Appendix A: Benefits Case Themes, Outcomes and Indicators

A separate report outlining a framework for the Business Case for sustainable transportation in Peel Region has been prepared and is under separate cover. The recommended structure of the benefits case includes themes (i.e. major issues), outcomes (i.e. major parameters of those issues) and indicators (i.e. attributes of those parameters to be forecasted or observed).

The five themes for the Business Case are transportation system performance, public health and safety, environment, economy and economic costing. The table below summarizes the outcomes contained within each theme.

A more detailed explanation on the development of these themes is presented in the stand-alone report: Business Case Framework, June 13, 2017.

Themes and outcomes

Transportation system performance

- Travel demand
- Travel choice
- Access to destinations
- Speed and delay
- Capacity
- Efficiency
- Safety
- Universal access
- Connectivity
- Reliability
- User awareness and satisfaction

Public health and safety

- Clean air
- Physical activity
- Injury and death from collisions
- Mental health
- Independent travel by children
- Personal security

Environment

- Greenhouse gas emissions from transportation
- Land consumption
- Greening

Economy

- Vitality and growth
- Land use density
- Land value
- Access to labour
- Retail vibrancy
- Cost of congestion
- Affordability of travel
- Commuter satisfaction

Economic costing

- Unit travel costs by mode
- Benefit-cost analysis

Sections A.1 through A.5 recommend possible indicators for consideration to describe each theme and outcome. For each indicator, the possible scale(s) of application is suggested, as is the typical derivation of data to express the indicator, as well as any other explanatory notes. For scale, the following definitions are suggested:

- Facility/corridor
- Transit station
- Destination (e.g. school, retail)
- Employment area/TMA (e.g. business park, Smart Commute service area)
- Neighbourhood (e.g. Secondary Plan area, subdivision)
- Municipality (i.e. one area municipality, or a major portion thereof)
- Region (i.e. Region of Peel, or a major portion thereof)

A.1 Theme: Transportation System Performance

This section recommends possible benefits case indicators that express the following outcomes related to transportation system performance:

- Travel demand
- Travel choice
- Access to destinations
- Speed and delay
- Capacity
- Efficiency
- Safety
- Universal access
- Connectivity
- Reliability
- User awareness and satisfaction

Some of these outcomes adhere to the key principle of "meaning" as described in Section 5.2, while others are useful to provide context and explanation to support the benefits case by tracing broad travel patterns or aspects of system performance over time.

An equity analysis may be performed for many of these indicators by examining the distribution of pertinent costs and benefits among demographic groups according to income, gender, age, race or other parameter.

Outcomes and indicators	Scale	Typical derivation	Notes
Outcome: Travel Demand			
Mode shares (walking, cycling, transit, vehicle passenger, vehicle driver, telework)	• Facility/corridor • Destination • Neighbourhood • Municipality • Region	Observed: Field counts, TTS or other travel survey (e.g. workplace survey)	Peak period or daily
Person trips: Total and by mode (walking, cycling, transit, vehicle passenger, vehicle driver, telework)	• Destination • Neighbourhood • Municipality • Region	Observed: Field counts, TTS or other travel survey. Or modelled: travel demand model	Total and per-capita, daily or annual
Person-kilometres travelled: Total and by mode (walking, cycling, transit, vehicle passenger, vehicle driver)	• Destination • Neighbourhood • Municipality • Region	Observed: TTS or other travel survey. Or modelled: travel demand model	Total and per-capita, daily or annual
Outcome: Travel Choice			
Motor vehicle ownership/capita	• Neighbourhood • Municipality • Region	Observed: Provincial data or TTS	Reduction in vehicle ownership/capita indicates greater reliance on non-driving options
Proportion of households within walking distance of bus stop with service every 30 minutes or better	• Municipality • Region	Observed or modelled: Spatial analysis	
Proportion of households within walking distance of quality transit service (10-minute frequency or better)	• Municipality • Region	Observed or modelled: Spatial analysis	
Proportion of households in urbanized areas with immediate access to a sidewalk	• Municipality • Region	Observed or modelled: Spatial analysis	Exclude rural areas
Proportion of households within 1 km of a cycling facility (trail, bike lane, cycle track)	• Facility/corridor • Neighbourhood • Municipality • Region	Observed or modelled: Spatial analysis	

