A Plan for Urban Goods Movement Data in the GTHA

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1. INTRODUCTION

1.1 Urban goods movement in the GTHA

The efficient movement of goods and services in the Greater Toronto and Hamilton Area (GTHA) is essential to the region's economic prosperity and quality of life. However, while governments have long invested in passenger transportation data to support land use and transportation planning, they have not done the same in the realm of freight transportation. Only in recent years have agencies in the GTHA begun to invest seriously in the collection and application of urban goods movement data.

Metrolinx has been working to improve goods movement in the GTHA. Its 2008 Regional Transportation Plan for the GTHA (*The Big Move*) included the development of a comprehensive strategy for goods movement as one of nine priority actions. Its 2011 *Urban Freight Study* identified a strategy for improving freight efficiency and capacity in the GTHA, and recommended the creation of an urban goods movement data collection program and better sharing of data. Metrolinx, Peel Region, Durham Region, Transport Canada and the Ministry of Transportation of Ontario (MTO) have invested directly in initiatives to collect data on urban goods movement. However, despite these efforts, and even though private-sector data on freight movement are also increasingly available, the existing sources of data on urban goods movement are limited in geography, small in scale, and not fully coordinated. A more comprehensive program is needed to support urban goods movement planning and policy.

This report is a partial summary of the detailed technical report Developing Urban Goods Movement Data in the GTHA: Framework and Preliminary Implementation *(Centre for Urban Freight Analysis, University of Toronto, 2013), which readers may download from www.metrolinx.com.*

1.2 The importance of data

Goods movement is affected by a wide range of policies enacted by all orders of government (see **Exhibit 1-1**). Without a fuller understanding of goods movement, which can be provided at least partly through better data, it is difficult to evaluate how broader policies might impact the transport of goods and services, and thus how they might ultimately affect the GTHA's economic health and quality of life.

Urban goods movement data have two key roles in the planning process, as **Exhibit 1-2** illustrates:

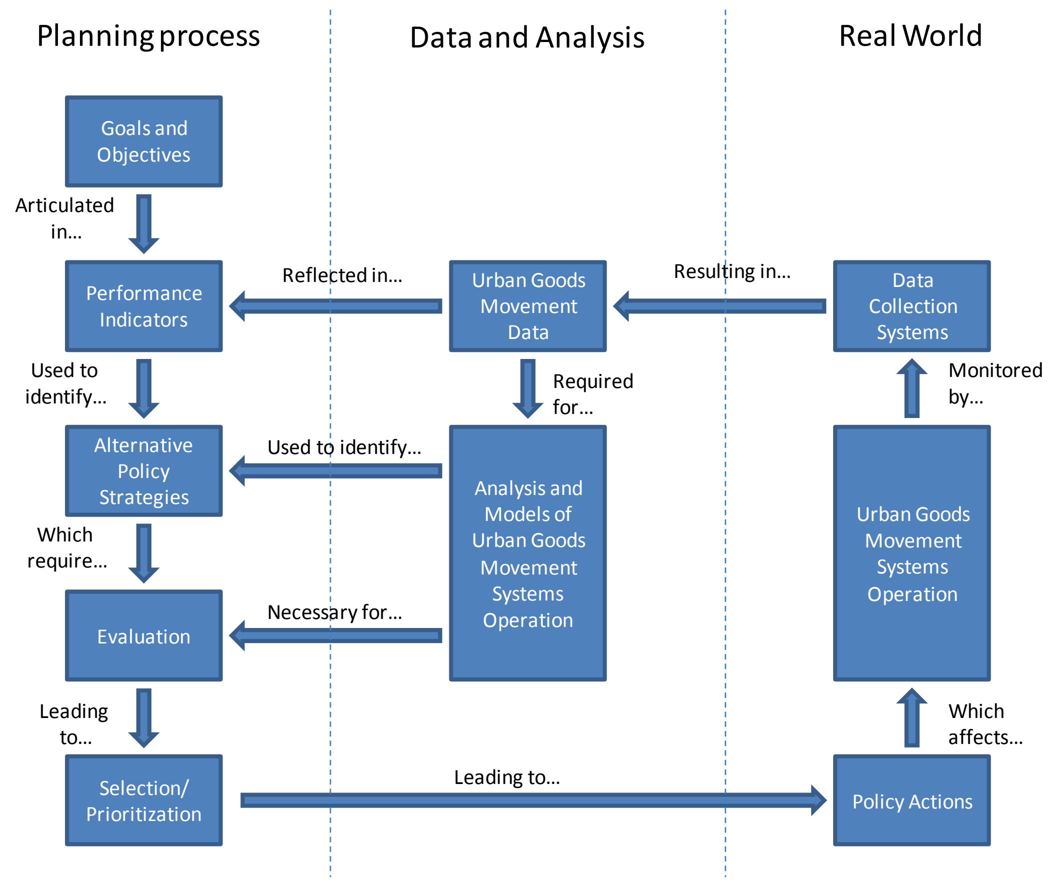
- *To develop performance indicators* for use in monitoring and benchmarking the urban goods movement system
- *To develop models* that capture the most important relationships between urban goods movement system inputs (e.g. employment, land use policies, transportation

infrastructure, regulations) and outputs (e.g. truck flows, greenhouse gas emissions, congestion), allowing us to identify effective planning strategies and quantify their impacts on system performance

