dust emissions.

The emission factors for BaP specific to the Great Lakes Region, derived by the Great Lakes Commission for on-road vehicles are expressed as a fraction of particulate matter (PM) emissions from various types of vehicles including: LDGV, HDGV, LDGT, motorcycle, LDDV, LDDT and HDDV. Therefore, as a conservative assumption, $PM_{2.5}$ was used a surrogate to represent BaP in the evaluation.

Table 2: 2031 Emission Factors (g/mile) for NOx

Road Type	Speed (mph)	2.5	5	10	15	20	25	30	35	40	45	50	55	60	65	Ramp
Arterial	24-Hour	0.557	0.487	0.398	0.342	0.314	0.297	0.285	0.281	0.285	0.292	0.299	0.308	0.319	0.333	--
	AM Peak	0.561	0.490	0.400	0.344	0.316	0.298	0.287	0.282	0.286	0.293	0.300	0.309	0.320	0.332	--
	PM Peak	0.562	0.490	0.400	0.344	0.315	0.298	0.287	0.282	0.286	0.292	0.299	0.308	0.318	0.330	--
Arterial with Streetcars	24-Hour	0.551	0.482	0.394	0.339	0.311	0.294	0.283	0.279	0.283	0.289	0.297	0.306	0.317	0.330	--
	AM Peak	0.554	0.484	0.396	0.341	0.313	0.296	0.284	0.280	0.284	0.291	0.298	0.307	0.318	0.331	--
	PM Peak	0.554	0.484	0.395	0.340	0.312	0.295	0.284	0.279	0.283	0.289	0.296	0.305	0.314	0.326	--
Freeway with Ramps Combined	24-Hour	0.558	0.488	0.352	0.285	0.285	0.284	0.284	0.283	0.288	0.295	0.303	0.314	0.327	0.343	0.329
	AM Peak	0.560	0.490	0.353	0.286	0.285	0.285	0.285	0.284	0.288	0.295	0.303	0.314	0.326	0.342	0.329
	PM Peak	0.558	0.488	0.349	0.282	0.283	0.283	0.283	0.282	0.287	0.293	0.301	0.310	0.321	0.334	0.329
Freeway with Ramps Inbound	24-Hour	0.558	0.489	0.352	0.285	0.285	0.284	0.284	0.283	0.288	0.295	0.303	0.314	0.327	0.343	0.329
	AM Peak	0.542	0.491	0.353	0.286	0.285	0.285	0.285	0.284	0.288	0.295	0.303	0.314	0.326	0.343	0.330
	PM Peak	0.559	0.489	0.349	0.282	0.283	0.283	0.283	0.282	0.287	0.293	0.301	0.310	0.321	0.334	0.329
Freeway with Ramps Outbound	24-Hour	0.557	0.488	0.352	0.285	0.285	0.284	0.284	0.283	0.288	0.295	0.303	0.313	0.327	0.343	0.328
	AM Peak	0.559	0.490	0.352	0.285	0.285	0.284	0.284	0.284	0.288	0.295	0.303	0.314	0.326	0.342	0.330
	PM Peak	0.558	0.488	0.349	0.282	0.282	0.283	0.283	0.282	0.286	0.293	0.300	0.310	0.321	0.334	
Lakeshore Combined	24-Hour	0.568	0.498	0.408	0.351	0.321	0.304	0.292	0.288	0.292	0.300	0.309	0.321	0.336	0.355	--
	AM Peak	0.564	0.494	0.404	0.348	0.319	0.301	0.290	0.286	0.290	0.297	0.318	0.306	0.332	0.350	--
	PM Peak	0.565	0.494	0.403	0.347	0.318	0.300	0.289	0.284	0.288	0.295	0.302	0.312	0.323	0.337	--
Lakeshore Eastbound	24-Hour	0.568	0.498	0.407	0.351	0.321	0.303	0.292	0.288	0.292	0.299	0.309	0.320	0.335	0.355	--
	AM Peak	0.563	0.493	0.404	0.348	0.319	0.301	0.290	0.286	0.290	0.297	0.306	0.318	0.332	0.350	--
	PM Peak	0.564	0.493	0.403	0.347	0.318	0.300	0.288	0.284	0.288	0.295	0.302	0.312	0.323	0.337	--
Lakeshore Westbound	24-Hour	0.569	0.499	0.408	0.352	0.322	0.304	0.292	0.288	0.292	0.300	0.309	0.321	0.336	0.355	--
	AM Peak	0.565	0.495	0.405	0.349	0.319	0.302	0.290	0.286	0.290	0.298	0.306	0.318	0.332	0.350	--
	PM Peak	0.566	0.495	0.404	0.347	0.318	0.300	0.289	0.284	0.288	0.295	0.303	0.312	0.323	0.337	--

Table 3: 2031 Emission Factors (g/mile) for $PM_{2.5}$

Road Type	Speed (mph)	2.5	5	10	15	20	25	30	35	40	45	50	55	60	65	Ramp
Arterial	24-Hour	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	--
	AM Peak	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	--
	PM Peak	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	--
Arterial with Streetcars	24-Hour	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	--
	AM Peak	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	--
	PM Peak	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	--
Freeway with Ramps Combined	24-Hour	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013
	AM Peak	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013
	PM Peak	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012
Freeway with Ramps Inbound	24-Hour	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013
	AM Peak	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013
	PM Peak	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012
Freeway with Ramps Outbound	24-Hour	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013
	AM Peak	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013
	PM Peak	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012
Lakeshore Combined	24-Hour	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	--
	AM Peak	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	--
	PM Peak	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	--
Lakeshore Eastbound	24-Hour	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	--
	AM Peak	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	--
	PM Peak	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	--
Lakeshore Westbound	24-Hour	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	--
	AM Peak	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	--
	PM Peak	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	--

Table 4: 2031 Emission Factors (g/mile) for VOCs

Road Type	Speed (mph)	2.5	5	10	15	20	25	30	35	40	45	50	55	60	65	Ramp
Arterial	24-Hour	2.939	1.186	0.677	0.522	0.427	0.388	0.363	0.344	0.332	0.322	0.314	0.012	0.302	0.298	--
	AM Peak	2.956	1.191	0.679	0.524	0.429	0.389	0.365	0.346	0.334	0.325	0.316	0.012	0.304	0.300	--
	PM Peak	2.969	1.194	0.680	0.525	0.429	0.390	0.366	0.347	0.335	0.326	0.317	0.012	0.305	0.301	--
Arterial with Streetcars	24-Hour	2.934	1.184	0.676	0.522	0.427	0.387	0.362	0.343	0.331	0.321	0.313	0.012	0.301	0.297	--
	AM Peak	2.943	1.187	0.677	0.523	0.428	0.388	0.363	0.344	0.332	0.323	0.314	0.012	0.302	0.298	--
	PM Peak	2.967	1.194	0.680	0.524	0.429	0.390	0.365	0.346	0.335	0.325	0.316	0.012	0.304	0.300	--
Freeway with Ramps Combined	24-Hour	2.888	1.174	0.648	0.489	0.411	0.381	0.360	0.342	0.330	0.320	0.311	0.013	0.299	0.296	--
	AM Peak	2.899	1.177	0.649	0.490	0.412	0.382	0.361	0.343	0.331	0.321	0.312	0.013	0.300	0.297	0.364
	PM Peak	2.936	1.186	0.651	0.491	0.414	0.384	0.364	0.345	0.334	0.324	0.316	0.012	0.304	0.300	0.368
Freeway with Ramps Inbound	24-Hour	2.889	1.174	0.648	0.489	0.412	0.381	0.360	0.342	0.330	0.320	0.311	0.013	0.299	0.296	0.364
	AM Peak	2.695	1.177	0.649	0.490	0.412	0.382	0.361	0.343	0.331	0.321	0.312	0.013	0.300	0.297	0.365
	PM Peak	2.937	1.187	0.651	0.491	0.414	0.384	0.364	0.345	0.334	0.324	0.316	0.012	0.304	0.300	0.368
Freeway with Ramps Outbound	24-Hour	2.887	1.173	0.648	0.489	0.411	0.381	0.360	0.342	0.330	0.320	0.311	0.013	0.299	0.296	0.364
	AM Peak	2.897	1.176	0.649	0.490	0.412	0.382	0.361	0.343	0.331	0.321	0.312	0.013	0.300	0.297	0.297
	PM Peak	2.935	1.186	0.651	0.491	0.414	0.384	0.364	0.345	0.334	0.324	0.316	0.012	0.304	0.300	0.368
Lakeshore Combined	24-Hour	2.865	1.169	0.673	0.520	0.425	0.385	0.359	0.340	0.328	0.318	0.309	0.013	0.297	0.293	--
	AM Peak	2.874	1.171	0.673	0.520	0.425	0.385	0.360	0.340	0.328	0.318	0.302	0.013	0.297	0.294	--
	PM Peak	2.946	1.190	0.680	0.524	0.429	0.390	0.365	0.346	0.334	0.324	0.316	0.012	0.304	0.300	--
Lakeshore Eastbound	24-Hour	2.862	1.168	0.672	0.519	0.425	0.385	0.359	0.340	0.328	0.318	0.309	0.013	0.297	0.293	--
	AM Peak	2.871	1.170	0.673	0.520	0.425	0.385	0.360	0.340	0.328	0.318	0.309	0.013	0.297	0.294	--
	PM Peak	2.943	1.189	0.679	0.524	0.429	0.390	0.365	0.346	0.334	0.324	0.316	0.012	0.304	0.300	--
Lakeshore Westbound	24-Hour	2.869	1.171	0.673	0.520	0.425	0.385	0.360	0.340	0.328	0.318	0.309	0.013	0.297	0.293	--
	AM Peak	2.878	1.173	0.674	0.520	0.425	0.385	0.360	0.340	0.328	0.318	0.309	0.013	0.297	0.294	--
	PM Peak	2.950	1.191	0.680	0.525	0.429	0.390	0.365	0.346	0.334	0.324	0.316	0.012	0.304	0.300	--

Table 5: 2031 Emission Factors (g/mile) for CO_2e

Road Type	Speed (mph)	2.5	5	10	15	20	25	30	35	40	45	50	55	60	65	Ramp
Arterial	24-Hour	524.8	524.8	524.8	524.8	524.8	524.8	524.8	524.8	524.8	524.8	524.8	524.8	524.8	524.8	--
	AM Peak	518.0	518.0	518.0	518.0	518.0	518.0	518.0	518.0	518.0	518.0	518.0	518.0	518.0	518.0	--
	PM Peak	512.4	512.4	512.4	512.4	512.4	512.4	512.4	512.4	512.4	512.4	512.4	512.4	512.4	512.4	--
Arterial with Streetcars	24-Hour	523.8	523.8	523.8	523.8	523.8	523.8	523.8	523.8	523.8	523.8	523.8	523.8	523.8	523.8	--
	AM Peak	519.9	519.9	519.9	519.9	519.9	519.9	519.9	519.9	519.9	519.9	519.9	519.9	519.9	519.9	--
	PM Peak	507.8	507.8	507.8	507.8	507.8	507.8	507.8	507.8	507.8	507.8	507.8	507.8	507.8	507.8	--
Freeway with Ramps Combined	24-Hour	542.2	542.2	542.2	542.2	542.2	542.2	542.2	542.2	542.2	542.2	542.2	542.2	542.2	542.2	542.2
	AM Peak	537.0	537.0	537.0	537.0	537.0	537.0	537.0	537.0	537.0	537.0	537.0	537.0	537.0	537.0	537.0
	PM Peak	519.2	519.2	519.2	519.2	519.2	519.2	519.2	519.2	519.2	519.2	519.2	519.2	519.2	519.2	519.2
Freeway with Ramps Inbound	24-Hour	542.2	542.2	542.2	542.2	542.2	542.2	542.2	542.2	542.2	542.2	542.2	542.2	542.2	542.2	542.2
	AM Peak	537.0	537.0	537.0	537.0	537.0	537.0	537.0	537.0	537.0	537.0	537.0	537.0	537.0	537.0	537.0
	PM Peak	519.2	519.2	519.2	519.2	519.2	519.2	519.2	519.2	519.2	519.2	519.2	519.2	519.2	519.2	519.2
Freeway with Ramps Outbound	24-Hour	542.2	542.2	542.2	542.2	542.2	542.2	542.2	542.2	542.2	542.2	542.2	542.2	542.2	542.2	542.2
	AM Peak	537.0	537.0	537.0	537.0	537.0	537.0	537.0	537.0	537.0	537.0	537.0	537.0	537.0	537.0	537.0
	PM Peak	519.2	519.2	519.2	519.2	519.2	519.2	519.2	519.2	519.2	519.2	519.2	519.2	519.2	519.2	
Lakeshore Combined	24-Hour	562.8	562.8	562.8	562.8	562.8	562.8	562.8	562.8	562.8	562.8	562.8	562.8	562.8	562.8	--
	AM Peak	556.7	556.7	556.7	556.7	556.7	556.7	556.7	556.7	556.7	556.7	556.7	556.7	556.7	556.7	--
	PM Peak	522.0	522.0	522.0	522.0	522.0	522.0	522.0	522.0	522.0	522.0	522.0	522.0	522.0	522.0	--
Lakeshore Eastbound	24-Hour	562.8	562.8	562.8	562.8	562.8	562.8	562.8	562.8	562.8	562.8	562.8	562.8	562.8	562.8	--
	AM Peak	556.7	556.7	556.7	556.7	556.7	556.7	556.7	556.7	556.7	556.7	556.7	556.7	556.7	556.7	--
	PM Peak	522.0	522.0	522.0	522.0	522.0	522.0	522.0	522.0	522.0	522.0	522.0	522.0	522.0	522.0	--
Lakeshore Westbound	24-Hour	562.8	562.8	562.8	562.8	562.8	562.8	562.8	562.8	562.8	562.8	562.8	562.8	562.8	562.8	--
	AM Peak	556.7	556.7	556.7	556.7	556.7	556.7	556.7	556.7	556.7	556.7	556.7	556.7	556.7	556.7	--
	PM Peak	522.0	522.0	522.0	522.0	522.0	522.0	522.0	522.0	522.0	522.0	522.0	522.0	522.0	522.0	--

Table 6: Re-entrained Road Dust Emission Factors

Road Type	$PM_{2.5}$ Emission Factor (g/mile)
Gardiner/DVP/ Ramps	0.02030
Lakeshore	0.02232
Arterial	0.01788

5 REGIONAL AIR QUALITY ASSESSMENT

Regional air quality is commonly described in terms of the concentrations of air pollutants that are important at a regional scale. Current knowledge on health and environmental effects clearly identifies ground level ozone (O_3) and fine particulate matter ($PM_{2.5}$) as the two pollutants of greatest regional importance. They are the major constituents of smog and are produced by numerous complex physical and chemical processes that usually take place over a large geographic area. Ground level O_3 and most $PM_{2.5}$ are secondary pollutants that are produced by precursors such as NOx, CO and VOCs.

There are various approaches to assess the impact of a project on regional air quality ranging from advanced (data intensive) modelling techniques to a qualitative discussion. Two common approaches referenced in the Guide are an empirical source-receptor model and regional air pollution burden analysis.

The empirical source-receptor model postulates a linear relationship between relative changes in concentrations and emissions of primary pollutants. However, the relationships for $PM_{2.5}$ and O_3, which are the major elements/drivers for regional air quality, are non-linear and highly variable. Thus, this empirical source-receptor approach is not relevant for broad assimilation and routine application.

The regional air pollution burden analysis entails a quantitative assessment of the net increase or decrease in pollutant emissions attributable to the project and the net effect of the project on regional emissions of relevant primary pollutants. The burden analysis is the preferred approach in many air quality impact assessments to look at the regional air quality implications of individual projects and has be used in this assessment. The burden analysis is also the recommended approach for assessment of regional air quality impacts within the Guide.

Within a burden analysis, the vehicular emissions are typically calculated for both the free flow and idling conditions. For this evaluation, emissions were calculated based on the average travelling speed (free flow and idling) of vehicles within each road segment (link). The emission rate for each link was calculated as:

$$ERF\left(\frac{g}{hr}\right) = EFF\left(\frac{g}{vehicle\ mile}\right) VPH\left(\frac{vehicle}{hr}\right) D(miles) \quad (1)$$

where ERF: Emission rate in g/hr;
EFF: Composite emission factor in g/vehicle/mile;
VPH: Traffic volume in vehicle/hr
D: Length of the road in miles.

Hourly emissions of each contaminant for each link were calculated using Equation (1). The regional hourly emissions for each contaminant were estimated by summing the emissions associated with all links within the RSA.

The daily emissions of each contaminant were calculated using a conservative assumption that AM peak emissions occur for 24 hours during a day.

The annual emissions of each contaminant were estimated by multiplying the conservatively estimated daily emissions by 365 days. Table 7 shows the estimated annual emissions for NOx, $PM_{2.5}$ and VOCs.

The annual emissions of NOx, $PM_{2.5}$ and VOCs for the four alternatives were then divided by their total Ontario emissions in 2011 (i.e., the percent of the 2011 Ontario emissions) to represent the burden.

To evaluate the four alternatives within the burden analysis, three ranking schemes were used:

[1] Total annual emissions – the alternative with the lowest annual emissions is the most preferred (highest ranking). As indicated in Table 7, the Remove alternative is the most preferred and Maintain is the least preferred in terms of both NOx and $PM_{2.5}$ emissions. However, the Maintain alternative is the most preferred in terms of VOCs emissions.

[2] Burden analysis – the lowest burden represents the least contribution to the regional emissions. The Remove alternative is the most preferred in terms of NOx and $PM_{2.5}$ emissions. The Improve and Maintain alternatives are the most preferred in terms of VOC emissions.

[3] Burden weighted ranking –total annual emissions ranking is weighted by the burden to combined all three contaminants together (i.e., the highest value is the most preferred). This allows for consideration of the fact that individual contaminants may have different significance within the burden analysis (e.g., VOCs have a higher predicted burden and may therefore be considered to be more important than $PM_{2.5}$ and NOx as indicator compounds). As shown in Table 7, the Remove alternative (0.008) is the most preferred while the Replace alternative (0.006) is the least preferred.

Based on the above three schemes it can be concluded that the Remove alternative is most preferred and Replace is marginally the least preferred, as shown in Tables 7 and 8.

Table 7: Estimated Annual Emissions and Burden Analysis

Estimated Annual Emissions					**Notes**
Scenario	NOx (t/yr)	VOCs (t/yr)	$PM_{2.5}$ (t/yr)		(AM Peak x 24 hours) x 365 days /year
Maintain	336	420.5	32.5		
Improve	315	436.5	29.9		
Replace	313	456.7	29.0		
Remove	300	453.4	27.4		
2011 Ontario	353300	402600	60300		
Ranking Based on Emission Levels					**Notes**
Scenario	NOx	VOCs	$PM_{2.5}$		Higher rank = more preferred
Maintain	1	4	1		
Improve	2	3	2		
Replace	3	1	3		
Remove	4	2	4		
Burden					**Notes**
Scenario	NOx	VOCs	$PM_{2.5}$	Total	Lower % of Ontario total is preferred
Maintain	0.0951%	0.1044%	0.0539%	0.2535%	
Improve	0.0891%	0.1084%	0.0497%	0.2472%	
Replace	0.0886%	0.1134%	0.0480%	0.2500%	
Remove	0.0848%	0.1126%	0.0454%	0.2429%	
Burden Weighted Ranking(Ranking Based on Emissions x Burden)					**Notes**
Scenario	NOx	VOCs	$PM_{2.5}$	Total	Higher number = more preferred
Maintain	0.10%	0.42%	0.05%	0.0057	
Improve	0.18%	0.33%	0.10%	0.0060	
Replace	0.27%	0.11%	0.14%	0.0052	
Remove	0.34%	0.23%	0.18%	0.0075	

Table 8: Evaluation Matrix Based on Regional Air Quality Assessment

Scenario	**Evaluation Matrix for Regional Air Quality**
Maintain	Moderately Preferred
Improve	Moderately Preferred
Replace	Less Preferred
Remove	Preferred

6 LOCAL AIR QUALITY ASSESSMENT

As described in Appendix 3 of the Guide, the local air quality assessment can be carried out by using either a credible worst-case analysis or a comprehensive analysis. The credible worst-case analysis is based on the concept that a project is acceptable under all conditions if it is accepted under a credible worst-case condition.