Outcomes and indicators	Scale	Typical derivation	Notes
Proportion of jobs within 1 km of a cycling facility (trail, bike lane, cycle track)	• Facility/corridor • Neighbourhood • Municipality • Region	Observed or modelled: Spatial analysis	
Outcome: Access to Destinations			
Transit access to employment opportunities from home	• Municipality • Region	Observed or modelled: Spatial analysis	Calculated as the number of jobs per resident accessible by transit within 45 minutes; useful for comparing transit access to employment among different communities
Access to greenspace	• Municipality • Region	Observed: Spatial analysis	
Average trip lengths (distance)	• Municipality • Region	Observed: TTS	Lower lengths indicate greater access. With mode shares, enables estimation of motor vehicle operating cost reductions
Average trip duration (time)	• Municipality • Region	Observed: TTS	Shorter durations indicate greater access
Outcome: Speed and Delay			
Delay to individuals	• Facility/corridor • Region	Observed or modelled: Delay encountered by motor vehicle and transit passengers	
Average speed as a % of posted speed on arterial roads (weighted by link volume, peak hour)	• Municipality • Region	Observed or modelled: Travel time surveys or travel demand model	
Average transit speed (total revenue veh-km/revenue veh-hr)	• Municipality • Region	Observed: Transit system operating statistics or travel time surveys	Can measure impact of transit priority measures

Outcomes and indicators	Scale	Typical derivation	Notes
Outcome: Capacity			
People-moving capacity: Total and by mode (walking, cycling, transit, vehicle passenger, vehicle driver)	• Facility/corridor	Modelled: Based on ROW allocation and geometry, average vehicle occupancies, operational characteristics	
Outcome: Efficiency			
Transportation facility efficiency (utilization of infrastructure)	• Facility/corridor • Destination • Neighbourhood • Municipality • Region	Observed: Based on field counts, surveys and GIS inventory	Calculated as transportation facility area per capita or per person-trip
Vehicle occupancy ratio	• Facility/corridor • Destination • Neighbourhood • Municipality • Region	Observed: TTS or other travel survey. Or modelled: travel demand model (calculated as person-km/vehicle-km travelled)	Calculated as person-km/vehicle-km travelled. Peak period, 24-hour or annual
Transit boarding efficiency	• Route/corridor • Municipality • Region	Observed: Transit system data	Calculated as boardings per bus-hour or bus-kilometre. Daily or annual
Outcome: Safety			
Collisions: Total or by mode (involving pedestrians, cyclists, buses, light-duty vehicles, heavy trucks)	• Facility/corridor • Neighbourhood • Municipality • Region	Observed: Collision data, or Modelled: Based on exposure and average collision rates by facility type	Daily, monthly or annual
Outcome: Universal Access			
% of traffic signals with accessible push buttons and audible signals	• Municipality • Region	Observed: Facility inventories	
% of bus stops with accessible shelters and seating	• Municipality • Region	Observed: Facility inventories	

Outcomes and indicators	Scale	Typical derivation	Notes
Outcome: Connectivity			
Multimodal trips	• Transit station • Destination • Municipality • Region	Observed: Walk-transit, bike-transit, kiss-and-ride, park-and-ride, park-and-bike	Daily or annual
Outcome: Reliability			
Transit on-time performance	• Route/corridor • Municipality • Region	Observed: Transit system data	Calculated as % of transit arrivals within acceptable on-time window. Peak period, daily, monthly, annual
Outcome: User Awareness and Satisfaction			
Awareness of travel options among Region of Peel residents	• Neighbourhood • Municipality • Region	Observed: Survey of residents (e.g. by telephone)	
Satisfaction with transportation options among Region of Peel residents	• Neighbourhood • Municipality • Region	Observed: Survey of residents (e.g. by telephone)	

A.2 Theme: Public Health and Safety

This section recommends possible benefits case indicators that express the following outcomes related to public health and safety:

- Clean air
- Physical activity
- Injury and death from collisions
- Mental health
- Independent travel by children
- Personal security

An equity analysis may be performed for many of these indicators by examining the distribution of pertinent costs and benefits among demographic groups according to income, gender, age, race or other parameter.