Exhibit 1-1: Policies that affect urban goods movement

Infrastructure planning and management	Land use and urban design
• Road expansion • Intermodal terminals • Road and traffic signal design • Truck routes • Lane management (e.g. truck-only lanes) • Parking provision and management	• Freight-supportive land uses • Development approvals • Zoning • Freight villages, hubs, logistics clusters • Urban transportation corridor preservation • Industrial land preservation near freight transportation infrastructure
Demand management	**Economic initiatives**
• Night-time deliveries • Time restrictions on deliveries • Freight consolidation centres • Freight on transit	• Road pricing • Parking rates • Carbon taxes or carbon trading
Production and distribution	**Environmental initiatives**
• Promotion of local food consumption • Home delivery programs	• Green vehicle subsidies • Permitting longer combination vehicles

Exhibit 1-2: The key role of data and analysis in urban goods movement



(Source: M.J. Roorda, T. Rashidi, C. Bachmann, M. Rudra. Developing Urban Goods Movement Data in the GTHA: Framework and Preliminary Implementation. Metrolinx, 2010)

Collecting data on urban goods movement is a complex activity. To make the problem more manageable, it helps to consider the different dimensions of goods movement. **Exhibit 1-3** presents several of the most important dimensions, along with reasons why each one is useful or important.

Exhibit 1-3: Dimensions of urban goods movement

Dimensions	Rationale for use
Unit of analysis (i.e. how to measure goods and services movement)	
• Commodities (measured in value, weight/volume and number of shipments) • Services (measured in value, hours of service and number of visits) • Vehicle trips and tours	• The picture painted using each analysis unit may be quite different, e.g. an auto assembly plant has large production by value, but an aggregate quarry has large production by weight. • Vehicle trips do not follow the same path as the commodities or services involved. Vehicles typically deliver to several receivers in one tour.
Geographic orientation	
• Internal movements • Inbound movements • Outbound movements • Through movements	• The geographic orientation and location of vehicle movements is important in assessing the use of transportation infrastructure and the resulting impacts.
Mode of transportation/distribution channel	
• Car/pickup/van • Truck • Non-motorized • Intermodal	• Each mode provides different levels of service (e.g. cost, speed, loss and damage, frequency, reliability). • Each mode has different impacts on the transportation system (e.g. emissions, pavement damage, noise).
Type of organization that generates the commercial travel	
• Shippers/receivers • Service providers • Transportation/logistics firms • Public sector • Households	• Different organizations generate different flows of goods, services and vehicles. • Different organizations have knowledge of different aspects of commercial flows (e.g. a shipper may know the commodity type and value, but the logistics firm knows the delivery routes).
Timing	

• Timing of goods, services and vehicle movements
  – Arrival/departure time
  – Stop/service duration
  – Time sensitivity
• Variations by time of year
• Variations from year to year
	• Commercial movements vary by time of day, day of week, time of year, and vary over longer time with economic cycles, changes in business patterns, and so on.
	• Time restrictions also have important effects on deliveries.
	• Many urban freight policies are time-related, such as:
	  – Incentives for night-time deliveries
	  – Truck parking or route restrictions by time of day
	  – Road pricing that varies by time
	  – Reduced load limits during spring thaws to prevent pavement damage

1.3 About this plan

Process. Metrolinx retained the Centre for Urban Freight Analysis at the University of Toronto to develop a coordinated urban goods movement data framework that supports performance measurement and modelling, with the ultimate purpose of informing public policy related to urban goods movement in the GTHA. The project involved four major tasks:

- *Summarize background information* on the context for urban goods movement data in the GTHA
- *Review related studies* of GTHA transportation data collection requirements, and consult with stakeholders
- *Propose an urban goods movement data framework* including plans for performance measurement, modelling, data collection and data management
- *Undertake preliminary implementation of the framework*, including some limited data collection