Further, the credible worst-case condition assumes that the weekday morning or afternoon traffic conditions occur all the time under an unfavorable dispersion condition (i.e., wind speed at 1 m/s; wind direction at 5 degree off the mainline highway axis, to the right or to the left off the axis; stability class of D for urban regions). This type of analysis is likely to reflect an overly conservative prediction of potential impacts.

The comprehensive analysis addresses the variability of traffic and meteorological conditions from hour to hour, thus representing a more realistic prediction of potential impacts.

The US EPA CAL3QHC and CAL3QHCR models are widely used to predict the maximum air quality concentrations at receptors from transportation projects like GELBR. These two models are also recommended by the MTO in its Guide. CAL3QHC is most suited to predict concentrations for a single set of meteorological conditions. Hence, it is the preferred model for the credible worst-case analysis. CAL3QHCR, on the other hand, can process 1-year of meteorological data in a single model run. This makes it most suited for the full-year comprehensive analysis.

Within the LSA, over 1400 links have to be included for the assessment while the CAL3QHC model allows a maximum of 600 links. Therefore, the CAL3QHCR model, which allows simulating up to 5000 links, was used in this evaluation

The meteorological data from the Environment Canada Toronto Island Airport meteorological station was provided by the MOE for use in the study. Figure 2 shows the wind rose for the period 2008 – 2012 and Figure 4 shows the wind rose during 2012. The two wind roses are very similar, demonstrating that conditions in 2012 were representative of the 5 year period of 2008 to 2012. Therefore, the CAL3QHCR model was run using the 2012 meteorological data.

Figure 4 is an isopleth plot of maximum concentrations predicted for one alternative. The maximum concentrations occur along the Gardiner Expressway and DVP and dissipate very quickly with distance away from these expressways.

Figure 2: Wind Rose at Toronto Island Airport (2008 – 2012)

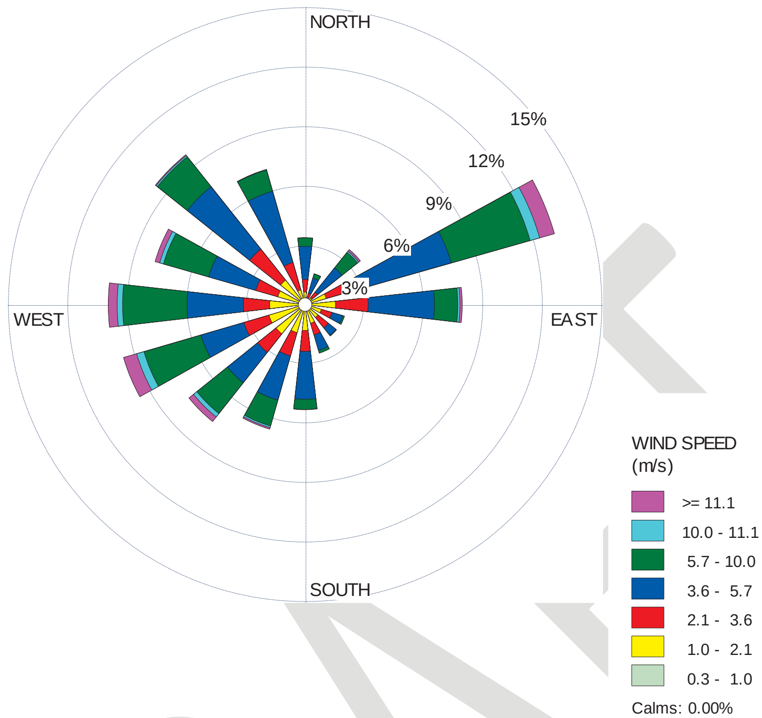


Figure 3: Wind Rose at Toronto Island Airport (2012)

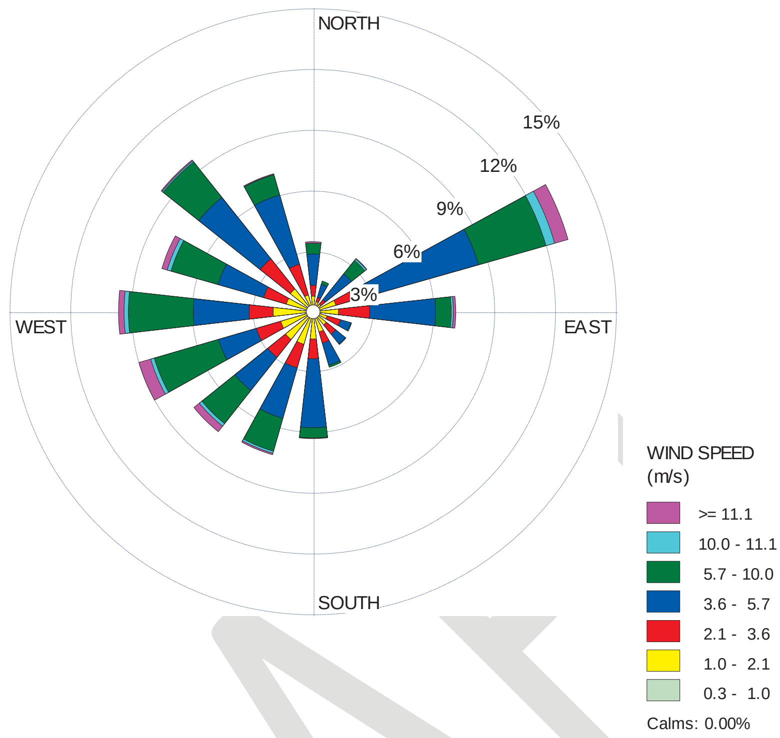
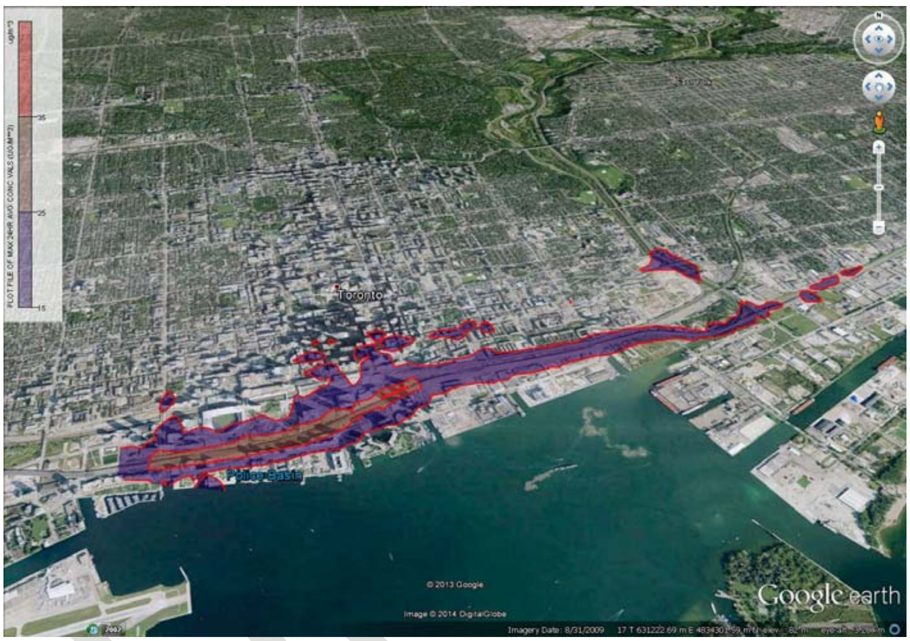


Figure 4: Isopleth Plot of Predicted Maximum Concentrations for the Improve Alternative



In order to evaluate the alternatives with regards to local air quality, the distributions of the predicted air quality concentrations (i.e., the maximum predicted concentrations, 90^{th} percentile, 80^{th} percentile) were developed.

Figures 5 and 6 show the predicted concentration distributions for three contaminants using the AM peak traffic data, for 1-hour and 24-hour averaging periods, respectively.

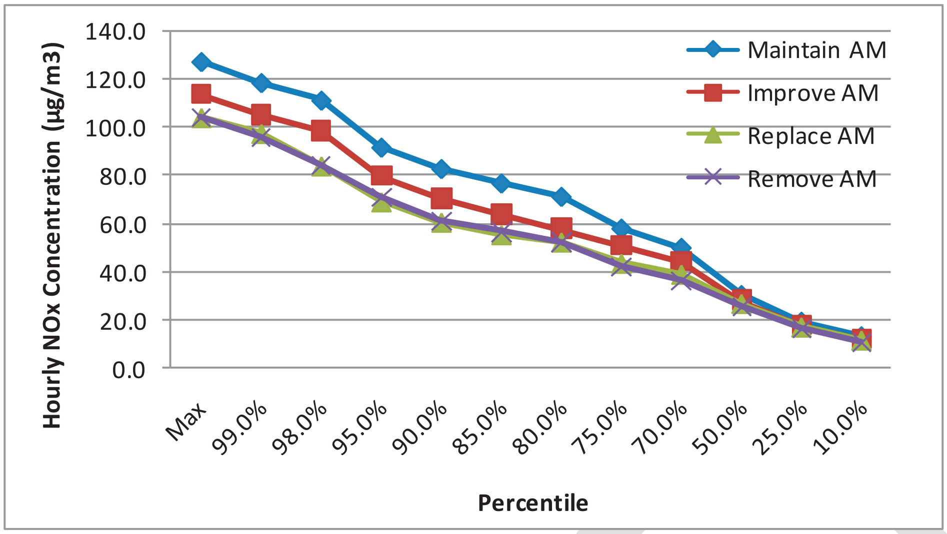
Related to local air quality, the more preferable alternatives are the ones that yield lower concentration distributions. As can be seen in Figure 5 and 6, the Remove and Replace alternatives can be identified as the most preferred while the Maintain alternative is the least preferred, for NO_x and $PM_{2.5}$ concentrations. For VOCs concentrations the Replace alternative is the most preferred.

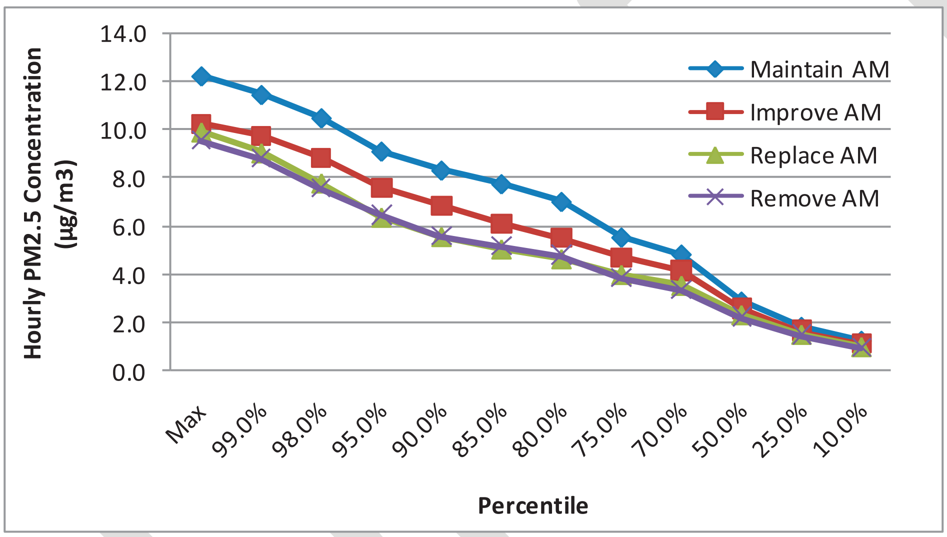
As discussed in Section 4, the primary drivers for characterizing local air quality are Benzene and BaP which can be represented by VOCs and $PM_{2.5}$, respectively. With no significant difference in VOC profiles for the 4 alternatives and more clear differences in profiles for $PM_{2.5}$, the Remove alternative emerges as the preferred and the Maintain alternative is considered to be less preferred.

Table 9: Evaluation Matrix Based on Local Air Quality Assessment

Scenario	**Evaluation Matrix for Local Air Quality**
Maintain	Less Preferred
Improve	Moderately Preferred
Replace	Preferred
Remove	Preferred

Figure 5: Predicted 1-Hour Percentile Concentrations





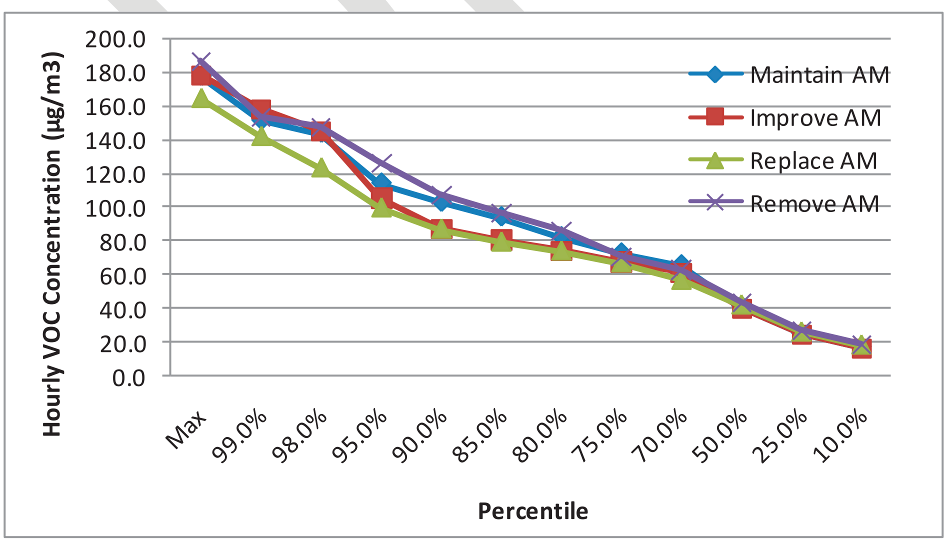
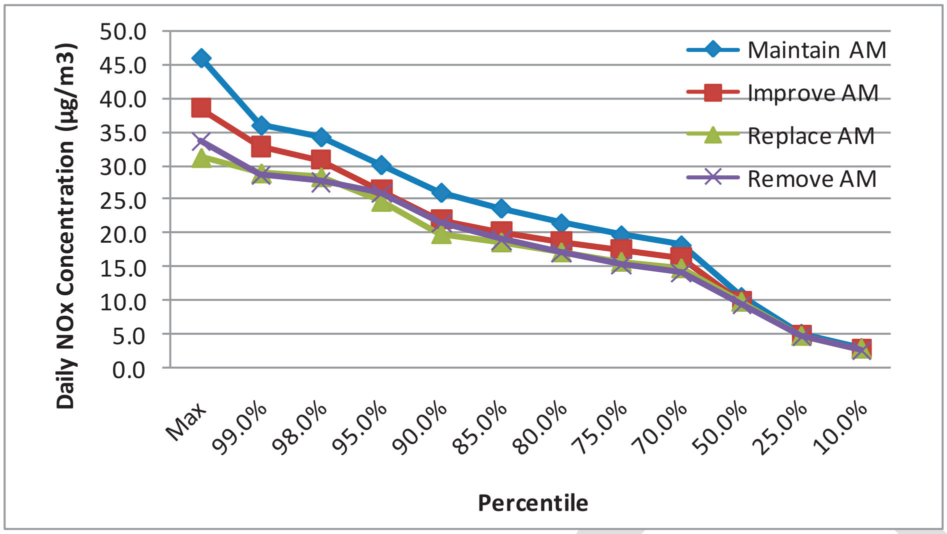
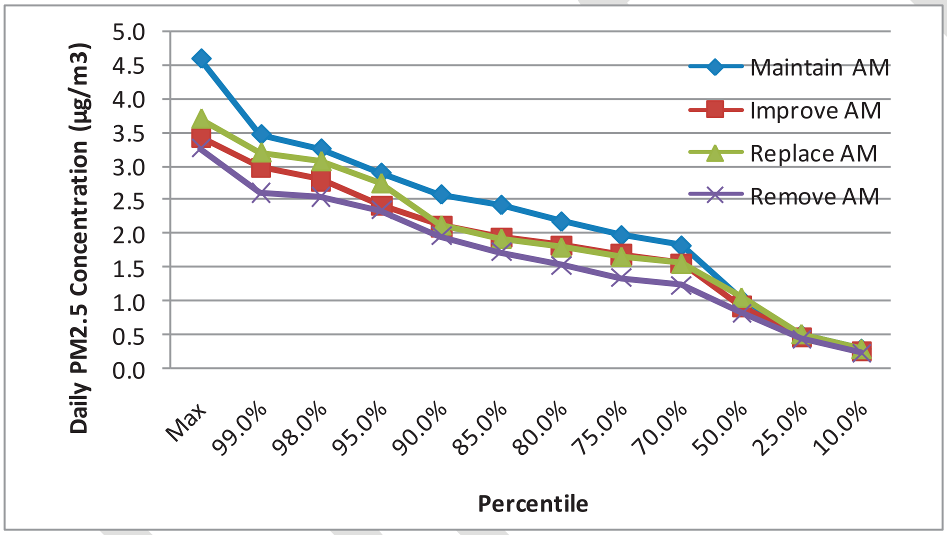
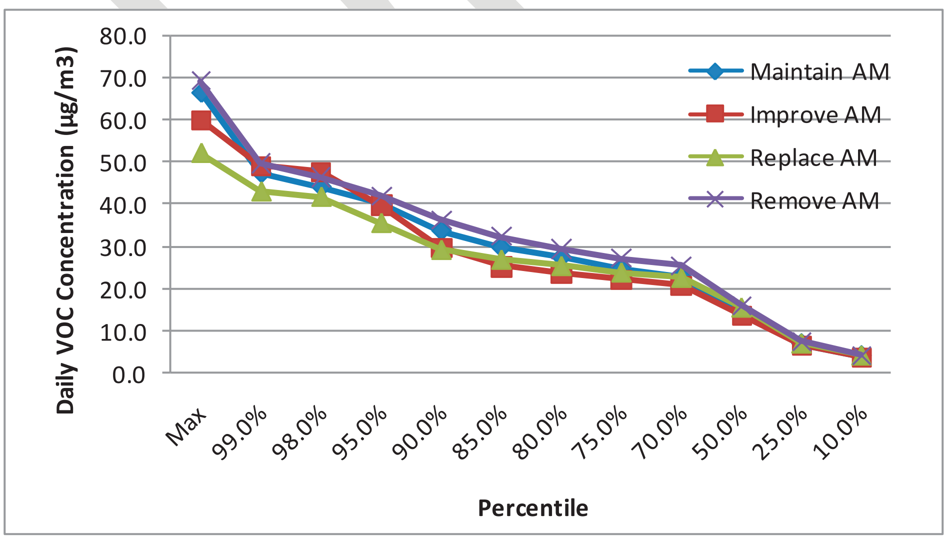


Figure 6: Predicted 24-Hour Percentile Concentrations







7 GHG EMISSION ASSESSMENT

Transportation sources produces almost one-third of Ontario's total anthropogenic greenhouse gas emissions – over 170 Mt in 2011 and growing by about 1.2% per annum[1]. Approximately three-quarters of this amount is attributable to road transportation. The principal transportation related GHG is carbon dioxide (CO_2). Other important GHGs include methane (CH_4) and nitrous oxide (N_2O). The relative impacts of various GHGs are often expressed in terms of their global warming potential (GWP) relative to CO_2. GWP represents a basis for combining the emissions of individual greenhouse gases by normalizing individual mass emission rates, based on the ability of each greenhouse gas to trap heat in the atmosphere relative to CO_2 over a specified time horizon.

GHG emissions were developed for changing levels of vehicle traffic associated with each of the alternatives, in accordance with the Guide. Based on the Guide, the following steps were taken to determine GHG emission levels:

1) Calculate the CO_2e emission factors (expressed as grams per vehicle miles travelled) for different type of vehicles for each alternative (i.e., maintain, improve, replace and remove) using the MOBILE6.2C model.
2) Quantify the hourly GHG emissions within the transportation system study area (Dundas St, to Lake Ontario and from Spadina Ave to Woodbine Ave) by multiplying the emission factors by the vehicle miles travelled (VMT) for each alternative. The hourly GHG emissions are then scaled up to daily and annual emissions by using the same approaches as described for the regional air quality assessment.
3) Compare the total annual GHG emissions among the four scenarios and benchmark them against the total Ontario GHG emissions in 2011. The results are expressed as the GHG emissions change.