Outcomes and indicators	Scale	Typical derivation	Notes
Outcome: Clean Air			
Hospital admissions related to poor air quality	• Region	Observed: Hospital admission records	
Emission of criteria air pollutants (PM2.5, PM10, NOx) from motor vehicles	• Facility/corridor • Neighbourhood • Municipality • Region	Modelled: Transportation demand model with emission factors	Absolute value could be normalized per capita. Proxy for actual health impacts, which are unlikely to be significant at less than a regional level
Annual air quality events (smog alerts)	• Region	Observed: Provincial data	Proxy for actual health impacts
Outcome: Physical Activity			
Deaths from all causes related to a given level of cycling and walking activity	• Municipality • Region	Modelled: Using WHO's Health Economic Assessment Tool (HEAT) for walking and cycling	Allows scenario comparison to determine impact of changes in walking and cycling activity. Does not address illness impacts other than death; does not estimate air pollution impacts. Estimates economic costs related to deaths.
Incidence of overweight and obesity	• Municipality • Region	Percentage of population considered obese, based on annual or periodic surveys	Active transportation contributes to reduced obesity, but is only one factor
Incidence of type II diabetes	• Municipality • Region	Modelled: Using the Diabetes Population Risk Tool based on physical activity levels	Allows comparison of scenarios to track changes over time, or to model contrasts. Economic costs can be determined using estimated annual cost of care per person

Outcomes and indicators	Scale	Typical derivation	Notes
Outcome: Injury and Death from Collisions			
Injuries and deaths from collisions	• Facility/corridor • Neighbourhood • Municipality • Region	Observed: Collision reports	Allows segmentation by victims' mode of transport. Economic costs can be determined using average rates per injury and death.
Outcome: Independent Travel by Children			
• % of children (kindergarten to grade 12) who walk or cycle to school	• Destination (school) • Neighbourhood • Municipality • Region	Observed: School-based or household surveys	

A.3 Theme: Environment

This section recommends possible benefits case indicators that express the following outcomes related to the environment:

- Greenhouse gas emissions from transportation
- Land consumption
- Greening

An equity analysis may be performed for some of these indicators by examining the distribution of pertinent costs and benefits among demographic groups according to income, gender, age, race or other parameter.

Outcomes and indicators	Scale	Typical derivation	Notes
Outcome: Emission of Greenhouse Gases			
Greenhouse gas emissions from transportation	• Facility/corridor • Neighbourhood • Municipality • Region	Observed: Community GHG inventory; fuel sales data. Or modelled: transportation demand models.	Absolute value could be normalized per capita.

Outcomes and indicators	Scale	Typical derivation	Notes
Outcome: Land Consumption			
Area of paved surface	• Neighbourhood • Municipality • Region	Observed: Municipal GIS inventory and/or aerial data	Includes paved land in rights-of-way and/or off-street parking areas. Absolute value could be normalized per capita. Proxy for water quality impact via runoff, and for habitat degradation via greenspace consumption.
Outcome: Greening			
Street trees	• Facility/corridor • Neighbourhood • Municipality • Region	Observed: Municipal GIS inventory and/or aerial data	Absolute value could be normalize d per capita.

A.4 Theme: Economy

This section recommends benefits case indicators that express the following outcomes related to the economy:

- Vitality and growth
- Land use density
- Land value
- Access to labour
- Retail vibrancy
- Cost of congestion
- Affordability of travel
- Commuter satisfaction

Outcomes and indicators	Scale	Typical derivation	Notes
Outcome: Vitality and Growth			
Sustainable mode use in key nodes	• Employment area/ TMA • Municipality • Region	Observed: Survey of workplaces, TTS	Higher sustainable mode usage maintains road capacity for trucks and other vehicles
Outcome: Land Use Density			
Population and employment density per hectare	• Corridor • Destination • Neighbourhood • Municipality • Region	Observed: Municipal databases, employment surveys, census	Of particular interest in transit-oriented development zones, and added density in infill vs greenfield sites.
Outcome: Land Value			
Average home cost	• Corridor • Destination • Neighbourhood	Observed: Home sales data before/after transportation initiative	Price change in subject area can be compared to concurrent change in Municipality/region
Average commercial land cost	• Corridor • Destination • Neighbourhood	Observed: Commercial land sales data before/ after transportation initiative	Price change in subject area can be compared to concurrent change in Municipality/region
Outcome: Access to Labour			
Transit access to potential workers from workplace	• Municipality • Region	Observed or modelled: Spatial analysis	Calculated as the number of potential workers per job accessible by transit within 45 minutes; useful for comparing transit access to labour force among different communities
Outcome: Retail Vibrancy			
Change in spending patterns	• Destination (retail) • Facility/corridor • Neighbourhood	Observed: Survey of retailers before/after transportation initiative	
Retail occupancy	• Destination (retail) • Facility/corridor	Observed: Survey of retail vacancies before/ after transportation initiative	Municipalities to collect this information.
Outcome: Cost of Congestion			