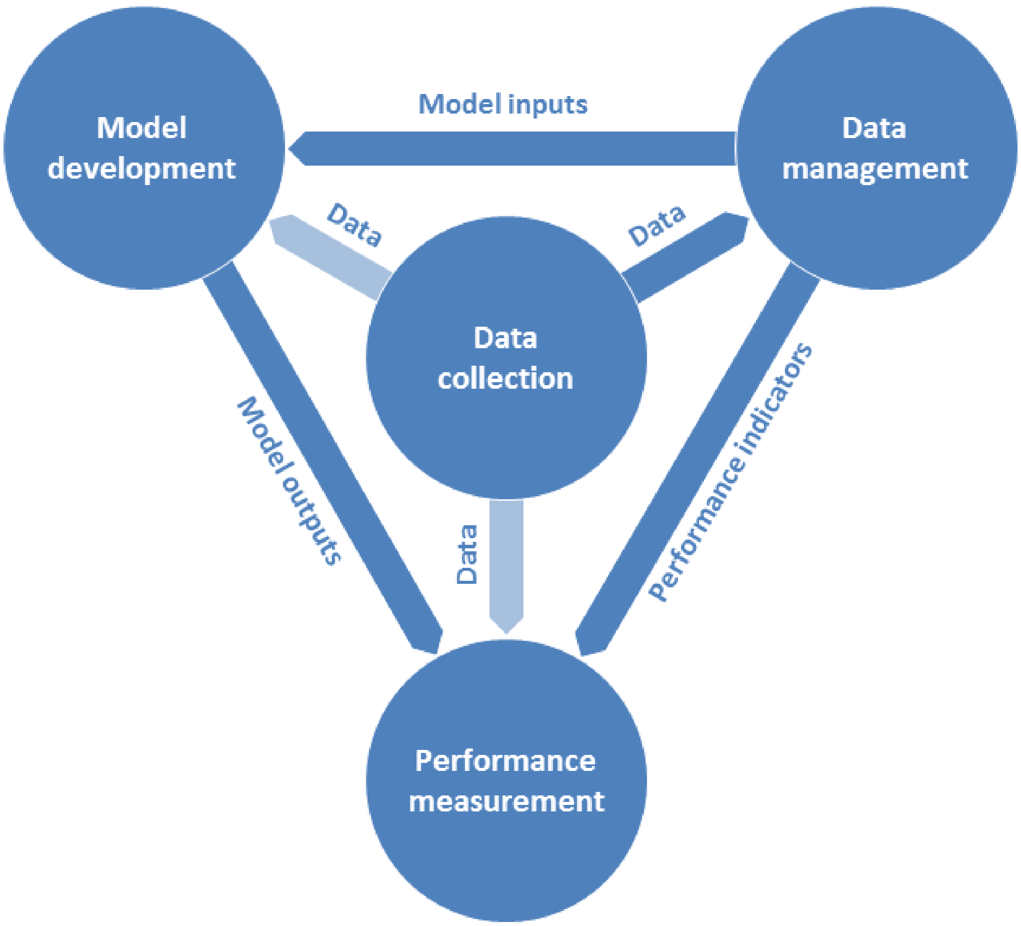
Consultation. Input from all levels of government and industry was an important part of this study, and the urban goods movement data framework incorporates many useful suggestions made by stakeholders. Consultation helped to identify perspectives on modelling and performance measurement, to ensure a solid understanding of existing and potential urban goods movement data collection methods, and to gather a variety of perspectives on how to develop the data framework. The consultation program had four main elements:

- *Stakeholder interviews* – Interviews to identify issues, needs, resources and plans were held with the transportation planning agencies that deliver most of the transportation infrastructure and policy related to urban goods movement in the GTHA (i.e. City of Toronto, City of Hamilton, Peel Region, Halton Region, Durham Region, York Region, MTO's Systems Analysis and Forecasting Office, and MTO's Goods Movement Office).
- *Steering Committee* – An advisory committee met six times, with representatives from Metrolinx, Ryerson University's School of Business, McMaster Institute for Transportation and Logistics, MTO, Peel Region, and Transport Canada's Ontario Region.
- *Extended advisory group* – At four points during the study the Steering Committee was expanded to include representatives from the Canadian Industrial Transportation Association, IBI Group, Resource Systems Group and Transport Canada.
- *Workshops* – The University of Toronto hosted two full-day workshops to present examples of how urban goods movement data can be used for research and policy analysis applications, to obtain feedback on these applications, to give study progress updates, and to build dialogue between public, private and academic sectors on urban goods movement.

Structure. This plan proposes a coordinated framework for urban goods movement data in the GTHA, with four major elements that are related as shown in **Exhibit 1-4**:

- *A plan for performance measurement* (see **Chapter 2**) with several classes of performance indicators including economy and productivity, commodity and service flow, commercial vehicle movement, road network performance, intermodal performance, and environmental and social impact
- *A plan for model development* (see **Chapter 3)** with three main phases that involve an upgraded truck trip-based model, followed by a tour-based microsimulation model, and ending with an agent-based microsimulation model
- *A plan for data collection* (see **Chapter 4**) to support the performance measurement and model development plans
- *A plan for data management* (see **Chapter 5**) to ensure that data are accessible to transportation planners, based on the use of MTO's iCorridor data management system as the platform for consolidating, protecting and disseminating goods movement data

Exhibit 1-4: Elements of the urban goods movement data framework



2. PERFORMANCE MEASUREMENT

2.1 Description and rationale

A primary use of urban goods movement data is to measure the performance of the freight system. For example:

- GPS tracking data can be used to measure average freeway speeds and monitor critical bottlenecks.
- Roadside interview data can be used to measure the total daily value of commodities being moved on a highway.
- Surveys of business establishments can be used to monitor freight production rates in different economic sectors, and in different parts of the region.

Performance measurement helps identify changes in the urban goods movement system that result from changes in policy or shifting background conditions related to urban growth patterns, economic development, business practices or technology. Performance measurement should be repeatable over time and across different geographic areas to allow consistent comparisons.