The GHG assessment allows for a comparison of GHG emissions associated with traffic volumes for each of the 4 alternatives. From a broader perspective, there may be GHG benefits (reductions) accrued from instances where transportation system modelling has assumed that vehicles on the road will be replaced with users opting for public transit (modal shift). Such changes will enhance the apparent GHG reduction of alternatives that reduce traffic volumes. Therefore, the analysis presented would be considered conservative.

Table 10 lists the total GHG emissions and changes with respect to the total Ontario emissions in 2011. It should be noted that the estimated annual GHG emissions, as shown in Table 10, are very conservative due to the conservative assumptions made in this evaluation. However, the conservative assumptions made here should not skew the evaluation as they have been applied equally to all four alternatives.

Based on the emissions presented in Table 10, the Remove alternative is the most preferred alternative and Maintain is the least preferred alternative.

[1] Ministry of Transportation, 2012, Environmental Guide for Assessing and Mitigating the Air Quality Impacts and Greenhouse Gas Emissions of Provincial Transportation Projects.

Table 10: Estimated Total GHG Emissions for All Four Alternatives

Scenario	Estimated Annual CO_2e Emissions (t/yr)	Notes
Maintain	501742	(AM Peak x 24 hours) x 365 days /year
Improve	484412	
Replace	480022	
Remove	409719	
2011 Ontario	170600000	
Scenario	**GHG Changes in 2011 Ontario Emission**	**Notes**
Maintain	0.29%	Lower number is better (preferred)
Improve	0.28%	
Replace	0.28%	
Remove	0.24%	

Table 11: Evaluation Matrix Based on GHG Emissions

Scenario	Evaluation Matrix for GHG Emissions
Maintain	Less Preferred
Improve	Moderately Preferred
Replace	Moderately Preferred
Remove	Preferred

8 CONCLUSIONS

The alternative solutions assessed have been performed using a regional air quality burden analysis, a local air quality assessment and a GHG emissions according to the Guide. The MOBILE6.2C model was used to determine site-specific mobile vehicle emission factors. Re-entrained particulate emissions were quantified according to US EPA AP-42, Section 13.2.1, 2011. The US EPA's CAL3QHCR model was used to predict the maximum concentrations of NOx, PM2.5 and VOCs (as a surrogate for air toxics) at all receptors.

Based on the regional air quality burden analysis, local air quality impact assessment and GHG emissions evaluation matrix, the results consistently indicate that the Remove alternative is preferred whereas the Improve and Replace can be considered as moderately preferred, and the Maintain as less preferred.

Study Lens/ Criteria Group	Criteria	Measures	MAINTAIN	IMPROVE	REPLACE	REMOVE
Social, Health, Recreation and Businesses	Health (Air Quality)& Climate Change	• Extent of change in regional air quality	Less Preferred	Moderately Preferred	Moderately Preferred	**Preferred**
		• Extent of change in local air quality	Less Preferred	Moderately Preferred	Moderately Preferred	**Preferred**
		• **Level of GHG Emissions**	**Less Preferred**	**Moderately Preferred**	**Moderately Preferred**	**Preferred**

These preference rankings reflect the Remove alternative's greater reduction in vehicle miles travelled in comparison to the other alternatives.

Limitations within this evaluation process that should be noted include:

- All links have been treated as free flow links with average traveling speeds. No queue links and signalization have been considered due to the complexity of such modeling and the timeline available to conduct the assessment.
- MOBILE6.2C produces fleet averaged emission rates typically in grams per vehicle-mile even though the vehicles travelling on the roadways are at different average speeds, e.g., predicts almost constant emission factors for both $PM_{2.5}$ and CO_2e. The model does not have the capability to produce emission factors varying by vehicular modal activities such as acceleration, deceleration, idle and cruise, at higher temporal resolution, particularly under congested conditions.
- CAL3QHCR only allows the release height to be 10 m or below while the Replace alternative would elevate the Gardiner by another 5 m which could not be accounted for.
- All the emissions quantified and maximum concentrations predicted for averaging periods of more than 1 hour are very conservative.

Appendix G
Noise Assessment Summary

Gardiner Expressway and Lake Shore Boulevard Reconfiguration Environmental Assessment
Preliminary Noise Report – February 2014

I. Background and Objectives

Dillon Consulting Limited (Dillon) was retained to assess the traffic noise impacts of four alternative solutions for the GELBR. The project is subject to a Class Environmental Assessment under the Ontario *Environmental Assessment Act* and is categorized as a Group B project by the Ministry of Transportation Ontario's (MTO's) document entitled: "*Class Environmental Assessment for Provincial Transportation Facilities*" (July, 2000).

The primary objective of this preliminary traffic noise impact assessment study is to determine and compare the traffic noise impact for each of the proposed alternatives through traffic noise prediction modeling. Once a preferred alternative is selected, a more detailed noise assessment will be undertaken which will includes assessment and feasibility study of noise mitigation measures, if required.

The assessment described herein follows the methodologies described within the MTO's document "*Environmental Guide for Noise*" (V3, June 2009) [the Guide] for Group 'B' projects.

II. Approach

The traffic noise impact assessment follows the requirements for noise assessment and mitigation relating to the expansion / modification of existing Provincial Highways as outlined in the Guide. Some of the key components of this assessment include:

- Identify study area/area of investigation;
- Identify Noise Sensitive Areas (NSAs);
- Determine future ambient and future noise levels with undertaking;
- Identify impacts and significance;
- Consider mitigation; and,
- Document the noise impact assessment in a Noise Report.

As mentioned above, the identification of impact and significance as well as mitigation measures will be completed for the preferred alternative at a later stage of the assessment.

III. Alternative Solutions

The proposed alternative solutions evaluated include Replace, Remove, Maintain, and Improve as described below.

Maintain –the Maintain alternative is to represent the base case (2031) or "do nothing" alternative. As this is a 2031 base case, the alternative also includes:

(a) Full deck replacement and rehabilitation of the Gardiner as per the City's current rehab plans.

(b) Build out of the current approved development applications within the study area (as per City's planning information), and the build out of West Don Lands, East Bayfront, and Lower Don Lands as per the current precinct plans.

(c) The assumed realignment of LSB between the Don River and Cherry Street as per the Keating Precinct Plan.

Improve – the Improve alternative is to improve the Gardiner between lower Jarvis and DVP and includes:

(a) Maintain the same number of ramps.
(b) Reduce the number of lanes for Gardiner between lower Jarvis and DVP.
(c) Reduce the number of lanes for LSB between Cherry Street and Don Roadway.
(d) Realignment of LSB between Don River and Cherry Street as per the Keating Plan.

Replace **–** the Replace alternative is to replace the Gardiner between Yonge Street and Don Valley Parkway (DVP) and includes:

(a) Elevate the Gardiner by 5 m from Lower Jarvis to DVP.
(b) Shift Gardiner between Don River and Cherry Street to the realigned Lake Shore Boulevard (LSB) as per the Keating Precinct Plan.
(c) Build the transitional section between Yonge Street and Jarvis Street.

Remove – the Remove alternative removes the Gardiner between lower Jarvis Street and DVP and expands the LSB to four lanes in both directions.

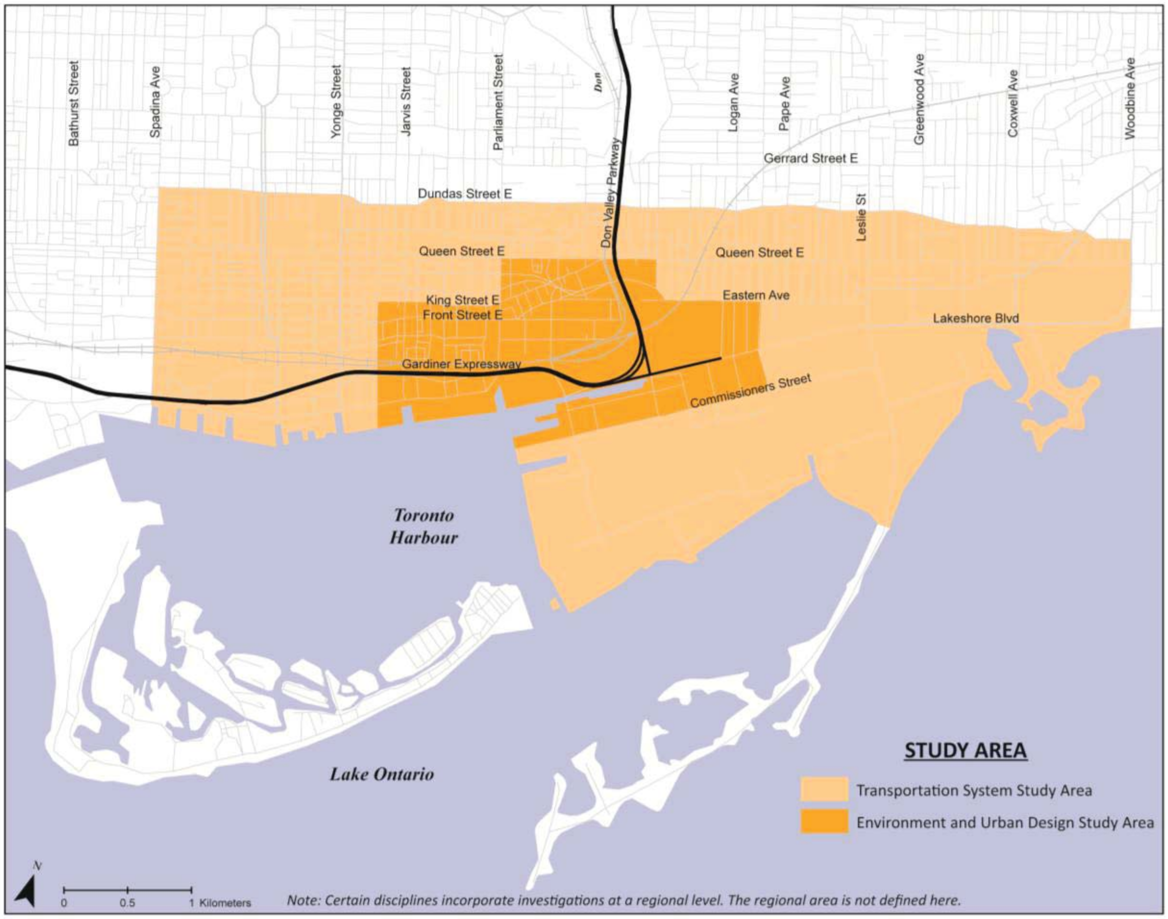
IV. Study Areas

The section of the Gardiner and LSB that has been examined for reconfiguration extends 2.4 km from approximately lower Jarvis Street to east of the DVP at Logan Avenue. Two study areas have been specified in the EA ToR, as shown in ***Figure 1***:

- Environment and Urban Design Study Area – including lands south of King Street to the waterfront, and from approximately Lower Jarvis Street to approximately Leslie Street.
- Transportation System Study Area – including lands extending from Dundas Street to Lake Ontario and from Spadina Avenue to Woodbine Avenue.

For the traffic noise assessment, receptors were identified in the area bound by Dundas St. to the north, Commissioner St. to the south, Yonge St. to the west and Carlaw Avenue to the east.

Figure 1: Study Area



V. Noise Prediction Methodologies

Noise prediction calculations were undertaken using applicable MTO guidelines (the Guide). As per the Guide, there are two noise prediction methodologies approved by the MOE and MTO. The first methodology is referred to as the Ontario Road Noise Analysis Method (ORNAMENT) and the second methodology is referred to as STAMINA 2.0. The ORNAMENT methodology is recommended when the topography is not complex and the noise level increases are expected to be less than 5 dBA. This methodology is implemented through STAMSON, a DOS-based computer program.

STAMINA 2.0 is a computer program that is based on the United States Federal Highway Administration (FHWA) Highway Noise Prediction Model. It uses more complex calculations and requires more detailed input data in comparison to STAMSON. The STAMINA 2.0 methodology is recommended when the noise level increases are expected to be greater than 5 dBA and mitigation is probable.

The ORNAMENT methodology was selected for this assessment, as it was anticipated that the noise level increases as a result of the four alternative solutions would be less than 5 dBA in the majority of cases.

VI. Receptors

For this comparative study, the study area (as described above) was divided into segments based on change in traffic related parameters, including traffic volumes, posted speed limit and percentage of medium and heavy trucks. Based on the review of the traffic related parameters, each segment consisted of a stretch of road between two consecutive intersections. It was conservatively assumed that a noise sensitive receptor (herein referred to as a 'node') exists in all the segments within the study area. For at grade road segments, the receptor heights were determined based on the review of the potential receptor locations. This included receptor heights of 1.5m and 4.5m above grade, for receptors at ground level and second storey, respectively. The height of 4.5m represents receptors at the plain of second storey window. For elevated roadways (e.g., Gardiner Expressway), a receptor height resulting in maximum noise impact was selected for the modelling.

In many instances, the setback distances from the centre of the roadways to receptors were less than the minimum limit of the STAMSON noise model (i.e., 15m). As such, for those receptors a setback distance of 15m was assumed.

Future potential receptors were also included in the analysis. The locations, heights and setback distances of those receptors were estimated from the proposed development plans, including the ones for Keating Precincts, West Donlands and East Bayfront.

For some of the nodes, more than one segment of road contributed to the overall noise levels. This was mainly the case for receptors in close vicinity of the Gardiner Expressway, where up to four (4) segments were included: Gardiner Eastbound, Gardiner Westbound, Lakeshore Eastbound and Lakeshore Westbound.

For the road segments that the traffic volumes were less than the STAMSON's lower limit of 40 vehicles per hour, the traffic noise contributions to the receptor noise levels were assumed to be negligible.

VII. Discussion of Results

Predicted traffic noise levels, presented in hourly sound level equivalent values (1-hour L_{eq}, dBA) are summarized in ***Table 1*** and ***Figure 2***. ***Figure 2*** allows for a comparison of traffic noise levels at each node for the four alternative solutions. The locations of nodes and receptors are marked in the ***.kmz*** file included, which can be opened with Google Earth. An overall view of the aerial photograph for the study area and the selected nodes is included in ***Figure 3***.

The results indicate that the noticeable differences in the predicted noise levels are mainly for the receptors in close proximity to the Gardiner Expressway and Lakeshore Boulevard (receptors are identified as R1 to R11 in ***Table 1***, below). The results of the noise analysis are as flows:

- Maintain results in the highest noise impact for the identified receptors;
- Predicted noise levels for the Replace and Improve alternatives are similar and are predicted to be less than Maintain; and
- Remove results in the lowest noise impact.

Table 1 – Comparative Traffic Noise Impact Analysis - Gardiner Expressway and Lakeshore Boulevard Reconfiguration

Representative POR	Location	Predicted Traffic Noise Level (dBA)			
		Replace	Remove	Maintain	Improve
2	Adelaide St from Church St to Jarvis St	**68.32**	**68.12**	**68.07**	**68.25**
3	Adelaide St from Jarvis St to Sherbourne St	**68.70**	**68.59**	**68.54**	**68.73**
4	Adelaide St from Parliament St to Cherry St	**69.01**	**69.79**	**70.43**	**68.88**
5	Adelaide St from Parliament St to St. Lawrence St	**69.01**	**69.79**	**70.43**	**66.17**
6	Adelaide St from Sherbourne St to Parliament St	**68.70**	**68.57**	**68.72**	**68.73**
7	Adelaide St from Yonge St to Church St	**66.61**	**66.36**	**66.27**	**66.40**
8	Bayview Ave from Broadview Ave to Boulton Ave	**66.72**	**65.01**	**65.34**	**65.26**
9	Bayview Ave from Front St to Queen St	**63.60**	**63.26**	**63.17**	**63.25**
10	Bouchette St from Commissioners St to Villiers St	**61.74**	**59.64**	**59.36**	**59.48**
11	Boulton Ave from Queen St to Dundas St	**63.05**	**63.10**	**62.74**	**62.71**

Representative POR	Location	Predicted Traffic Noise Level (dBA)			
		Replace	**Remove**	**Maintain**	**Improve**
12	Broadview Ave from Eastern Ave to Queen St	**63.58**	**63.46**	**63.36**	**63.35**
13	Broadview Ave from Queen St to Dundas St	**61.54**	**61.27**	**61.54**	**61.45**
14	Carlaw Ave from Commissioners St to Villiers St	**63.39**	**61.73**	**63.07**	**63.71**
15	Carlaw Ave from Eastern Ave to Queen St	**63.54**	**63.52**	**63.76**	**63.60**
16	Carlaw Ave from Lakeshore to Eastern Ave	**64.08**	**64.57**	**64.13**	**64.31**
17	Carlaw Ave from Queen St to Dundas St	**63.40**	**63.15**	**63.43**	**63.43**
18	Cherry St from Commissioners St to Villiers St	**63.02**	**62.19**	**62.49**	**62.21**
19	Cherry St from Eastern Ave to King St	**61.26**	**61.18**	**61.26**	**61.26**
20	Cherry St from Front St to Eastern Ave	**61.86**	**61.50**	**61.82**	**61.03**
21	Cherry St from Gardiner to Mill St	**62.74**	**64.13**	**62.46**	**62.01**
22	Cherry St from Mill St to Front St	**61.70**	**61.44**	**60.80**	**60.40**
23	Cherry St from Villiers St to Queens Quay	**65.15**	**64.82**	**65.14**	**64.79**

Representative POR	Location	Predicted Traffic Noise Level (dBA)			
		Replace	Remove	Maintain	Improve
24	Church St from Adelaide St to Richmond St	**66.43**	**66.26**	**66.23**	**66.31**
25	Church St from Front St to King St	**65.75**	**65.59**	**65.58**	**65.76**
26	Church St from King St to Adelaide St	**65.97**	**65.87**	**65.75**	**65.88**
27	Church St from Queen St to Shuter St	**66.05**	**65.88**	**36.96**	**66.00**
28	Church St from Richmond St to Queen St	**66.44**	**66.30**	**66.27**	**66.32**
29	Church St from Shuter St to Dundas St	**66.16**	**65.95**	**66.14**	**66.07**
30	Church St from The Esplanade to Front St	**61.55**	**60.88**	**60.69**	**61.08**
31	Commissioners St from Bouchette St to Carlaw Ave	**62.87**	**61.28**	**61.80**	**62.79**
32	Commissioners St from Cherry St to Don Roadway	**62.68**	**61.82**	**61.18**	**61.12**
33	Commissioners St from Don Roadway to Bouchette St	**64.26**	**63.53**	**62.77**	**62.01**
34	Don Roadway from Commissioners St to Villiers St	**63.93**	**64.09**	**64.33**	**64.05**
35	Don Roadway from Villiers St to Lake Shore	**64.47**	**64.93**	**65.20**	**65.04**

Representative POR	Location	Predicted Traffic Noise Level (dBA)			
		Replace	Remove	Maintain	Improve
36	Don Valley Parkway from Broadview Ave to Boulton Ave	**75.17**	**74.52**	**75.67**	**75.30**
37	Don Valley Parkway from DVP Ramps to Eastern Ave	**74.41**	**73.42**	**75.65**	**75.04**
38	Don Valley Parkway from Eastern Ave to Queen St	**75.42**	**74.62**	**76.38**	**75.88**
39	Don Valley Parkway from Gardiner to DVP ramp	**See Results for R1 - R11**	**See Results for R1 - R11**	**See Results for R1 - R11**	**See Results for R1 - R11**
40	Dundas St from Boulton Ave to Carlaw Ave	**67.24**	**67.20**	**67.03**	**67.01**
41	Dundas St from Broadview Ave to Boulton Ave	**67.20**	**67.10**	**66.72**	**66.78**
42	Dundas St from Church St to Jarvis St	**65.03**	**65.93**	**65.87**	**65.92**
43	Dundas St from DVP ramp to Broadview Ave	**67.37**	**67.31**	**66.84**	**66.91**
44	Dundas St from Jarvis St to Sherbourne St	**65.07**	**65.02**	**64.58**	**64.66**
45	Dundas St from Logan Ave to Carlaw Ave	**67.60**	**67.51**	**67.43**	**67.42**
46	Dundas St from Parliament St to Sumach St	**64.92**	**65.06**	**64.40**	**64.51**
47	Dundas St from River St to DVP Ramp	**66.57**	**66.67**	**66.15**	**66.19**