Outcomes and indicators	Scale	Typical derivation	Notes
Cost of delay to individuals	• Facility/corridor • Region	Modelled: Estimates of delay hours and cost/ hour for personal travel by motor vehicles and transit	
Costs of delay to goods and services	• Facility/corridor • Region	Modelled: Estimates of delay hours and cost/hour for trucks and other commercial vehicles	
Outcome: Affordability of Travel			
Cost of personal transportation	• Region	Modelled: Total private vehicle ownership, operating and parking costs, plus transit, taxi and ride-hailing fares	Could be normalized per capita.
Proportion of average household income spent on transportation	• Municipality • Region	Observed: Statistics Canada surveys	
Outcome: Commuter Satisfaction			
Satisfaction with commutes by Region of Peel residents or workers	• Destination • Employment area/ TMA • Region	Observed: Survey of residents (e.g. by telephone) or employees (e.g. by Smart Commute)	

A.5 Theme: Economic Costing

This section recommends two different approaches to economic costing, each having its own advantages and disadvantages.

Unit travel costs by mode

Section 3.7 discussed the 2011 update to the City of Ottawa's Cost of Travel Model, which is based on extensive research into individual, government and social costs and benefits of each person-km travelled by auto, transit, cycling and walking. This approach allows rapid quantification of the economic costs and benefits of mode shifts, such as the shifts that will be proposed as targets for STS, where:

Incremental annual cost or benefit, mode A ($)	=	(Total person-trips by all modes)
	x	(Incremental mode share, mode a)
	x	(Average trip length, mode a, km/trip)
	x	(Unit travel cost, mode a, $/person-km)

For example, in a hypothetical scenario where 1% of 500 million annual person-trips are shifted from automobile (average trip length = 10 km) to cycling (average trip length = 4 km), the Cost of Travel Model would yield the following:

Incremental annual cost or benefit, auto ($)	=	500 million trips
	x	- 1% change in auto mode share
	x	10 km/trip
	x	$1.038/person-km
	=	$51.9 million benefit
Incremental annual cost or benefit, cycling ($)	=	500 million trips
	x	+ 1% change in cycling mode share
	x	4 km/trip
	x	$0.627/person-km
	=	$12.5 million cost
Net incremental annual benefit	=	$51.9 million – $12.5million
	=	$39.4 million

NB: This benefit includes operating, infrastructure, time/delay and environmental/social costs.

Note that excluding personal time/delay costs would dramatically increase the net benefits of mode shift from auto to other modes (particularly walking). This approach may be justified, as opinions about the value of time borne by individuals can vary greatly.

The monetary values applied by the City of Ottawa need to be updated from 2011 to 2017 dollars, which is straightforward. They also need to be adjusted to reflect Region of Peel conditions, which are different than Ottawa's; however, even in the absence of such updating the unit costs may be reasonably transferable, given that the populations of Ottawa (about 970,000) and Peel (about 1.45 million) are roughly similar, and that both municipalities include urban, suburban and rural areas.

Benefit-cost analysis

The guidance provided by Metrolinx for business case development is comprehensive and detailed, and could be adopted by the Region of Peel for large individual projects (the application for which the guidance is intended). The Metrolinx approach is designed to yield both a benefit-cost ratio and a net present value for a given investment. However, its utility may be more limited for general scenario analysis (e.g. broad mode shifts) or for smaller initiatives (e.g. neighbourhood TDM programs) that do not involve large capital investments.

Appendix C identifies some economic values recommended in the Metrolinx business case documentation that could also be applied to business cases for initiatives in Peel Region.