2.2 Current status

Existing data collection practices enable some performance measurement of the GTHA's freight system in key areas including the overall economy and productivity of business, the flow of commodities and services, the movement of commercial vehicles, and road network performance. However, the effectiveness of performance measurement is limited by infrequent data collection practices, inconsistent practices and datasets across regions, and non-measurement of some key activities (e.g. activity within intermodal terminals). Some key performance data are aggregated centrally (e.g. within MTO's iCorridor System), while others remain dispersed among multiple agencies with varying degrees of accessibility.

2.3 Recommendations

Exhibit 2-1 identifies six classes of recommended performance measurement indicators for urban goods movement in the GTHA. These indicators reflect the various dimensions of urban goods movement presented in Exhibit 1-3:

- *Units of analysis* include commodities, services and vehicle trips and tours.
- *Geographic orientation* is identified by the origin and destination of the commodity or service flows and commercial vehicle movements.
- *Mode of transportation* is explicitly identified and includes the vehicle type for commercial vehicle movements, and the flows into and out of intermodal terminals.

- *The type of organization* generating the commercial travel is identified, in the sense that flows and vehicle movements are linked to shipper, receiver and carrier attributes.
- *Timing* is included. All indicators, other than economic productivity, are collected by time of day. Performance measures are also intended to be collected at regular intervals, to track changes over time.

Exhibit 2-1: Comprehensive list of performance indicators for urban goods movement

Economy/productivity	**Road network performance**
Establishment attributes: • Geographic location • Industry classification(s) • Resources (e.g. vehicles, employees, buildings) • Financial information • Participation in incentive schemes and other government programs	Basic information necessary to compute the majority of road network performance indicators: • Vehicle flow, speed and density by – Vehicle type – Time of day – Weight class • Intersection delays
Commodity/service flow	**Intermodal performance**
• Shipments and services by origin/destination, linked to shipper/receiver/carrier attributes • Commodity and service flow by – Origin-destination pair – Time of day – Commodity type – Road segment – Time sensitivity – Special handling characteristics	Indicators for container drayage (i.e. movement of containers from the intermodal yard by truck): • Vehicles entering/exiting intermodal facilities by time of day • Loaded trips per day • Distribution of turn times at intermodal terminals • Distribution of travel time on drayage trips • Daily hours on duty • Queue length on access roads
Commercial vehicle movement	**Environmental and social impact**
• Commercial vehicles by origin/destination, linked to shipper/receiver/carrier attributes • Commercial vehicle flow by – Time of day – Origin-destination pair – Vehicle type – Road segment • Commercial vehicle stops by – Time of day – Stop dwell time – Stop location/purpose • Commercial vehicle travel times • Commercial vehicle tours • Idle time	Truck-related noise, air quality emissions, GHG emissions and fuel consumption can be estimated as a function of: • Vehicle flow and speed by time of day, by vehicle class • Vehicle characteristics • Physical variables such as distance from the road, presence of embankments and noise walls, road grade, wind speed and direction

3. MODEL DEVELOPMENT

3.1 Description and rationale

Why model urban goods movement?

The value of urban goods movement data can be dramatically enhanced if it is used to develop models of the urban goods movement system. Models add value in four important ways.

Synthesizing diverse datasets. Models are a useful tool to synthesize freight transportation datasets. While it is tempting to imagine that datasets about different aspects of the goods movement system can be “added up” to build a complete picture, this is not accurate. Data have different formats, different levels of precision and varied biases. They are often available only for small samples, they overlap, and are always incomplete or outdated in some respect. A better analogy would be to say that each dataset provides a different and incomplete perspective. While some data will always be missing or conflicting, we can manipulate each dataset using sound analytical methods (as well as the modeller’s judgment) to develop a model that best reflects the most important parts of reality.

Developing a deeper understanding of the current state of the system. Models are important for learning about relationships in the current system, and for making generalizations based on statistical evidence rather than anecdotes. Models of freight generation, for example, can identify the relative transportation intensity of different industry sectors and the most relevant attributes of business establishments.

Forecasting. Models can forecast future demands for goods movement, based on assumptions about the economy, levels of employment and other conditions. In this way they can help identify potential freight bottlenecks, identify new infrastructure requirements or plan maintenance programs. Of course, forecasts involve uncertainty and are limited by the quality of the model structure and inputs—but they are important, given the time it takes to plan and successfully implement changes to freight infrastructure and policy, and in view of the risks of failure.

Scenario analysis. Urban goods movement models are used to test land use, infrastructure or policy scenarios. By changing inputs to the model (for example, by adding freeway lanes or road tolls, or by modifying employment growth projections), we can test the impacts on freight generation, congestion and other outputs that help us understand the possible effects of a policy. Models can also help identify the unintended effects of policies (e.g. a ban on heavy trucks downtown may be intended to reduce congestion, but instead may result in higher volumes of smaller delivery vehicles).