Representative POR	Location	Predicted Traffic Noise Level (dBA)			
		Replace	Remove	Maintain	Improve
48	Dundas St from Sherbourne St to Parliament St	**64.85**	**64.84**	**64.28**	**64.39**
49	Dundas St from Shuter St(Sumach St) to River St	**65.30**	**65.43**	**64.83**	**64.89**
50	Dundas St from Yonge St to Church St	**65.64**	**65.43**	**65.44**	**65.54**
51	Eastern Ave from Boulton Ave to Carlaw Ave	**69.37**	**69.65**	**68.73**	**68.81**
52	Eastern Ave from Broadview Ave to Boulton Ave	**69.38**	**69.76**	**68.98**	**69.00**
53	Eastern Ave from Cherry St to DVP Ramps	**72.64**	**71.01**	**70.50**	**65.68**
54	Eastern Ave from DVP ramps to Broadview Ave	**67.06**	**67.21**	**66.86**	**66.96**
55	Eastern Ave from Stl Lawrence St to DVP Ramps	**72.64**	**71.01**	**70.50**	**70.57**
56	Eastern Ave from Trinity St to Cherry St	**67.04**	**66.90**	**66.61**	**66.82**
57	Front St from Cherry St to Bayview Ave	**63.07**	**62.74**	**62.77**	**62.91**
58	Front St from Church St to Jarvis St	**67.71**	**68.48**	**67.73**	**67.65**
59	Front St from Jarvis St to Sherbourne St	**68.15**	**68.05**	**68.31**	**67.95**

Representative POR	Location	Predicted Traffic Noise Level (dBA)			
		Replace	Remove	Maintain	Improve
60	Front St from Parliament St to Trinity St	**67.99**	**71.01**	**70.50**	**67.82**
61	Front St from Sherbourne St to Parliament St	**68.07**	**67.96**	**68.17**	**68.07**
62	Front St from Trinity St to Front St	**61.73**	**62.08**	**62.11**	**61.63**
63	Front St from Yonge St to Church St	**67.32**	**67.45**	**67.28**	**67.88**
64	Gardiner Expressway from Cherry St to DVP ramps	**See Results for R1 - R11**	**See Results for R1 - R11**	**See Results for R1 - R11**	**See Results for R1 - R11**
65	Gardiner Expressway from Jarvis St to Sherbourne St	**See Results for R1 - R11**	**See Results for R1 - R11**	**See Results for R1 - R11**	**See Results for R1 - R11**
66	Gardiner Expressway from Parliament St to Cherry St	**See Results for R1 - R11**	**See Results for R1 - R11**	**See Results for R1 - R11**	**See Results for R1 - R11**
67	Gardiner Expressway from Sherbourne St to Parliament St	**See Results for R1 - R11**	**See Results for R1 - R11**	**See Results for R1 - R11**	**See Results for R1 - R11**
68	Gardiner Expressway from Yonge St to Jarvis St	**See Results for R1 - R11**	**See Results for R1 - R11**	**See Results for R1 - R11**	**See Results for R1 - R11**
69	Jarvis St from Adelaide St to Richmond St	**67.46**	**67.47**	**67.88**	**67.37**
70	Jarvis St from Front St to King St	**66.49**	**66.74**	**67.23**	**66.51**
71	Jarvis St from Queen St to Shuter St	**67.43**	**67.23**	**67.66**	**67.31**

Representative POR	Location	Predicted Traffic Noise Level (dBA)			
		Replace	Remove	Maintain	Improve
72	Jarvis St from Richmond St to Queen St	**67.73**	**67.58**	**68.01**	**67.65**
73	Jarvis St from Shuter St to Dundas St	**67.26**	**67.10**	**67.42**	**67.26**
74	King St from Church St to Jarvis St	**64.79**	**64.61**	**64.79**	**64.87**
75	King St from Jarvis St to Sherbourne St	**64.62**	**64.40**	**64.58**	**64.69**
76	King St from Parliament St to Sumach St	**63.27**	**63.55**	**63.37**	**62.75**
77	King St from River St to Queen St	**64.08**	**64.15**	**63.81**	**63.22**
78	King St from Sherbourne St to Parliament St	**63.28**	**63.65**	**62.94**	**63.08**
79	King St from Shuter St to River St	**64.35**	**64.27**	**64.62**	**64.22**
80	King St from Yonge St to Church St	**64.72**	**64.42**	**64.77**	**64.74**
81	Lake Shore Blvd from Bouchette St to Carlaw Ave	**69.27**	**71.48**	**70.36**	**70.14**
82	Lake Shore Blvd from Cherry St to Don Roadway	**See Results for R1 - R11**	**See Results for R1 - R11**	**See Results for R1 - R11**	**See Results for R1 - R11**
83	Lake Shore Blvd from Don Roadway to Bouchette St	**See Results for R1 - R11**	**See Results for R1 - R11**	**See Results for R1 - R11**	**See Results for R1 - R11**

Representative POR	Location	Predicted Traffic Noise Level (dBA)			
		Replace	**Remove**	**Maintain**	**Improve**
84	Lake Shore Blvd from Jarvis St to Sherbourne St	**See Results for R1 - R11**	**See Results for R1 - R11**	**See Results for R1 - R11**	**See Results for R1 - R11**
85	Lake Shore Blvd from Parliament St to Cherry St	**See Results for R1 - R11**	**See Results for R1 - R11**	**See Results for R1 - R11**	**See Results for R1 - R11**
86	Lake Shore Blvd from Sherbourne St to Parliament St	**See Results for R1 - R11**	**See Results for R1 - R11**	**See Results for R1 - R11**	**See Results for R1 - R11**
87	Lake Shore Blvd from Yonge St to Jarvis St	**See Results for R1 - R11**	**See Results for R1 - R11**	**See Results for R1 - R11**	**See Results for R1 - R11**
88	Logan Ave from Queen St to Dundas St	**58.18**	**57.90**	**58.04**	**58.07**
89	Lower Jarvis St from Adelaide St to Richmond St	**67.46**	**67.47**	**67.88**	**67.37**
90	Lower Jarvis St from Gardiner to The Esplanade	**67.84**	**67.55**	**69.23**	**67.74**
91	Lower Jarvis St from King St to Adelaide St	**65.99**	**66.14**	**66.77**	**65.97**
92	Lower Jarvis St from Queens Quay to Gardiner	**64.19**	**62.85**	**62.32**	**63.41**
93	Lower Jarvis St from The Esplanade to Front St	**67.13**	**66.99**	**68.03**	**67.05**
94	Lower Sherbourne St from Gardiner to The Esplanade	**64.87**	**65.23**	**65.07**	**63.29**
95	Lower Sherbourne St from Queens Quay to Gardiner	**65.30**	**62.29**	**60.99**	**60.38**

Representative POR	Location	Predicted Traffic Noise Level (dBA)			
		Replace	Remove	Maintain	Improve
96	Lower Sherbourne St from The Esplanade to Front St	**64.90**	**65.11**	**65.02**	**64.39**
97	Mill St from Cherry St to Bayview Ave	**Traffic Vol < 40 VPH**	**Traffic Vol < 40 VPH**	**Traffic Vol < 40 VPH**	**Traffic Vol < 40 VPH**
98	Mill St from Parliament St to Cherry St	**61.07**	**60.35**	**61.15**	**61.20**
99	Parliament St from Adelaide St to Richmond St	**65.21**	**65.06**	**65.28**	**65.17**
100	Parliament St from Front St to King St	**65.43**	**65.23**	**65.37**	**65.32**
101	Parliament St from Gardiner to Mill St	**65.48**	**64.78**	**65.74**	**65.60**
102	Parliament St from King St to Adelaide St	**65.04**	**64.88**	**65.16**	**65.02**
103	Parliament St from Mill St to Front St	**65.28**	**64.63**	**65.56**	**65.78**
104	Parliament St from Queen St to Shuter St	**63.88**	**63.41**	**63.70**	**63.66**
105	Parliament St from Richmond St to Queen St	**64.77**	**64.25**	**64.95**	**64.81**
106	Parliament St from Shuter St to Dundas St	**63.17**	**62.90**	**63.13**	**63.11**
107	Queen St from Boulton Ave to Carlaw Ave	**64.48**	**64.64**	**63.36**	**63.53**

Representative POR	Location	Predicted Traffic Noise Level (dBA)			
		Replace	Remove	Maintain	Improve
108	Queen St from Broadview Ave to Boulton Ave	**65.59**	**65.59**	**64.83**	**64.79**
109	Queen St from Church St to Jarvis St	**64.10**	**63.95**	**63.89**	**64.12**
110	Queen St from DVP ramp to Broadview Ave	**65.65**	**65.74**	**64.90**	**64.88**
111	Queen St from Jarvis St to Sherbourne St	**64.26**	**64.16**	**63.91**	**64.09**
112	Queen St from King St to DVP Ramp	**65.60**	**65.83**	**65.07**	**64.86**
113	Queen St from Logan Ave to Carlaw Ave	**64.48**	**64.64**	**63.27**	**63.54**
114	Queen St from Parliament St to Sumach St	**62.81**	**62.89**	**62.12**	**62.38**
115	Queen St from River St to King St	**64.08**	**64.15**	**63.81**	**63.22**
116	Queen St from Sherbourne St to Parliament St	**63.66**	**63.68**	**63.29**	**63.48**
117	Queen St from Shuter St to River St	**63.47**	**63.65**	**62.77**	**62.89**
118	Queen St from Yonge St to Church St	**64.62**	**64.42**	**64.67**	**64.76**
119	Queens Quay E from Jarvis St to Sherbourne St	**68.09**	**67.12**	**67.21**	**66.93**

Representative POR	Location	Predicted Traffic Noise Level (dBA)			
		Replace	Remove	Maintain	Improve
120	Queens Quay E from Sherbourne St to Parliament St	**65.27**	**65.18**	**64.52**	**64.71**
121	Queens Quay E from Young St to Jarvis St	**69.01**	**68.99**	**68.44**	**68.44**
122	Queens Quay from Queens Quay to Gardiner	**Cannot be Modelled**	**Cannot be Modelled**	**Cannot be Modelled**	**Cannot be Modelled**
123	Richmond St W from Church St to Jarvis St	**69.01**	**68.80**	**68.97**	**69.13**
124	Richmond St W from Jarvis St to Sherbourne St	**68.53**	**68.35**	**68.60**	**68.67**
125	Richmond St W from Sherbourne St to Parliament St	**68.71**	**68.61**	**68.54**	**68.70**
126	Richmond St W from Yonge St to Church St	**67.31**	**67.19**	**67.20**	**67.42**
127	River St from Queen St to Shuter St	**58.23**	**57.98**	**57.63**	**57.72**
128	River St from Shuter St to Dundas St	**61.79**	**61.83**	**61.63**	**61.65**
129	Sherbourne St from Adelaide St to Richmond St	**65.43**	**65.37**	**65.37**	**65.30**
130	Sherbourne St from Front St to King St	**64.75**	**65.01**	**64.82**	**64.64**
131	Sherbourne St from King St to Adelaide St	**64.94**	**65.12**	**64.81**	**64.65**

Representative POR	Location	Predicted Traffic Noise Level (dBA)			
		Replace	Remove	Maintain	Improve
132	Sherbourne St from Queen St to Shuter St	**63.24**	**62.88**	**63.41**	**63.33**
133	Sherbourne St from Richmond St to Queen St	**65.10**	**64.68**	**65.25**	**65.29**
134	Sherbourne St from Shuter St to Dundas St	**63.03**	**62.67**	**63.21**	**63.03**
135	Shuter St from Church St to Jarvis St	**64.22**	**64.04**	**64.40**	**64.19**
136	Shuter St from Jarvis St to Sherbourne St	**62.92**	**62.62**	**62.69**	**62.73**
137	Shuter St from Parliament St to Sumach St	**64.17**	**63.99**	**64.03**	**63.97**
138	Shuter St from Sherbourne St to Parliament St	**62.69**	**62.45**	**62.45**	**62.49**
139	Shuter St from Shuter St to River St	**64.02**	**63.98**	**63.77**	**63.73**
140	Shuter St from Yonge St to Church St	**63.07**	**63.00**	**63.31**	**62.97**
141	Sumach St from King St to Queen St	**Traffic Vol < 40 VPH**	**Traffic Vol < 40 VPH**	**Traffic Vol < 40 VPH**	**Traffic Vol < 40 VPH**
142	Sumach St from Queen St to Shuter St	**54.07**	**Traffic Vol < 40 VPH**	**53.85**	**53.54**
143	The Esplanade from Church St to Jarvis St	**62.14**	**62.75**	**62.56**	**62.21**

Representative POR	Location	Predicted Traffic Noise Level (dBA)			
		Replace	Remove	Maintain	Improve
144	The Esplanade from Jarvis St to Sherbourne St	**62.14**	**62.43**	**62.65**	**62.16**
145	The Esplanade from Yonge St to Church St	**61.80**	**62.16**	**61.72**	**62.37**
146	Trinity St from Front St to Eastern Ave	**61.53**	**60.20**	**61.73**	**61.69**
147	Villiers St from Cherry St to Don Roadway	**56.78**	**57.47**	**57.60**	**57.17**
148	Villiers St from Don Roadway to Saulter St	**56.78**	**56.43**	**56.93**	**56.79**
149	Wellington St from Yonge St to Church St	**67.32**	**67.45**	**67.28**	**67.88**
150	Yonge St from Front St to King St	**66.05**	**66.03**	**65.81**	**66.03**
151	Yonge St from Gardiner to The Esplanade	**66.79**	**65.02**	**67.07**	**67.17**
152	Yonge St from King St to Adelaide St	**66.13**	**66.09**	**65.86**	**66.13**
153	Yonge St from Queen St to Shuter St	**65.64**	**65.38**	**65.50**	**65.60**
154	Yonge St from Richmond St to Queen St	**65.63**	**65.37**	**65.49**	**65.58**
155	Yonge St from Shuter St to Dundas St	**65.79**	**65.42**	**65.84**	**65.81**

Representative POR	Location	Predicted Traffic Noise Level (dBA)			
		Replace	Remove	Maintain	Improve
156	Yonge St from The Esplande to Front St	**67.05**	**65.97**	**67.54**	**67.47**
R1	Receptor 1 (65 + 84)	**70.44**	**66.57**	**71.82**	**71.30**
R2	Receptor 2 (65 + 84)	**67.18**	**63.38**	**68.67**	**68.02**
R3	Receptor 3 (65 + 84)	**71.72**	**67.83**	**76.35**	**72.57**
R4	Receptor 4 (68 + 87)	**69.05**	**61.50**	**69.80**	**69.50**
R5	Receptor 5 (68 + 87)	**71.16**	**63.56**	**75.86**	**71.61**
R6	Receptor 6 (67 + 86)	**71.40**	**66.82**	**72.49**	**72.03**
R7	Receptor 7 (67 + 86)	**67.87**	**63.36**	**68.97**	**68.49**
R8	Receptor 8 (67 + 86)	**76.71**	**71.89**	**76.79**	**77.33**
R9	Receptor 9 (64 + 85)	**77.79**	**68.79**	**77.54**	**78.13**
R10	Receptor 10 (64 + 82)	**68.63**	**60.22**	**69.21**	**68.59**
R11	Receptor 11 (64 + 82)	**77.98**	**68.88**	**78.03**	**76.72**

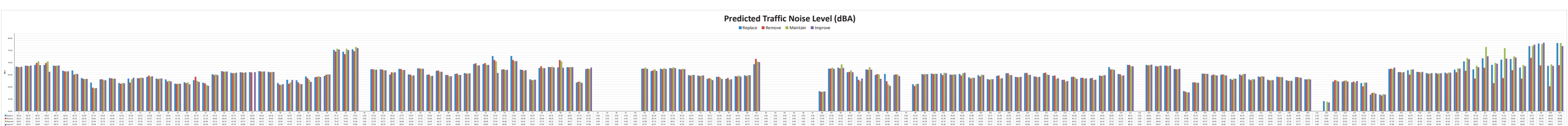
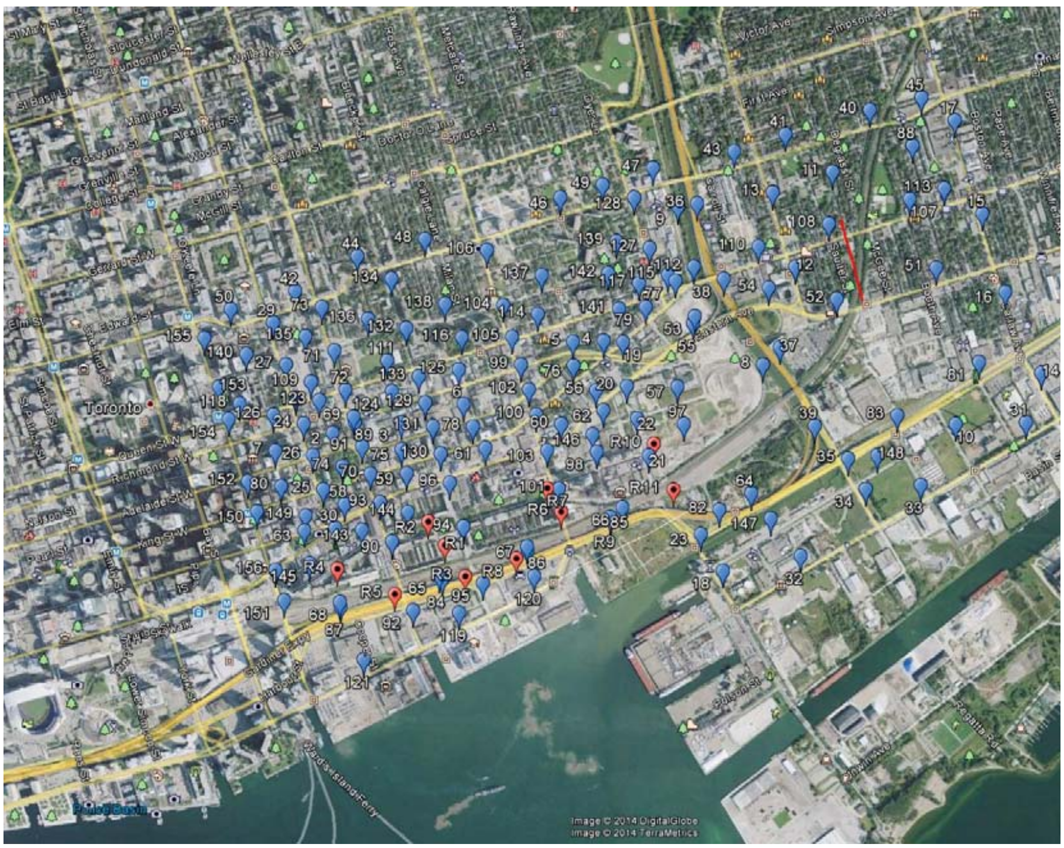

Predicted Traffic Noise Level (dBA)
Replace
Remove
Maintain
Improve

Figure 3 – Aerial Photograph of the Study Area and the Selected Receptor Locations



Appendix H
Economic Assessment Summary

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Gardiner Expressway
Economic Evaluation of Proposed Alternatives

Assessment of Public Value Creation

Updated February 12, 2014

HR&A Analyze. Advise. Act.

Table of Contents

Introduction

Scope of Work

Evaluate Baseline Conditions	• Benchmark Toronto's economy against peer cities worldwide
	• Assess the status of Waterfront neighbourhoods and real estate development
	• Evaluate the impact of Waterfront Toronto's development program by calculating:
	    • Permanent jobs created
	    • Public disposition proceeds from land sales

Evaluate Alternative Scenarios	• Complete a high-level cost/benefit analysis assessing the impact of improving, replacing or removing the Gardiner on adjacent Waterfront real estate and the City as a whole based on:
	    • Potential to increase City's economic competitiveness
	    • Enhanced value of existing land

Toronto's competitive position

- Toronto is competing increasingly with a set of global cities for talent and investment capital.
- The fourth largest City in North America, Toronto is a key location for many businesses, especially those in the finance and insurance, information and cultural industries, and management sectors. These high-salary industries value being in a dynamic urban environment with quality open spaces, cultural resources and recreational activities.
- The City's assets include a highly educated workforce, relative affordability, and an internationally recognized creative economy.
- As the economy shifts to favour innovation industries (creative, tech, and the finance and services to support them) that show strong preferences for dynamic urban environments, Toronto must continue to develop new amenities to successfully attract 21st century businesses and workers.