Approaches to modelling

While urban goods movement models have emerged only recently, travel demand models have been used since the 1950s for policy analysis. These models capture the most important aspects of the transportation system and its users, replicate the system behaviour with acceptable accuracy, and forecast how travel demands will respond to changes in infrastructure, land use and other conditions. Typically, they consist of a digital representation of the land use and transportation system, and a series of mathematical equations that emulate the behaviour of people within those systems. These equations define the relationships between inputs (such as land use, employment and population location) and outputs (such as vehicle volumes, toll revenues, congestion levels, pavement damage, noise levels, fuel consumption and air emissions). Data are required to define these mathematical relationships. Several considerations guide the selection of a modelling approach:

- Models should be built with a specific purpose(s) in mind, which will influence the assumptions that are made and the level of detail that is required.
- Models should reflect a reasonable theoretical understanding of the system.
- Models should be policy-sensitive, such that policy changes lead to realistic output changes.
- Model quality should be evaluated through a process of validation, including comparison of model outputs to real-world observations for the current year and for forecast years.
- Models should be upgraded as our understanding of the underlying system evolves and better data become available. A modelling program should be evolutionary and should aim to create ever-better models.

3.2 Current status

Recent goods movement modelling initiatives in the GTHA

Since 1995, several methods have been used to model goods movement in the GTHA :

- The Ministry of Transportation of Ontario (MTO) factors up records from Commercial Vehicle Survey roadside interviews so they reflect seven-day commercial vehicle counts at the survey sites. The MTO estimates that this method results in modelled flows that represent 75% of all commercial travel on the provincial highway system by trucks with a gross vehicle weight exceeding 4,500 kg.
- A Greater Golden Horseshoe model was prepared for MTO by IBI Group in 2007. The model estimates demand for light, medium and heavy trucks over a 12.5-hour period. It used data from the Region of Peel Commercial Travel Survey (for base trip generation rates), land use information (for modification of the base trip generation rates), traffic counts from the cordon count program (for model calibration), MTO Commercial Vehicle Survey data (for external truck trips), and Statistics Canada population and employment

data. A forecasting method was developed to reflect growth in internal truck trips as a function of projected growth in employment and population; it involved an updating procedure for intercity trips to reflect projected GDP growth by industry, Canada-United States trade projections, and the application of a freight generation model.

- The Durham Region Goods Movement Model (2010) uses a method similar to the Greater Golden Horseshoe Model. The model was based on data from the Durham Region Commercial Travel Survey, and was calibrated to reflect local cordon counts.
- A Truck Travel Demand Model (2010) was developed by the University of Toronto as part of a study funded by Infrastructure Canada to assess the potential for exclusive truck lanes in the Central GTA corridor. The model used a method similar to the Greater Golden Horseshoe model, with some enhancements to reflect imprecise trip-end information in the MTO Commercial Vehicle Survey. A multiclass user equilibrium model was used to assign traffic to the road network for morning and afternoon peak hours. The study area was the GTHA, rather than the Greater Golden Horseshoe.
- McMaster Institute for Transportation and Logistics developed a tour-based model for the GTHA in 2010. The model was based on a full inventory of business establishments in the GTHA, and applied models that were either borrowed from the City of Calgary, or were re-estimated using data from the Region of Peel Commercial Travel survey. The model development was limited by the sample size of business establishments that reported commercial vehicle tours in the Region of Peel Commercial Travel Survey.
- The Centre for Urban Freight Analysis at University of Toronto and other academic institutions have conducted research to advance the state of agent-based urban goods movement models.

Each of these modelling approaches reflects the data and experience available at the time. The less sophisticated approaches (i.e. survey data expansion and vehicle trip-based modelling) are operational, but use a simplified representation of the complex urban goods movement system and cover only a limited number of the dimensions outlined in Exhibit 1-3. The more sophisticated approaches (i.e. tour-based microsimulation modelling and agent-based modelling) attempt to more fully reflect the complexity of the real world, but cannot be considered fully operational because of data limitations. Improving current simplified approaches, while experimenting with and planning for more sophisticated approaches, is a suitable way to move forward.

Existing Greater Golden Horseshoe Model

The currently operational urban goods movement model for the GTHA is MTO’s Greater Golden Horseshoe model. This model provides a sound starting point for further development because:

- It considers both urban and inter-urban commercial vehicle movements in the GTHA urban area.

- It is tied to zonal employment by industry type, which is an important indicator of economic activity.
- It incorporates long-distance truck trips from the Commercial Vehicle Survey, which is the best available information on intercity highway flows.

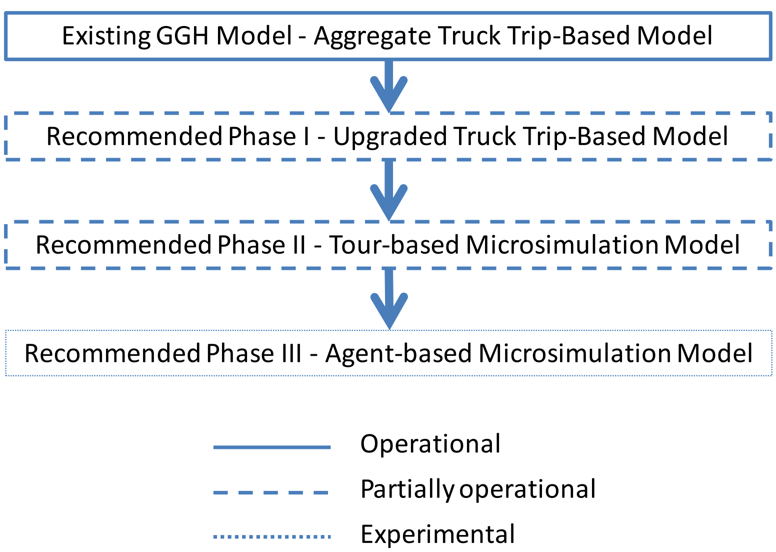
However, it is important to recognize that the Greater Golden Horseshoe model has some important limitations:

- It is based on data from a relatively small survey in the Region of Peel, not the wider GTHA. This necessitates simplified approaches, and assumes the validity of applying local data to a much wider area.
- Some key aspects of the model (e.g. truck trip generation, trip distribution, truck assignment to different routes, time of day consideration) could benefit from greater complexity, sensitivity and calibration.
- The model's treatment of commercial vehicle tours, non-truck commercial travel, and "special generators" (e.g. Pearson International Airport, intermodal facilities, very large manufacturers) is lacking.

3.3 Recommendations

This plan recommends a three-phase progression of model development for the GTHA, as shown in **Exhibit 3-1**. This reflects an evolutionary approach to modelling, and builds on the current simplified but operational approach to develop newer, upgraded methods as better information and experience becomes available.

Exhibit 3-1: Phased modelling approach



Phase I. Upgrading of the existing Greater Golden Horseshoe model is recommended to address the limitations noted in the previous section. The upgraded model should:

- Use data from across the GTHA to improve the model's generation of truck trips and distribution of trip lengths
- Give greater consideration or representation to different industry classes and sizes of firms, the value of time for toll road users, special generators, external gateway trips, and freight flow forecasts at marine, intermodal and border crossing ports
- Assign commercial vehicle and passenger vehicle trips simultaneously
- Assess the quality of its forecasts

Most of these improvements could be made with existing data, and would not change the structure of the existing Greater Golden Horseshoe model. They would, however, improve the quality of model outputs because the model would be based on more up-to-date data from across the GTHA.

Phase II. It is recommended that the simplified model of Phase I be replaced with a tour-based microsimulation model. A preliminary effort to develop such a model has been undertaken by the McMaster Institute for Transportation and Logistics, but that model could not be fully adapted to local conditions because of a lack of data. A tour-based microsimulation model has several advantages:

- Biases due to aggregation are reduced because the microsimulation method explicitly represents individual business establishments.
- Pickup and delivery tours are explicitly represented, leading to more accurate truck movement forecasts.
- Goods movements and services movements are accounted for separately, allowing (for example) better assessment of scenarios that reflect an economic shift from manufacturing to service industries.
- Tour-based models allocate travel throughout the day (compared with truck trip models which typically do not distinguish between times of day, or focus on AM and PM peak hours only). The model could therefore project the effects of peak spreading.
- The model would respond to (for example) changes in road network capacity or employment distribution, and would identify changes to tour generation, trip start time, tour purpose, vehicle type choice, stop purpose and stop location. This range of sensitivities is wider than that provided by aggregate truck trip-based models.

Phase III. Further investment in research is recommended to support development of an agent-based microsimulation model. This approach is currently experimental, but would be more sophisticated and possibly more policy-sensitive. Agent-based microsimulation models have several advantages over tour-based microsimulation models:

- The fleet size, building floor area, location and employment of business establishments are considered. This could allow analysis of the effects of taxation, zoning by-laws and transportation infrastructure on business establishment growth and location change.

- Interactions between freight agents in freight markets are considered (e.g. contract relationships between shippers and carriers, or trade in commodities and services between firms). The potential exists to assess how growth in one industry sector can lead to growth for businesses in other sectors.
- Logistics are incorporated in the modelling approach, including a more realistic representation of warehouses and distribution centres, inventory, truck tours and load scheduling. This could lead to more accurate truck forecasts.
- Supply chains are represented, meaning that the effects of transportation infrastructure improvements on supply chains could be assessed.

Exhibit 3-2 summarizes the recommended model evolution in terms of the incremental features to be added at each phase.

Exhibit 3-2: Incremental features of model development

Model feature	Existing aggregate truck trip-based model	Incremental improvements by phase		
		Phase I: Upgraded truck trip-based model	Phase II: Tour-based microsimulation model	Phase III: Agent-based microsimulation model
Level of aggregation	• Aggregate zone based model	• Disaggregate establishment based models, but applied at the zonal level	• Disaggregate establishment-based models applied in a microsimulation framework	—
Unit of analysis	• Vehicle trips (light, medium, heavy trucks)	—	• Vehicle tours (light, medium and heavy; services and goods)	• Shipments, services and vehicle tours
Establishment characterization	• 4 categories of industry class	• Additional categories of industry class • Distinction of large versus small/ medium size firms	• Explicit treatment of special generators • Explicit treatment of carriers	• Endogenous treatment of establishments on the basis of commercial fleet, warehousing, production facilities, and contracts with other firms
Trip/tour/ shipment generation	• Trip generation single-variable trip rate model based on employment and number of households	• Trip generation multivariate regression model with an intercept, employment, location and other establishment variables	• Tour generation multivariate regression model with an intercept, employment, location and other establishment variables	• Shipment generation model with carrier selection, shipment scheduling and logistics model