Source: Economic Technical Study, Baseline Conditions

Study Area

The baseline analysis considered existing and planned conditions in 9 neighbourhoods. The baseline assumes full build out of precinct plans in East Bayfront, Lower Yonge, Keating Channel, Lower Don Lands, and the Port Lands.

Source: Perkins+Will

Study Area – Property Value Impacts for Alternatives Evaluation

The alternatives analysis only considered property value impacts in **Lower Yonge, East Bayfront, and North Keating.** The rail berm prevents the distillation of impacts to the north. Neighborhoods to the south and east are too far away to experience property impacts.

Source: Perkins+Will

Neighbourhoods most impacted by changes to the Gardiner

The potential configurations for the Gardiner Expressway affected the neighbourhoods differently. The following analysis often breaks down the impacts as:

- West of Cherry Street (Lower Yonge, East Bayfront, Keating West)
- East of Cherry Street (Keating East)

HR&A used the following approach to consider impacts on two key development sites:

- 3C – assumes will develop as currently proposed.
- First Gulf – HR&A excluded from the quantitative analysis because project is not yet entitled. However, property owners from First Gulf submitted a letter to Waterfront Toronto expressing the following views on each scenario:
  - **Maintain** – DVP and GA ramps are in unsuitable locations that constrain development. They do not support this scenario.
  - **Improve** – Constrains development unless DVP and GA ramps are reconfigured. They do not support this scenario without reconfigured ramps.
  - **Replace** – Concept includes new and better ramp placement that would help site development. They support further investigation of this scenario.
  - **Remove** – Concept would facilitate development if enhancements to functionality of local road network can support traffic. Property owners support further investigation of this scenario.

Summary of baseline development plans

Current development plans project 19.3 million square feet of development in the areas impacted by the Gardiner's potential alteration between 2013 and 2036. The projections below assume the "Do Nothing" case: the Gardiner remains in place and Lake Shore Boulevard moves north to the east of Cherry Street, consistent with the Keating Channel Precinct Plan.

Square Feet	Residential	Commercial [1]	Institutional	Total
Lower Yonge	3,131,080	788,070	TBD	3,919,150
East Bayfront	7,400,880	921,110	517,180	8,839,170
Lower Don Lands[2]				
Keating West	3,731,970	510,910	0	4,242,890
Keating East	1,426,830	692,390	201,020	2,320,230
Total				**19,321,430**

1. Commercial square footage includes office and retail developments.
2. This analysis only considers Keating West and Keating East as impacted by modifications to the Gardiner.

Source: Waterfront Toronto, June 2013. Lower Yonge's development plan taken from the Waterfront Toronto Economic Impact Assessment (Urban Metrics, 2013)

Baseline jobs

HR&A projects development in these areas could support approximately 10,000 permanent jobs[1] over the next 20 years.

	Total Commercial Development (SF)	Total Jobs
Lower Yonge	779,570	2,420
East Bayfront	1,438,290	3,700
Lower Don Lands		
Keating West	510,910	1,470
Keating East	893,400	2,380
Total	**3,622,170**	**9,970**

1. Calculations based on employee per square foot calculations used in Urban Metrics Economic Impact Analysis for Waterfront Toronto (2013).

Baseline public disposition proceeds

HR&A estimates Waterfront Toronto's baseline development program will generate approximately **$254 million (NPV)** [1] in disposition proceeds from publicly-owned[2] land sales.

Precinct	Baseline Value (NPV)
Lower Yonge	$30,000,000
East Bayfront	$152,000,000
Lower Don Lands	
Keating West	$35,000,000
Keating East	$37,000,000
Total	**$254,000,000**

1. NPV calculated using a discount rate of 6.5%.
2. Public or private land ownership determined by Waterfront Toronto (June 2013)

Summary of configurations evaluated

	Maintain	Improve	Replace	Remove
Gardiner Configuration	Existing structure	Gardiner remains in place with some modifications to ramps and width.	New elevated expressway build in place. Modern structure is narrower and is relocated closer to the rail berm through Keating.	Gardiner is removed.
Lake Shore Boulevard Configuration	Consistent with the existing Keating Channel Precinct Plan.	Lake Shore Boulevard runs under the Gardiner West of Cherry St. Consistent with the Keating Channel Precinct Plan.	Lake Shore Boulevard has two fewer lanes and runs under the Gardiner West of Cherry St. Enables more development in Keating East.	Lake Shore Boulevard is rebuilt as a wider, eight-lane landscaped boulevard. Enables more development in Keating East. Two sided street possible between Yonge and Sherbourne.

Criteria for evaluating impact of altering Gardiner

City Competitiveness

- Ability to support citywide economic growth

Business Activity

- Number of jobs created in the study area

Public Disposition Proceeds

- Public disposition proceeds from new development parcels
- Public disposition proceeds from enhanced value of development parcels

Evaluation of Impacts

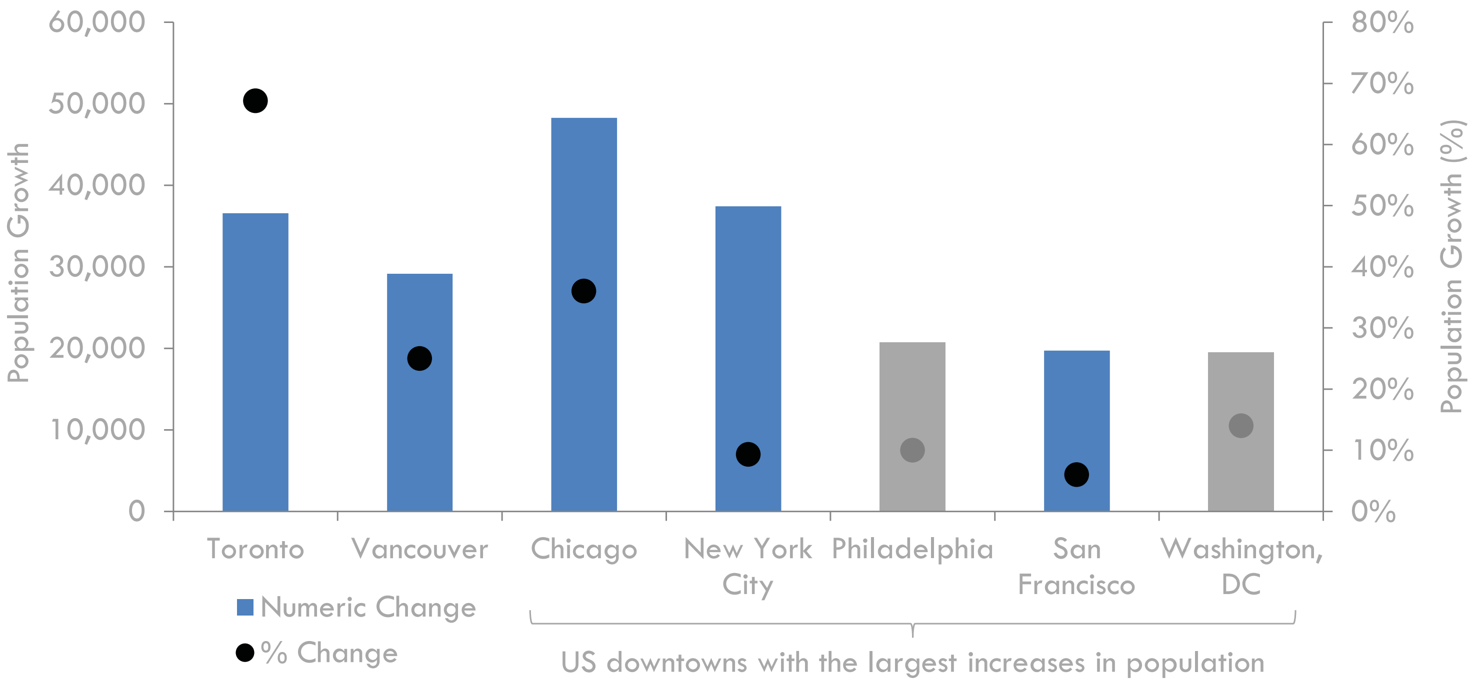
Economic Criteria #1:
City's Economic Competitiveness

Survey of North American competitive cities indicates variety of approaches to CBD freeway access.

	City	Citigroup/Economist North American Competitiveness Ranking	CBD Freeway Access
✶	New York	1	Remove
✶	Chicago	9	Never Built
	Toronto	10	Under Study
	Washington	14	Maintain
	Los Angeles	17	Maintain
✶	San Francisco	18	Remove
	Boston	19	Replace (Tunnel)
	Houston	27	Maintain
✶	Vancouver	28	Never Built
	Dallas	32	Maintain
	Atlanta	33	Maintain
	Seattle	35	Improve/Replace (Tunnel)
	Montréal	36	Under Study
	Miami	40	Maintain
	Philadelphia	48	Improve

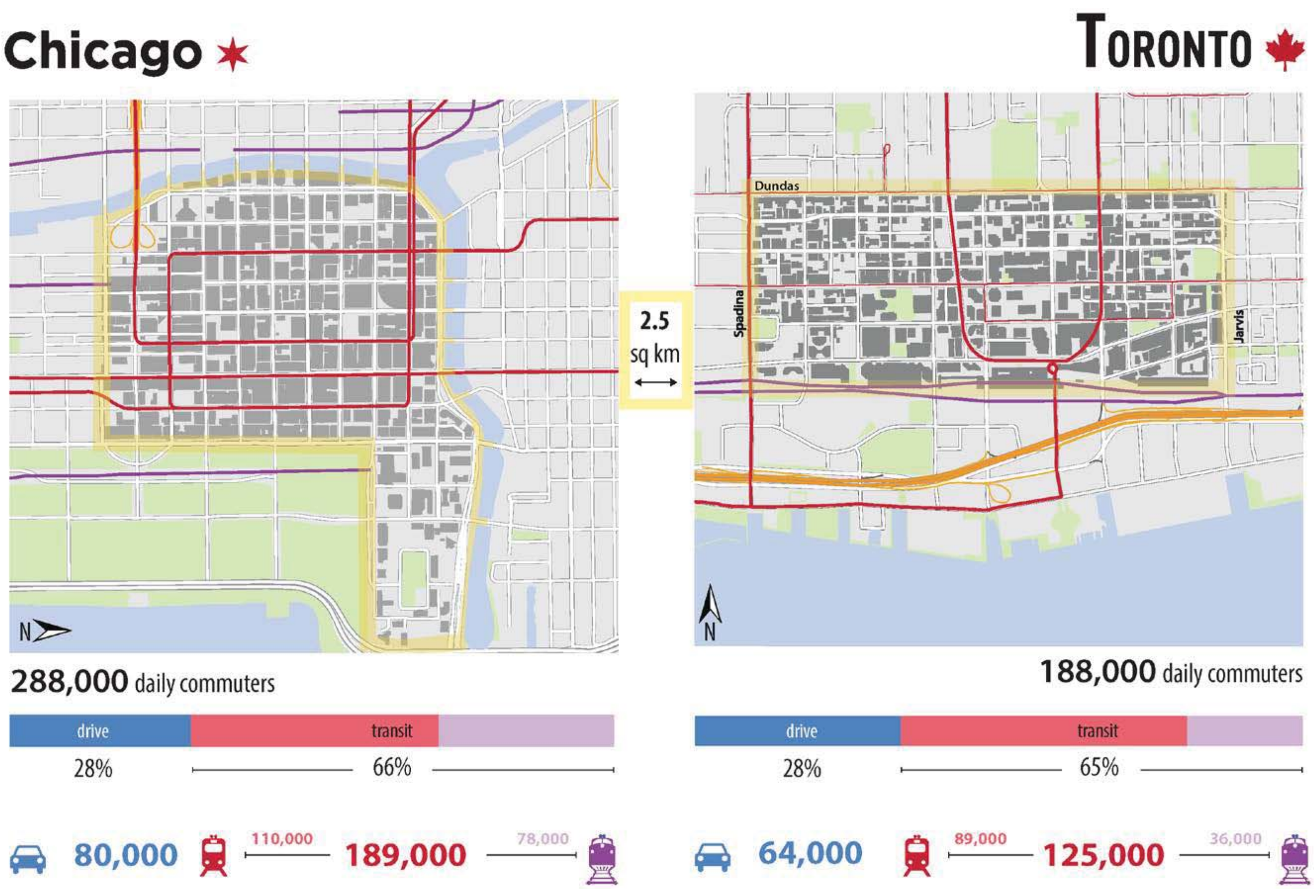
Case study cities have experienced significant population growth since 2000/2001.

Downtown population growth, 2000/2001-2010/2011

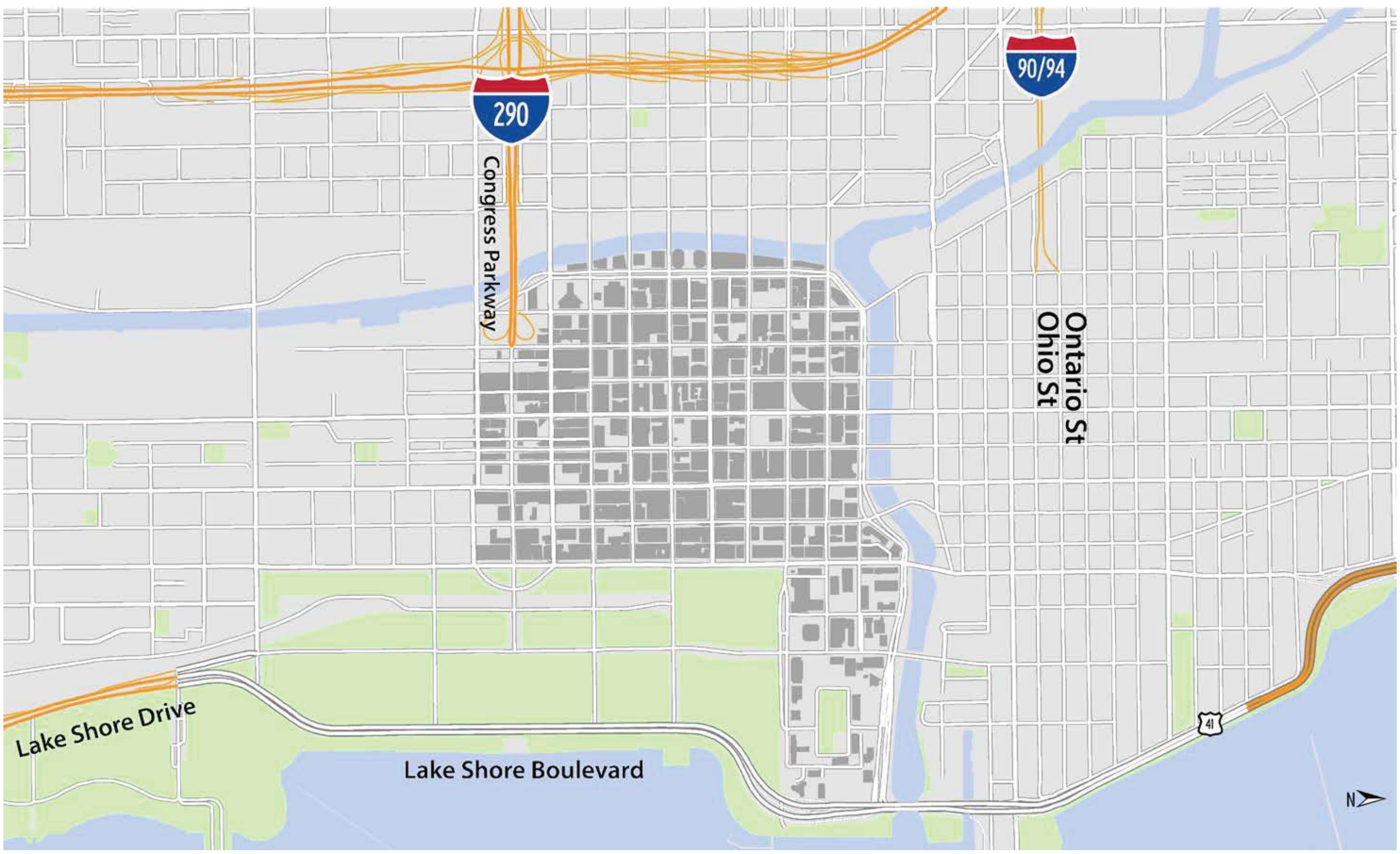


Chicago and the Loop

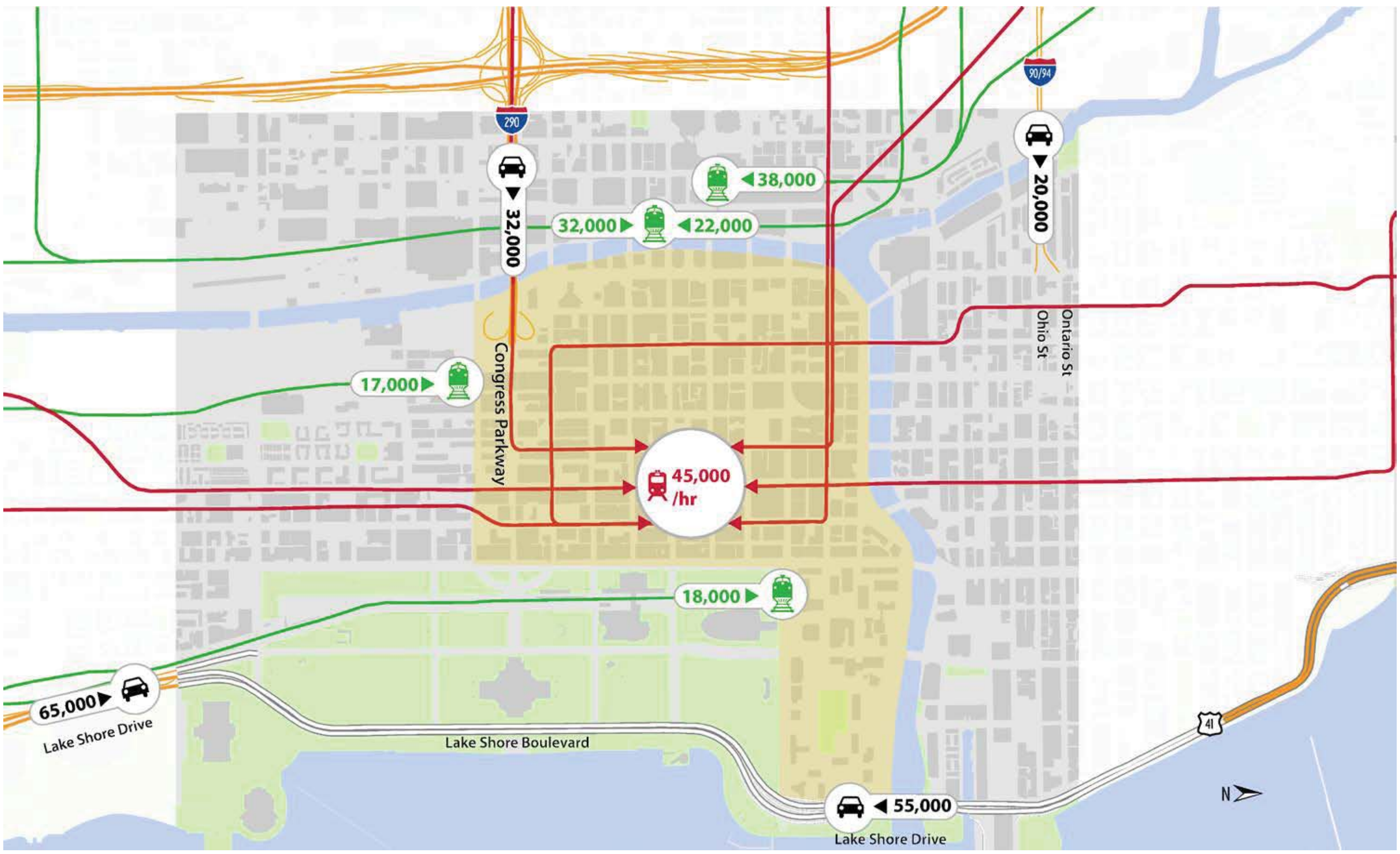
Comparable to Toronto's CBD in terms of size and mode split.