Exhibit 3-2: Incremental features of model development				
Model feature	**Existing aggregate truck trip-based model**	**Incremental improvements by phase**		
		Phase I: Upgraded truck trip-based model	**Phase II: Tour-based microsimulation model**	**Phase III: Agent-based microsimulation model**
Trip distribution/ stop location	• Gravity model data from Phoenix, AZ used as reference for trip distribution model	• Gravity model, GTHA survey trip and shipment O-D data, and TCOD data used as reference for trip distribution model	• Trip distribution is an outcome of the next stop location model	• Shipment distribution based on simulated contracts between firms • Trip distribution is an outcome of logistics model
Trip assignment	• All-or-nothing trip assignment model (does not account for congestion)	• Multiclass user-equilibrium assignment model (accounts for congestion, value of time)	—	—
External gateway trips	• Based on data from 2006 MTO Commercial Vehicle Survey with limited O-D precision	• Based on data from 2011 MTO Commercial Vehicle Survey with refined O-D precision	—	• Based on a market model of commodity flow through the provincial/national economy
Special generation	• No treatment of special generators	• Explicit treatment of special generators	• Explicit treatment of couriers and public sector fleets	• Special generators treated as explicit agents
Supply chain	• Not represented	—	—	• Represented
Model calibration	• Calibrated to reflect GTA cordon counts	• Calibrated to reflect GTA cordon counts, MTO traffic counts, and other count sources	—	—
Model validation	• No formal model validation	• "Backcasting" validation of model forecasts on earlier data	—	—

4. DATA COLLECTION

4.1 Description and rationale

Fulfillment of the performance measurement and model development elements of this framework would require new efforts to collect data on urban goods movement. This can be done in a variety of ways, and by a wide range of stakeholders.

4.2 Current status

The following paragraphs describe a number of recent efforts to collect urban goods movement data in the GTHA. These include roadside intercept surveys, establishment surveys, truck commodity origin-destination surveys, truck count data, and data collected via on-vehicle technology. A number of other surveys of specialized commercial vehicles have also taken place.

MTO Commercial Vehicle Survey (1995, 2001, 2006, 2012). The MTO Commercial Vehicle Survey (CVS) is a province-wide roadside vehicle survey conducted about every five years since 1995, in coordination with the National Roadside Survey. The most recent CVS was conducted at about 150 roadside sites in Ontario, including about 10 sites in the GTHA. Truck drivers report on themselves, their vehicle, carrier and commodity, as well as their origin, destination and route. The CVS is estimated to capture about 75% of the vehicle-kilometres of truck travel on provincial highways in the GTHA. Interview data from the CVS are expanded to reflect the seven-day continuous traffic vehicle classification counts that are collected at survey sites. Only trucks with a gross vehicle weight of 4,500 kg or more are sampled, so light trucks, pickups, cars and other small commercial vehicles are excluded.

Region of Peel (2006-2007) and Region of Durham (2009) Commercial Travel Surveys. The Region of Peel Commercial Travel Survey collected information from 600 business establishments and 100 truck drivers in the Region of Peel. The survey consisted of a mail-back survey sent to selected firms, which responded with information about the firm and all shipments and services delivered or received on the previous day. A survey of the commercial vehicle drivers for that firm gathered details of the tours they made. Some vehicles were outfitted with an electronic recorder that collected GPS location information and engine information over the course of one week. The Peel survey was later enhanced for the Region of Durham and delivered to a sample of about 500 business establishments.

Trucking Commodity Origin-Destination Survey (annual). This Statistics Canada survey measures commodity movements and outputs of the Canadian trucking industry. It collects total tonnage by commodity type, and revenue by shipment origin and destination. Trucking companies in the business register having at least $1.3 million in annual revenue are included in the scope of the survey. Its primary limitation is the confidentiality of carrier firm attributes and shipment origins and destinations. It also fails to obtain information about vehicle movements, which differ from commodity flows in an urban area. In 2010, this survey involved a sample size of about 2,800 establishments.

Truck count data (various years). Several GTHA count programs provide valuable data:

- The City of Toronto and the Regions of Durham, York, Peel and Halton participate in the GTA Cordon Count program, conducted every two to three years on all roads crossing cordons throughout the GTA. The counts classify different types of vehicles including light, medium and heavy trucks.
- The MTO collects road count data through its Traffic Volume Information System over three seasons, then compiles them to produce estimates of annual average daily traffic.
- The MTO's COMPASS freeway traffic management system collects commercial vehicle counts using inductance loops embedded in the pavement on freeways, entrance and exit ramps, and transfer roads. As well, the City of Toronto's RESCUE system collects similar information on the Gardiner Expressway, the Don Valley Parkway and major arterials in Toronto. These counts do not classify trucks separately from passenger vehicles.
- Local and regional municipalities periodically collect intersection count data including all car and truck movements, but without distinguishing different truck sizes or configurations.