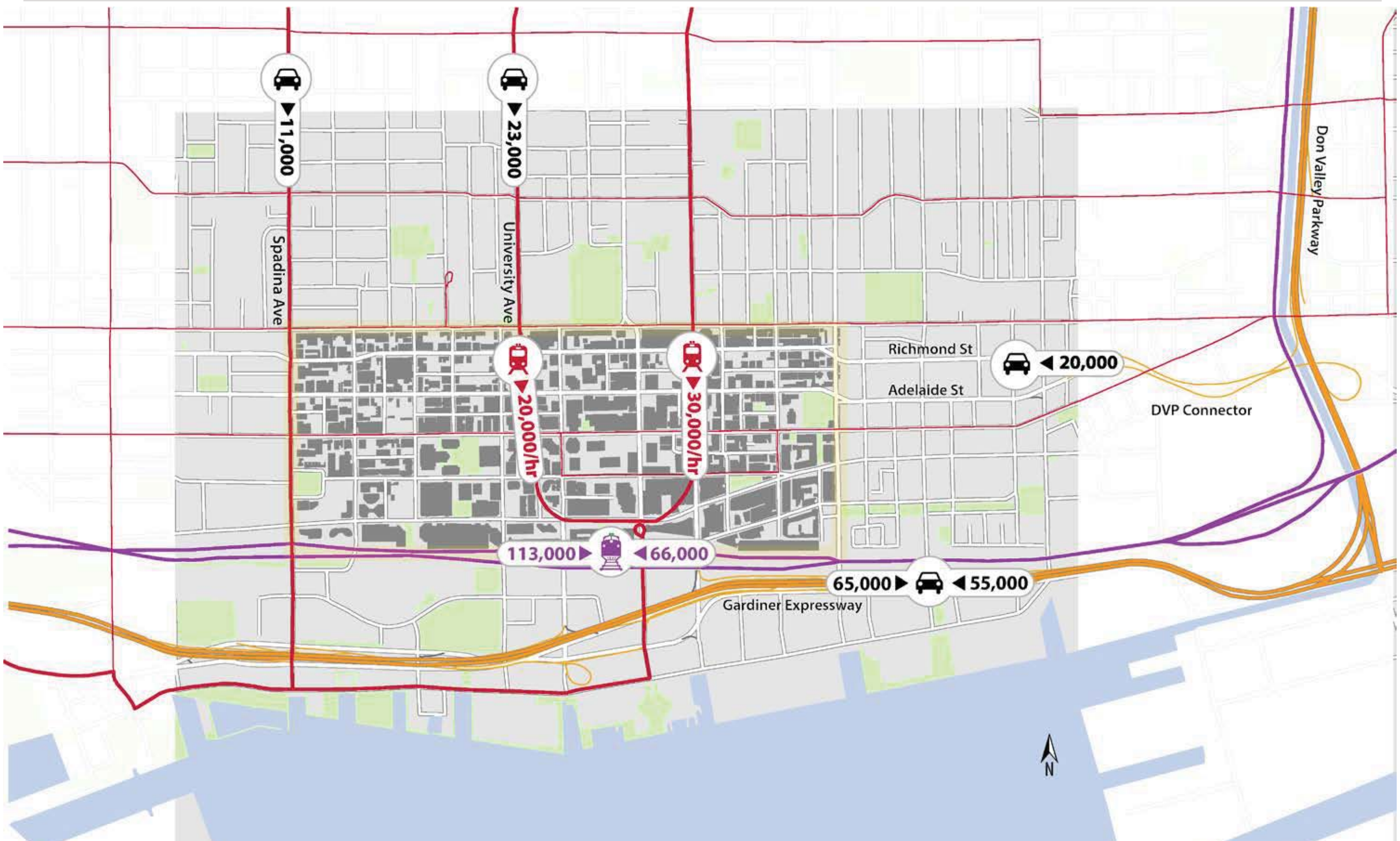
No highways directly accessing the Loop.



Lake Shore Drive handles ~130,000 vehicles per day.

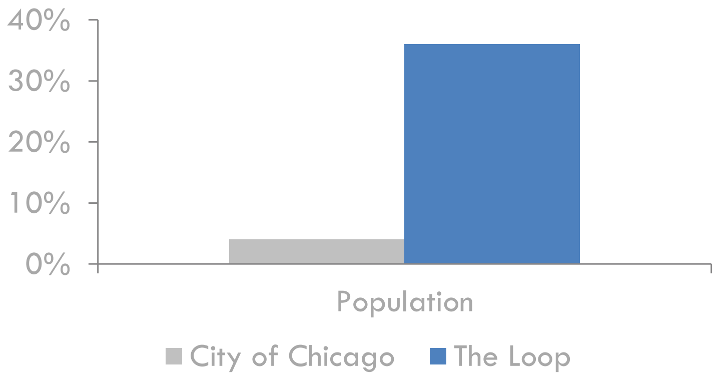


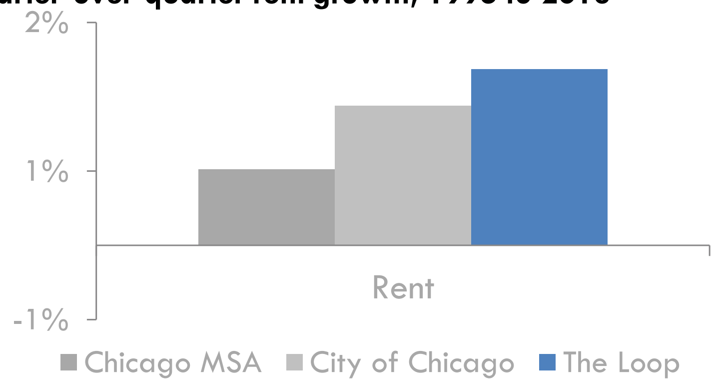
Gardiner handles ~130,000 vehicles per day.



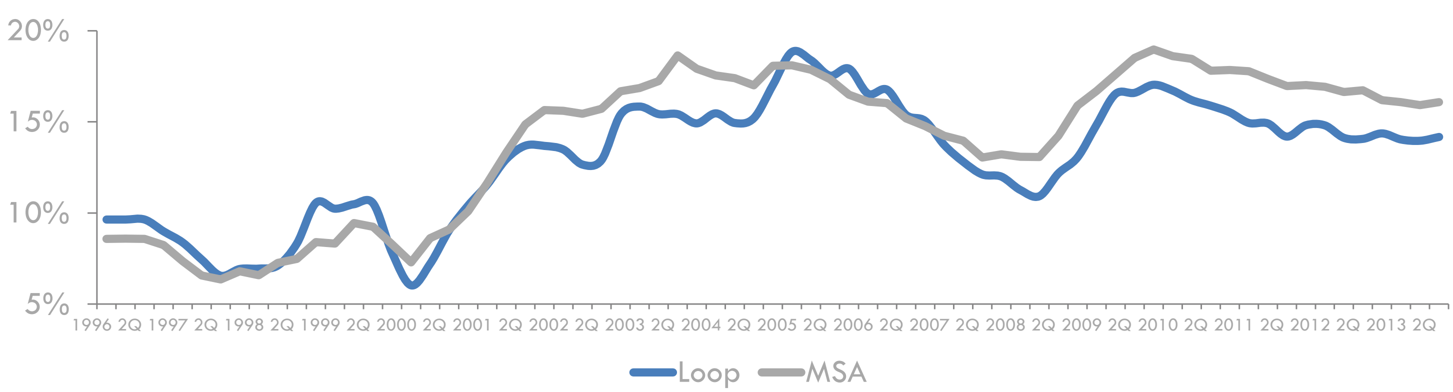
The Loop has thrived with existing transportation access.

Population and job growth, 2000 to 2010; Average quarter-over-quarter rent growth, 1996 to 2013

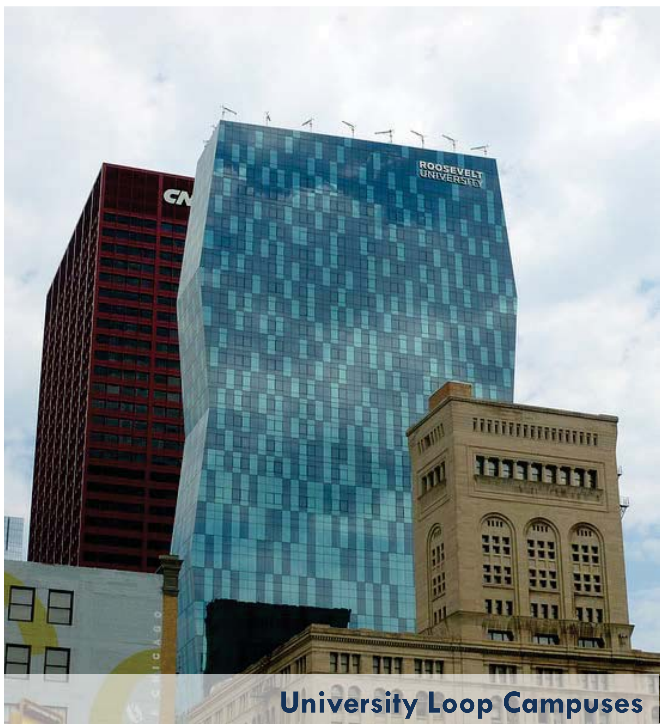




Office vacancy, 1996 to 2013



Improving competitiveness of the Loop has been about creating amenities for businesses and their employees.



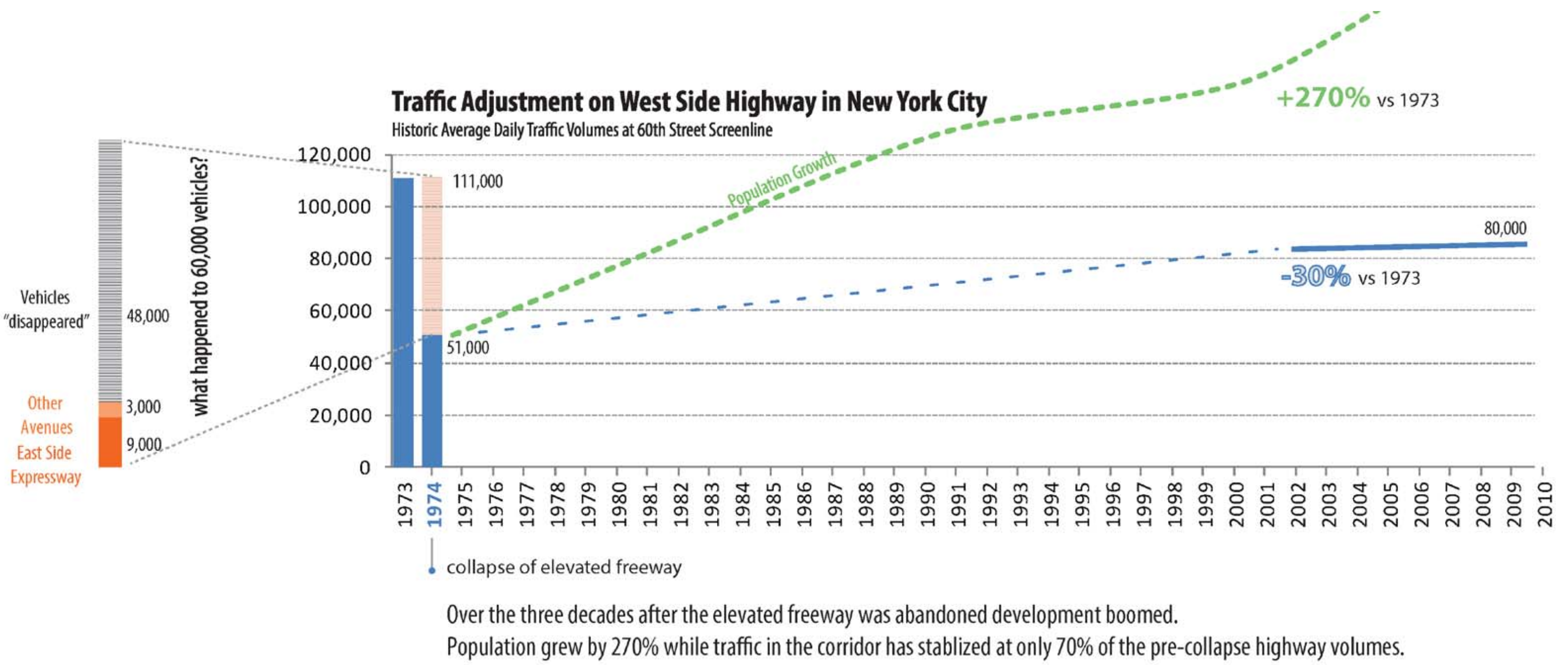
University Loop Campuses

Signature Public Realm

Walkable Commutes through New Housing

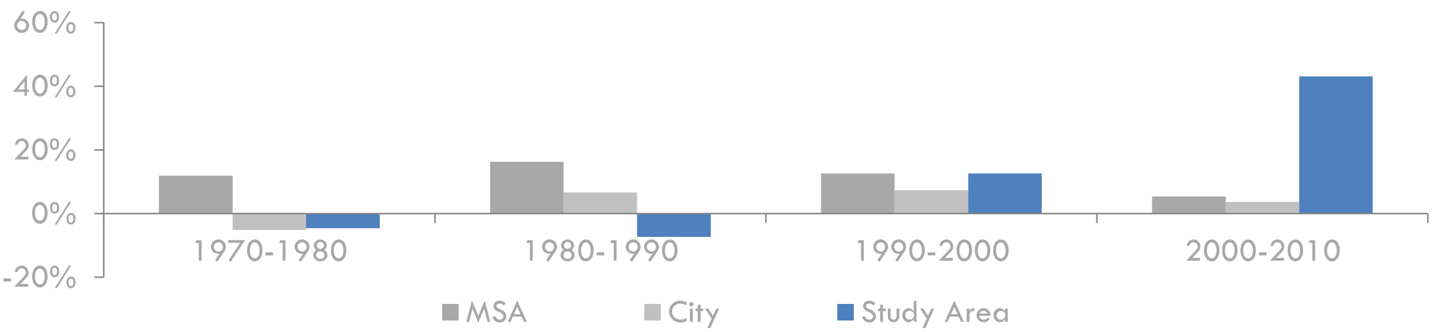
New York City and the West Side

Over three decades, New York City transformed its West Side Highway into a surface boulevard.

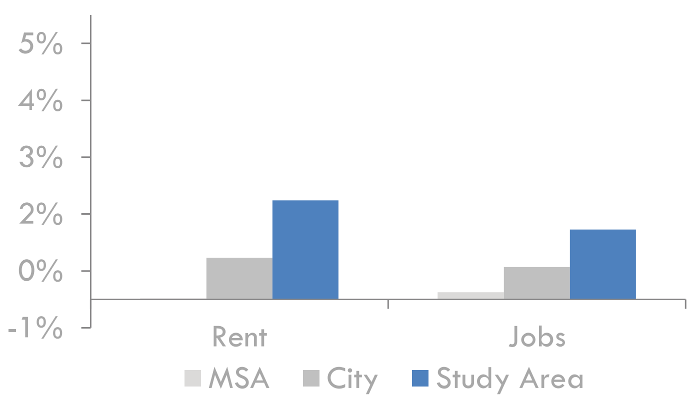


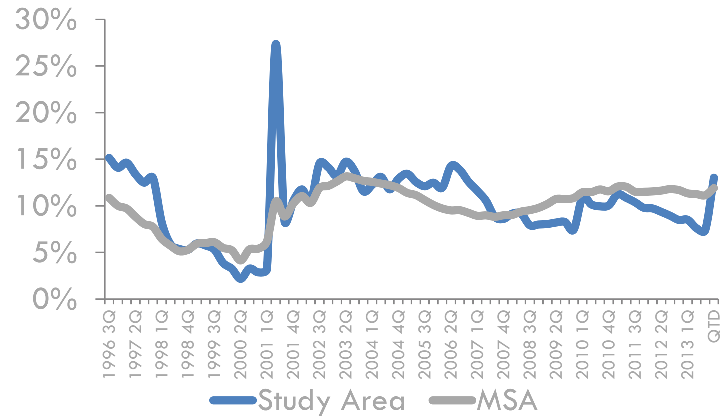
Growth on the West Side has outpaced the rest of New York City.

Population growth by decade



Average quarter-over-quarter rent growth, 1996-2013; Job growth, 2002-2012; Vacancy, 1996-2013





Pedestrian-friendly boulevard amenitizes recent economic assets.

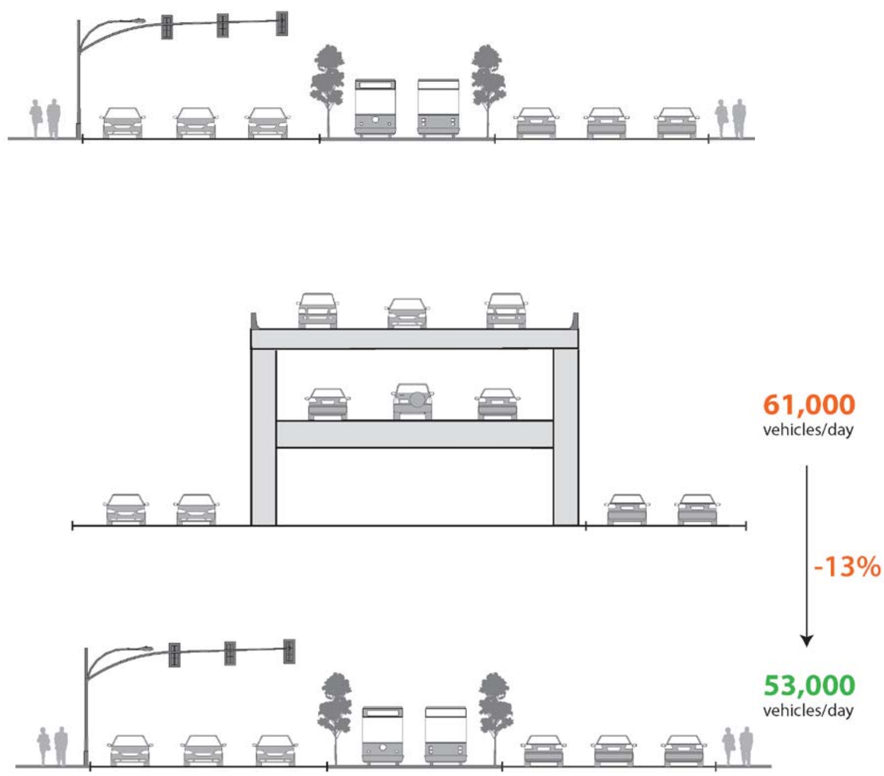

Destination Entertainment


Signature Mixed-Use Office


New Housing Options

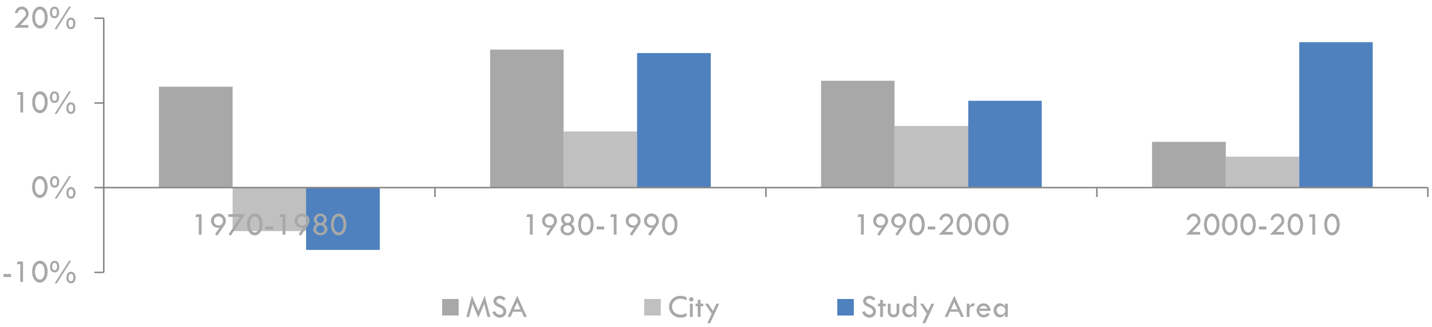
San Francisco and the Embarcadero

San Francisco transformed the elevated Embarcadero highway into a surface boulevard after a 1989 earthquake.

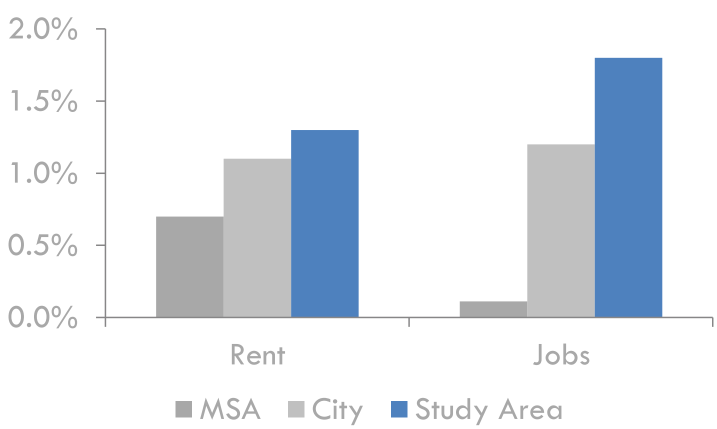


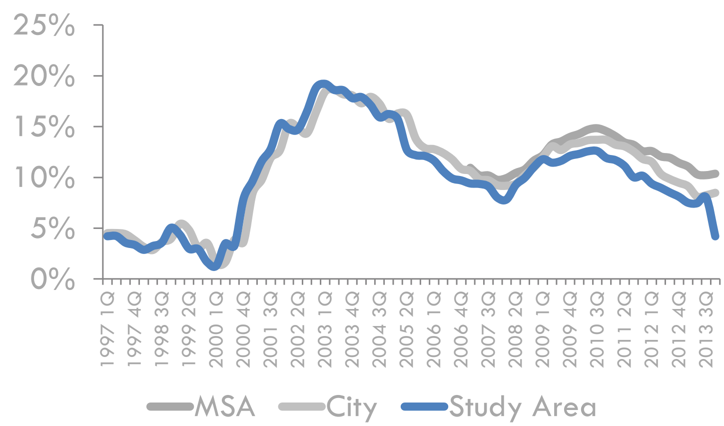
The districts along the Embarcadero have outpaced the region economically.

Population growth by decade, 1970-2010



Average quarter-over-quarter rent growth, 2007-2013; Job growth, 2002-2011; Class A office vacancy, 1997-2013





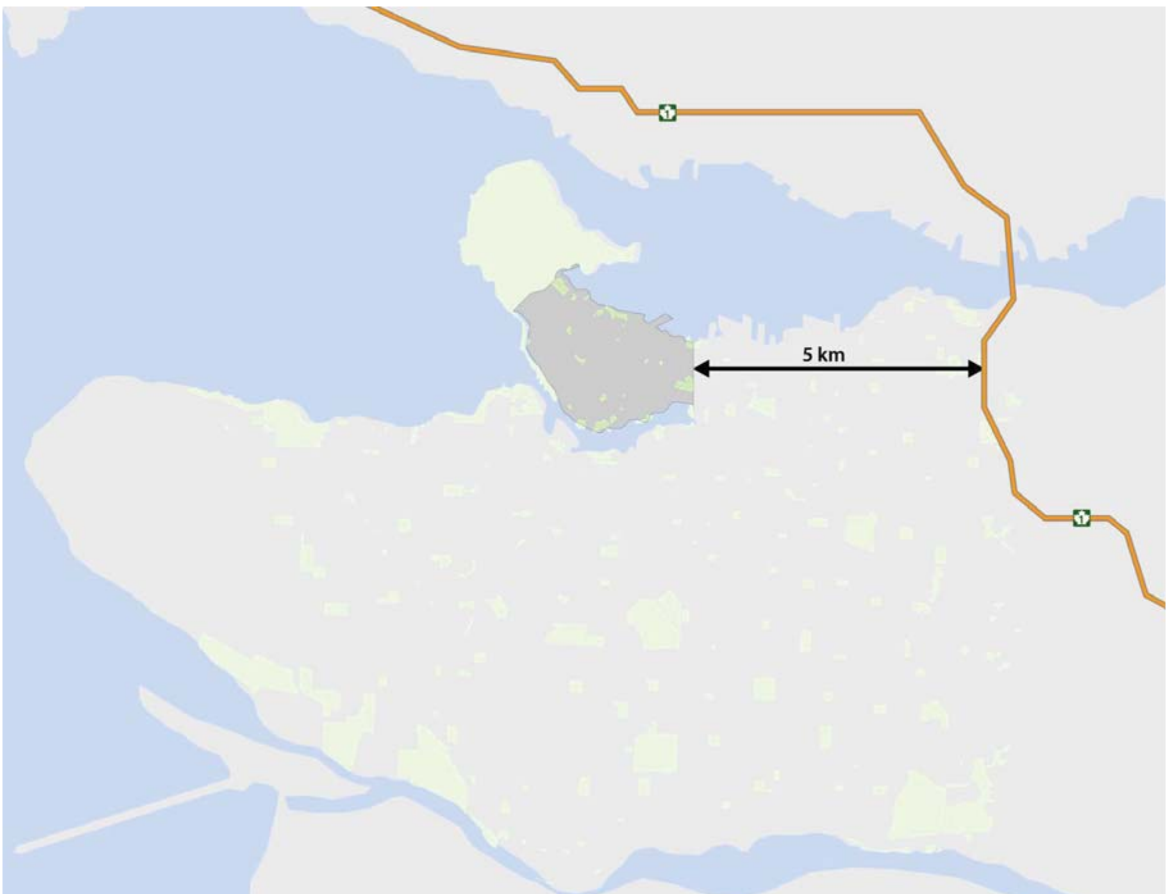
Recent waterfront economic growth has taken advantage of waterfront adjacency.

Mission Bay Institutional Development

High-Rise Residential Development

Downtown Vancouver

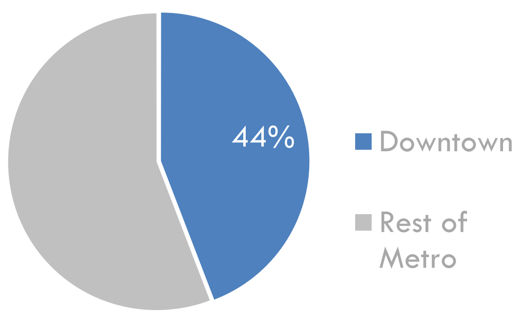
The nearest highway is 5 kilometers from downtown Vancouver.



Downtown Vancouver employers rely on transit, a walk-to-work population, and a system of arterials.

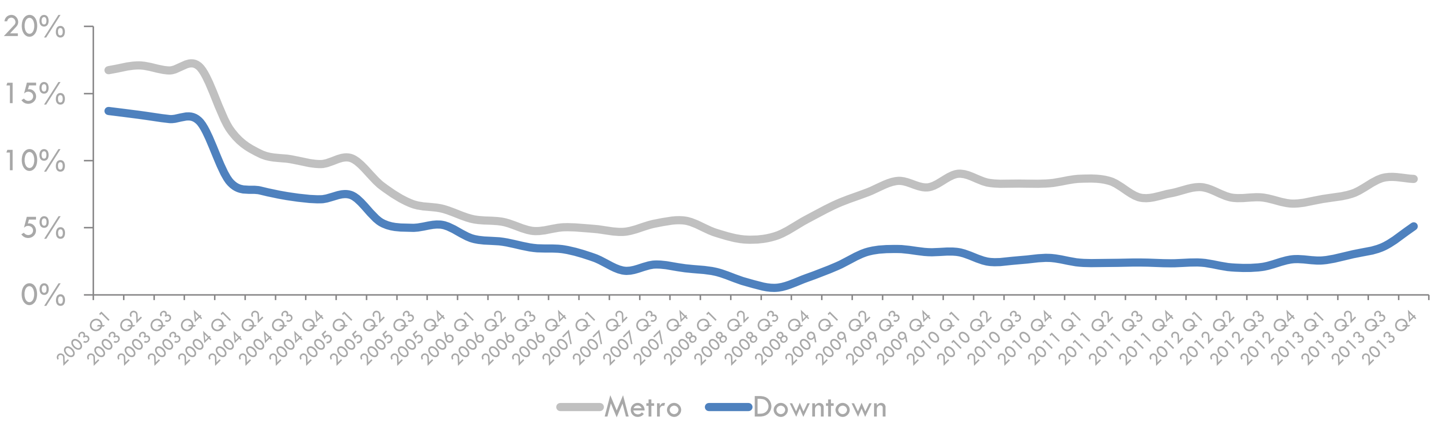
Downtown is the region's premier business district with significant growth underway.

Office space under construction, 2013Q4

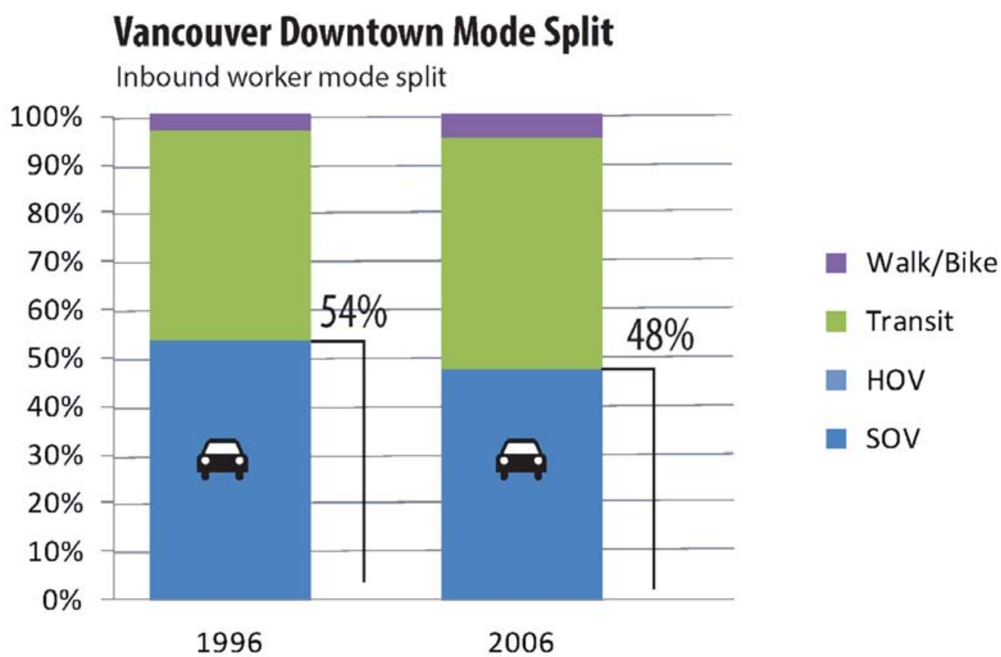


Office space, net asking rents, 2013Q4

Office space, Class AAA and Class A vacancy rates, 2003-2013



Driving has decreased over time with the advent of new transit, increasing preference for transit, and growth in downtown population.



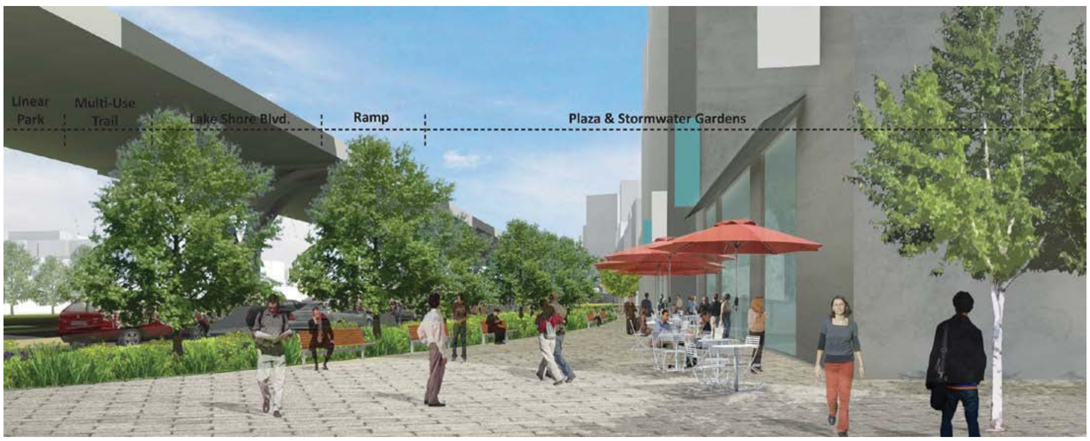
CONFIDENTIAL DRAFT FOR DISCUSSION

Implications for Toronto and its competitiveness

- CBDs are not at risk without through highways.
- A pedestrian environment and a workforce that lives downtown is an important ingredient for competitiveness.
- High capacity boulevards can provide vehicular capacity almost to the level of limited-access highways.
- A system of arterials distributes traffic by providing options.

Economic Criteria #2: Business activity

Impact on local economy



REPLACE

REMOVE

Example: The Embarcadero in San Francisco improves the pedestrian shopping experience on the waterfront and non-waterfront properties.

Retail performance and quality

	Maintain	Improve	Replace	Remove
West of Cherry	**None**	**Low** • Small scale open space	**Low to Medium** • Light and air • Public realm • Additional development	**High** • 2-sided Lake Shore segment • Light and air • Public realm • Additional development
East of Cherry	**None**	**None**	**High** • Road access • Additional development	**High** • Road access • Additional development

Economic Criteria #2: Business activity

Altering the Gardiner may open up new land for real estate development. While most of the development would likely be residential, there is some potential for commercial development that would support job growth in the area.

	Maintain	Improve	Replace	Remove
Lower Yonge	0	0	+80	+ 730
East Bayfront	0	0	+90	+ 420
Keating West*	N/A	N/A	N/A	N/A
Keating East	0	0	+ 1,580	+ 1,610
Total	**0**	**0**	**+ 1,750**	**+2,760**

*Keating West includes private lands for which plans would not likely be impacted by modifications to the Gardiner

Square feet per job based on assumptions in Urban Metrics Economic Impact of Waterfront Toronto (2013). Report assumed 2.5 retail jobs, 3.11 office jobs, 1.74 institutional jobs and 0.1 residential jobs per 1,000 square feet of development..

Criteria #3:
Public Disposition Proceeds

Economic Criteria #3: Public disposition proceeds

Altering the Gardiner impacts public disposition proceeds by:

- Opening up new land for real estate development
- Enhancing the value of existing development parcels

Assessment of Alternatives: Opening up new land for real estate development– West of Cherry (REMOVE)

Assessment of Alternatives: Opening up new land for real estate development– East of Cherry (REMOVE)

[redacted]

Assessment of Alternatives: Opening up new land for real estate development

Altering the Gardiner could affect the amount of real estate development in the study area neighbourhoods.

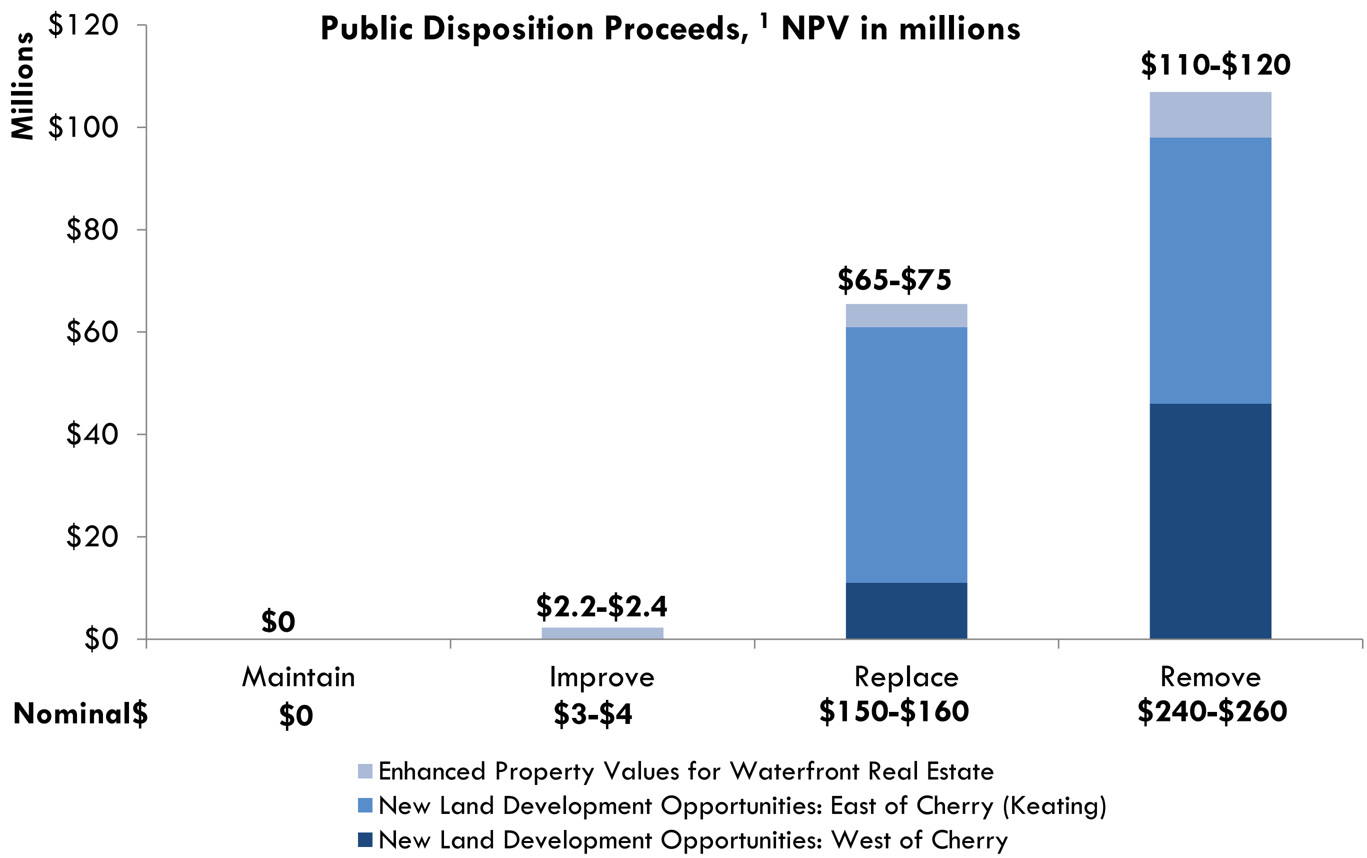
Square Feet	Maintain	Improve	Replace	Remove
Baseline Development	19,300,000	19,300,000	19,300,000	19,300,000
Additional Development: West of Cherry Street[1]	0	0	500,000	1,800,000
Additional Development: East of Cherry Street[2]	0	0	1,430,000	1,460,000
First Gulf Site	0	*Non-quantifiable - Could enhance development of site, which includes some public property in master plan*[3]		
Total	**19,300,000**	**19,300,000**	**21,200,000**	**22,600,000**

1. Developable square footage based on a FAR of 10 (based on guidance from Perkins + Will).
2. Developable square footage based on a FAR of 6.57 (based on guidance from Waterfront Toronto).
3. Per letter 12/02/13 letter from First Gulf to Waterfront Toronto. The developers do not support maintain. They support further investigation for the other 3 scenarios.

Assessment of Alternatives: Enhanced value for study area property

	Maintain	**Improve**	**Replace**	**Remove**
Enhanced value assumption	0%	1%	3%	4%
Rationale	Status quo plans.	Moving Lake Shore Boulevard under the Gardiner west of Cherry Street could improve the public realm, providing a slight increase in value for existing planned development.	A new, narrower Gardiner could increase air and light for existing parcels. Shifting Gardiner towards the rail berm east of Cherry St. would open up access to the waterfront in Keating, enhancing the value of existing land.	Removing the Gardiner would allow for increased air and light throughout the corridor by creating a grand boulevard, which will be two-sided between Yonge and Sherbourne. Change would also open up waterfront access in Keating, boosting the value of existing land.

Economic Criteria #3: Public disposition proceeds

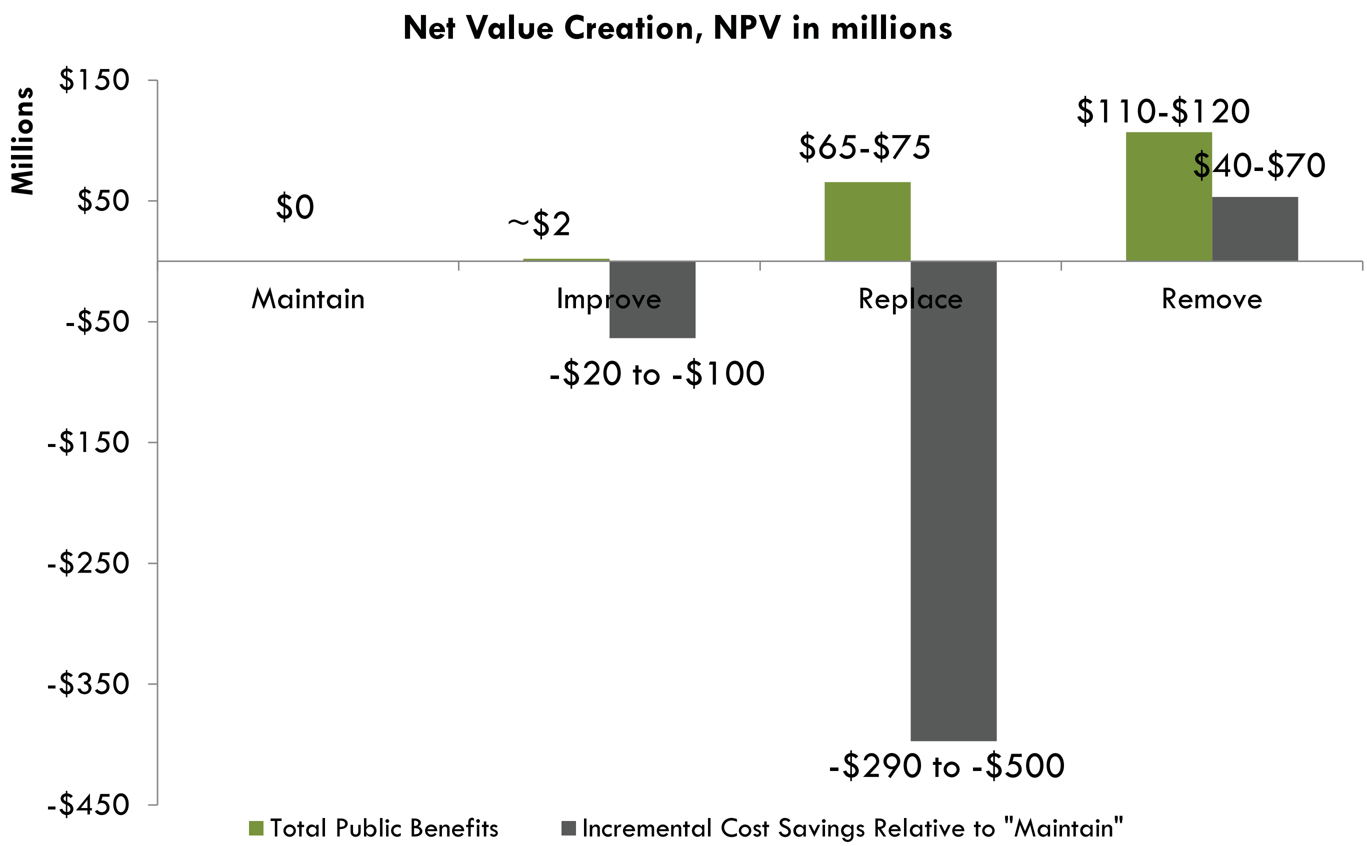


Conclusion

Conclusion: City's economic competitiveness and business activity

	Maintain	Improve	Replace	Remove
Criteria #1: City's Economic Competitiveness	None	Low	Medium	High
Criteria #2: Business Activity	Low	Low to Medium	Medium	High
Criteria #3: Public Disposition Proceeds (NPV)	$0	$2.2-$2.4	$65-$75	$110-$120
Overall Impact	**None**	**Low**	**Medium**	**High**

Conclusion: Public value creation, relative to Maintain



Appendix I
Capital Cost and Net Present Value Estimate Summary

Capital Cost and Net Present Value Estimates

Table I-1 presents the capital cost and net present value estimate analysis for the alternative solutions.

The estimate of probable costs that was completed for the evaluation of alternative solutions involved the determination of comparative capital and operations and maintenance costs over a 100-year period starting in 2013. This was completed for the Improve, Replace and Remove Alternatives. The estimate for the Maintain Alternative that was used was based on the previous methodology developed by the City in completing the Life Cycle Analysis for their long-term Gardiner Expressway rehabilitation program. The methodology used for the three new alternatives was based on the City's Gardiner rehabilitation costing methodology.

Capital Cost Estimate

Capital costs in the estimates were defined as the major capital expenditures necessary for either new bridge or road construction or for bridge deck replacement. These included cost determination for the following Major Costs Items:

1. Roadworks
   - Lakeshore Boulevard
   - Other Roadworks and Intersections
2. Structures
   - Bridge and Ramp Demolition
   - Bridge Deck Replacement
   - Other Bridges (e.g. Transition Areas, River Crossing)
   - New Ramp Bridges
   - Bridge Deck Modification
   - Bent Relocations
3. Utility Relocations
4. Traffic Maintenance During Construction
   - Major Detours, Temporary Roadworks and Outside corridor works
5. Landscaping and Urban Design
   - Type 1: Hardscape w/ Planting Area (Urban, street trees in paving, structural soil)
   - Type 2: Hardscape w/ Planting Areas & Special Amenities (skate park, court sports, 1/3 planting)
   - Type 3: Hardscape w/ Planting Areas (Paving, Gardens, Street trees, 1/3 Planting)
   - Type 4: Softscape (Primarily groundcover Planting, trees, Paths, 2/3 planting)
   - Vegetative green screening of railway retaining wall (non structural)

For utility costs an inventory of the buried utilities under the existing Gardiner Expressway was developed and costed for complete removal and relocation. For the alternatives, a percentage of this cost was assigned as follows: Maintain Alternative - included in original estimates by the City: Improve and Remove Alternatives - 15% and; Replace Alternative - 25%. An allowance for traffic maintenance during construction was determined as a percentage of the total Major Cost Items as follows: Improve Alternative - 5%; Replace Alternative - 10% and; Remove Alternative - 10%.

Totals for the Major Cost Items outlined above were developed and the following percentages added to determine the total capital costs for each alternative:

- Miscellaneous items (costs for items not specifically identified but will be required with each alternative - e.g. illumination, drainage etc.) – 18% for Replace and Remove Alternatives only
- Engineering and design costs – (7% for Maintain, 10% for Improve, 15% for Replace and Remove)
- Contingencies (13% for Maintain, 15% for Improve, 20% for Replace and Remove)
- An additional 20% cost range was applied for the total capital, operations and maintenance costs for Improve, Replace and Remove

Due to the advanced development of the Maintain Alternative for which the design was essentially complete, an additional allowance for miscellaneous costs were not considered appropriate and engineering/design/contingency costs were reduced.

Quantities (e.g. deck areas, LSB lanes) for costing were taken from concept plans for each of the alternatives. Unit costs were applied to these quantities to determine the capital cost. The unit costs were estimated based on the following principles:

- The major reference for prices was the Ontario Ministry of Transportation (MTO)'s Parametric Estimating Guide (PEG), 2011.
- For items not directly related to the MTO PEG (e.g. retaining walls, and bridge conversions) the work was quantified and priced according to MTO's Highway Costing (HiCo) 2013 data base.
- Other items that were not covered or not directly related to PEG or HiCo were estimated based on recent, similar project experience and added to the total cost. These include the following:
  - intersection costs (drainage, curb, pavement marking etc.)
  - bent relocation (removal of pier column, reconstruction of pier cap, associated; foundation and temporary support); and
  - landscaping and urban design

Although the majority of unit prices were based on the MTO PEG, price adjustments were made. Prices from recent City of Toronto projects (e.g. bridge removal) were reviewed and some of the unit prices were adjusted to account for complexity of the Gardiner project, the increased durability required to provide for the extended service life of 100 years, use of advanced construction materials and the work in downtown core. Unit prices used in the analysis were corrected to 2013 year values, and are in line with current market prices. Additional adjustments were made as follows;

- Available MTO PEG 2011 prices were updated with inflation rate of 5% per year for two year in order to represent 2013 prices.
- A complexity factor of 2.0 was applied for bridge items – New Bridge Gardiner, Ramp, and Bridge Conversion. This was to account for the difficult urban city construction environment for bridge work. This factor was not considered applicable to demolition, road, signal, and other structural items.

Life Cycle Costs and Operations and Maintenance Considerations

A life cycle cost analysis was conducted for the alternatives for a 100 year cycle starting in 2013. The City previously had conducted a Life Cycle Analysis for maintaining the Gardiner. A similar approach was applied to Improve, Replace, and Remove options. The capital and remedial treatment cost occurrences were assigned throughout the 100 year time line using year 2013 construction costs without adjustment for inflation. The maintenance methodology followed the City of Toronto's model proposed for Major and Minor Arterial Roads. A 4% discount rate was applied to convert all costs to

2013 present value and summed together as the total LCCA cost for each individual alternative. The following are the key comments and assumptions related to this analysis:

- The majority of the capital costs for new bridge works were started in 2020 and carried out over a period of 4 to 10 years depending on the total cost and project complexity for each alternative followed by designating specific life-cycle repairs over the remaining period up to 100 years
- The decks of the ramps follow a similar model once their remaining life-spans expired
- Operations and maintenance (O&M) costs include allowances for the following:
    - Superstructure Repairs (OWP) – overlay, waterproof and pave
    - Superstructure Repairs (PWP) – patch, waterproof and pave
    - Bent Repairs
    - Steel Painting
- O&M unit costs were based on ongoing and recent City costs for these types of remediation works
- It was assumed that the new decks will have a life span of 100 years, having been replaced with reinforcing materials inert to chlorides such as Stainless Steel and/or Glass Fibre Reinforced Polymer (GFRP) in conjunction with high performance concrete, waterproofing membrane and asphalt protection layer.
- For the Maintain Alternative, decks of the ramps will complete their 50-year life-spans (the typical rehabilitation cycle of decks reinforced with "black" steel) before entering the 100-year rehabilitation cycle at the time of deck replacement. The existing Jarvis and Sherbourne ramps expire within the next decade and the Logan and DVP ramps within four decades.
- The section of the F.G. Gardiner Expressway from Yonge Street was divided into eight (11) zones based on similar condition, dates of construction or rehabilitation for the existing deck. The capital and O&M costs for these zones were developed for each of the alternatives:
    - Zone 1: Jarvis Street to Small Street
    - Zone 2: Small Street to Cherry Street
    - Zone 3: Cherry Street to Don River
    - Zone 4: Gardiner to LSB Ramps at east
    - Zone 5: Jarvis on-ramp
    - Zone 6: Sherbourne off-ramp
    - Zone 7: Gardiner off ramp to DVP
    - Zone 8: DVP on-ramp to Gardiner
    - Zone 9: Yonge Street to west of Jarvis Street
    - Zone 10: West of Jarvis Street to Jarvis Street
    - Zone 0: LSB Bridge over the Don River

Life cycle costs have been summarized in two ways:

- All 2013 capital and maintenance costs were assigned over the 2013 – 2113 timeline at the appropriate years and discounted to a 2013 net present worth
- The initial phase construction capital costs (essentially in the period of 2020 to 2028) were stripped out of the 100 year timeline and classified as 2013 capital costs and the remaining costs in the 100 year period were discounted to 2013 and added to the 2013 capital costs.

The above costing methodology was peer reviewed by an independent consultant and has been adjusted based on comments and suggestions that were received. Property costs are not included in the capital cost estimates

Lifecycle Cost Estimates

Morrison Hershfield/ Dillon/ Waterfront Torotno/ City of Toronto

Capital Cost Estimate (in Millions)

2013$

Item ID	Item	Maintain: City Budget (Jarvis to Don River)	Maintain: City Budget (Yonge to Jarvis & DVP Ramps)	Maintain: Total	Maintain: Accelerated	Improve	Replace	Remove
1	Bridge Demolition	0.0	0.0	0.0		0.0	45.0	43.0
2	Ramps Demolition	0.0	0.0	0.0		0.0	9.0	9.0
3	Bridge Structure (Jarvis and Sherbourne Ramps)	10.5	0.0	10.5		18.4	11.6	0.0
4	Bridge Structure (Yonge to Jarvis)	0.0	47.6	47.6		37.6	104.3	22.6
5	Bridge Structure (Jarvis to Cherry St)	108.3	0.0	108.3		77.7	159.7	0.0
6	Bridge Structure (Cherry to Don)	58.5	0.0	58.5		40.6	73.0	0.0
7	Bridge Structure (DVP Ramps)	0.0	17.3	17.3		42.5	60.1	40.2
8	Bridge Structure (Logan Ramp)	0.0	15.6	15.6		36.9	37.2	0.0
9	Bent Relocation	0.0	0.0	0.0		12.0	0.0	0.0
10	Don Bridge *Unfunded	0.0	10.8	10.8		10.8	10.8	10.8
11	Lake Shore (Yonge to Cherry)	0.0	2.2	2.2		3.4	27.8	38.0
12	Lake Shore (Cherry to Don Rd) *Unfunded	0.0	9.1	9.1		14.3	13.3	13.5
13	Lake Shore (Don Rd to Logan)	0.0	0.6	0.6		0.9	8.0	6.9
14	Utilities, Don Rd, Intersections, Signals & Misc	0.0	5.0	5.0		13.6	17.0	11.0
15	Traffic Maintenance During Construction	0.0	0.0	0.0		15.1	55.5	17.8
16	Maintain Acceleration Premium	NA	NA	NA		NA	NA	NA
17	**Sub-Total**	**$ 177.3**	**$ 108.1**	**$ 285.4**	**$ -**	**$ 323.9**	**$ 632.3**	**$ 212.8**
18	Contingencies	13% 23.0	13% 14.1	13% 37.1	13% 0.0	15% 48.6	20% 126.5	20% 42.6
19	Engineering & Design	7% 12.4	7% 7.6	7% 20.0	7% 0.0	10% 32.4	15% 94.8	15% 31.9
20	Misc Costs (Illumination, Drainage, etc)	0.0	0.0	0.0	0.0	0.0	113.8	38.3
21	**Total Capital Cost Estimate (2013$)**	**$ 212.7**	**$ 129.7**	**$ 342.4**	**$ -**	**$ 404.8**	**$ 967.4**	**$ 325.6**
22	**Total Capital Cost Estimate (NPV)**	**$ 146.3**	**$ 50.1**	**$ 196.4**	**$ -**	**$ 285.9**	**$ 641.3**	**$ 221.0**
23	**Cost Ranges Rounded Up (2013$)** 90% (Maintain) 80% (Others)	**$ 200**	**$ 120**	**$ 310**		**$ 330**	**$ 780**	**$ 270**
	100% (Maintain) 100% (Others)	**$ 220**	**$ 130**	**$ 350**		**$ 410**	**$ 970**	**$ 330**
	110% (Maintain) 120% (Others)	**$ 240**	**$ 150**	**$ 380**		**$ 490**	**$ 1,170**	**$ 400**

Operations and Maintenance Cost Estimate (in Millions)

2013$

Item ID	Item	Year	Maintain: City Budget (Jarvis to Don River) 2013$	NPV	Maintain: City Budget (Yonge to Jarvis & DVP Ramps) 2013$	NPV	Maintain: Total 2013$	NPV	Maintain: Accelerated Total 2013$	NPV	Improve 2013$	NPV	Replace 2013$	NPV	Remove 2013$	NPV
1	Bridge Structure (Yonge to Jarvis)		0.0	0.0	68.2	5.1	68.2	5.1			67.6	10.0	80.7	8.6	17.5	1.9
2	Bridge Structure (Jarvis and Sherbourne Ramps)		18.6	2.5	0.0	0.0	18.6	2.5			14.5	2.3	9.2	1.0	0.0	0.0
3	Bridge Structure (Jarvis to Cherry St)		182.4	26.6	0.0	0.0	182.4	26.6			130.9	19.6	116.7	12.4	0.0	0.0
4	Bridge Structure (Cherry to DVP Ramps)		98.6	14.4	0.0	0.0	98.6	14.4			70.7	10.6	63.1	6.7	0.0	0.0
5	Bridge Structure (DVP Ramps)		0.0	0.0	41.3	11.6	41.3	11.6			33.4	4.7	47.6	5.0	31.8	3.5
6	Bridge Structure (Logan Ramp)		0.0	0.0	37.2	9.8	37.2	9.8			62.6	8.3	28.7	3.0	0.0	0.0
7	Don Bridge		0.0	0.0	8.4	1.0	8.4	1.0			8.4	1.3	8.4	0.9	8.4	0.9
8	Lake Shore (Yonge to Logan)		0.0	0.0	48.1	4.6	48.1	4.6			48.1	5.0	43.8	2.5	60.0	3.6
9	Intersection Signals		0.0	0.0	8.3	0.9	8.3	0.9			8.3	1.1	8.3	0.9	8.3	1.0
10	Interim Repair		0.0	0.0	9.1	9.1	9.1	9.1			9.1	9.1	9.1	9.1	9.1	9.1
11	**Total Operations & Maintenance Cost Estimate (2013$)**		**$ 299.6**		**$ 220.7**		**$ 520.3**				**$ 453.7**		**$ 415.6**		**$ 135.2**	
12	**Total Operations & Maintenance Cost Estimate (NPV)**			**$ 43.5**		**$ 42.1**		**$ 85.6**				**$ 71.9**		**$ 50.1**		**$ 20.0**

Lifecyle Cost Estimate (2013$'s in Millions)

Item ID	Item	Maintain	Maintain (Accelerated)	Improve	Replace	Remove
1	Capital Cost Estimate	350		410	970	330
2	Operations & Maintenance Cost Estimate	530		460	420	140
3	**Total Lifecycle Cost Estimate (2013$)**	**$ 880**		**$ 870**	**$ 1,390**	**$ 470**
4	**Cost Ranges (2013$)** 90% (Maintain) 80% (Others)	$ 800		$ 700	$ 1,120	$ 380
	100% (Maintain) 100% (Others)	$ 880		$ 870	$ 1,390	$ 470
	110% (Maintain) 120% (Others)	$ 970		$ 1,050	$ 1,670	$ 570

Lifecyle Cost Estimate (NPV in Millions)

Item ID	Item	Maintain	Maintain (Accelerated)	Improve	Replace	Remove
1	Total Capital Cost Estimate (NPV)	200.0		290.0	650.0	221.0
2	Total Operations & Maintenance Cost Estimate (NPV)	90.0		80.0	60.0	20.0
3	**Total Lifecycle Cost Estimate (NPV)**	**$ 290.0**		**$ 370.0**	**$ 710.0**	**$ 241.0**
4	**Cost Ranges (NPV)** 90% (Maintain) 80% (Others)	$ 270		$ 300	$ 570	$ 200
	100% (Maintain) 100% (Others)	$ 290		$ 370	$ 710	$ 250
	110% (Maintain) 120% (Others)	$ 320		$ 450	$ 860	$ 290

Net Cost (NPV in Millions)

	Net Cost (NPV in Millions)	Maintain	Maintain (Accelerated)	Improve	Replace	Remove
1	Revenue from Public Land Sales (NPV) +/- 10%	0		2	68	85
2	Lifecycle Cost Estimate (NPV)	290		370	710	250
3	**Net Cost (NPV)**	**$ 290**		**$ 368**	**$ 643**	**$ 165**

Net Cost (2013$ in Millions)

1	Revenue from Public Land Sales (2013$) +/- 10%	0		3	155	230
2	Lifecycle Cost Estimate (2013$)	880		870	1,390	470
3	**Net Cost (2013$ in Millions)**	**$ 880**		**$ 867**	**$ 1,235**	**$ 240**