Data collected using on-vehicle technology (continuous data stream). MTO purchases GPS data for commercial fleets from third-party providers. The data are collected by devices installed for corporate purposes and impose no additional burden on drivers. The data are compiled in the iCorridor system to provide a record of roadway performance. They offer precise spatial and temporal information, but do not include any information about the establishment, the vehicle, its contents or the purpose of any stops.

Canadian Vehicle Use Survey (2013). Transport Canada's Canadian Vehicle Use Survey includes surveys of randomly selected passenger cars and commercial vehicles across the country. The passenger car survey was launched in 2012, and the commercial vehicle survey is being tested in 2013. The survey collects digital data through on-vehicle data loggers rather than paper surveys. Commercial vehicle data collected includes time, geographical position, distance travelled, speed, fuel consumed, vehicle configuration and body style, and trip information including reasons for stops, cargo weight or volume, cargo commodity class and fuel costs.

4.3 Recommendations

Data collection for performance measurement. For each class of performance indicator identified in Exhibit 2-1 above, **Exhibit 4-1** describes the relevant existing data and the additional data that are recommended to be collected.

Exhibit 4-1: Data collection for performance measurement indicators

Indicator class	Indicators	Existing data	Additional data needed
Economy/ productivity	Establishment attributes including: • Geographic location • Industry classification(s) • Resources (e.g. vehicles, employees, buildings) • Financial information • Participation in incentive schemes and other government programs	• InfoCanada • Quarterly Trucking Survey & Annual Motor Carriers of Freight Survey • Municipal business registries • Region of Peel and Durham Commercial Travel Surveys	• Consolidated tracking of business establishments across the GTHA (purchased InfoCanada data or streamlined/acquired municipal business registry information) • Survey of establishments across the GTHA using the same instruments as used in the Region of Peel and Region of Durham studies
Commodity/ service flow	• Shipments and services by origin/destination, linked to shipper/ receiver/carrier attributes • Commodity and service flow by – Origin-destination pair – Time of day – Commodity type – Road segment – Time sensitivity – Special handling characteristics	• Trucking Commodity Origin Destination Survey • Region of Peel/Durham Commercial Travel Surveys • MTO Commercial Vehicle Survey	• Survey of establishments across the GTHA using the same instruments as used in the Region of Peel and Region of Durham studies
Commercial vehicle movement	• Commercial vehicles by origin/destination, linked to shipper/receiver/ carrier attributes • Commercial vehicle flow by – Time of day – Origin-destination pair – Vehicle type – Road segment • Commercial vehicle stops by – Time of day – Stop dwell time – Stop location/ purpose • Commercial vehicle travel times • Commercial vehicle tours • Idle time	• Data from third-party GPS data providers • Region of Peel and Region of Durham Commercial Vehicle Surveys • MTO Commercial Vehicle Survey	• Survey of establishments across the GTHA, using the same instruments as used in the Region of Peel and Region of Durham studies

Exhibit 4-1: Data collection for performance measurement indicators			
Indicator class	**Indicators**	**Existing data**	**Additional data needed**
Road network performance	Basic information necessary to compute the majority of road network performance indicators includes: • Vehicle flow, speed and density by – Vehicle type – Time of day – Weight class • Intersection delays	• GTA Cordon Count Program • MTO Traffic Volume Information System Counts • MTO Commercial Vehicle Survey • GPS data purchased by MTO • COMPASS/ RESCUE freeway traffic management system	• Extend GTA Cordon count time period and harmonize with MTO counts • Additional MTO Commercial Vehicle Survey data collection sites in the GTHA • No additional data collection recommended. However, additional processing / fusion of existing data could add value
Intermodal performance	Indicators for container drayage are as follows: • Vehicles entering/ exiting intermodal facilities • Loaded trips per day • Distribution of turn times at intermodal terminals • Distribution of travel time on drayage trips • Daily hours on duty • Queue length on access roads	• No recent data (MTO Commercial Vehicle Survey last included data collection sites at intermodal terminals in 2001)	• Roadside intercept survey at intermodal terminals
Environmental and social impact	Truck related noise, air quality emissions, GHG emissions and fuel consumption can be estimated as a function of: • Vehicle flow and speed by time of day, by vehicle class • Vehicle characteristics • Physical variables such as distance from the road to the prediction point, embankments and noise walls, road grade, wind speed and direction	*Same as for commercial vehicle movement/road network performance (above)*	*Same as for commercial vehicle movement/road network performance (above)*

Data collection for model development. Exhibit 4-2 presents the incremental data requirements for each phase and model feature, and **Exhibit 4-3** presents the detailed data collection needs to support Phases I through III of the model development plan.

Exhibit 4-2: Incremental data requirements for model development

Model feature	**Existing Greater Golden Horseshoe Model** (aggregate truck trip-based model)	**Phase I: New data** (upgraded truck trip-based model)	**Phase II: New data** (tour-based microsimulation model)	**Phase III: New data** (agent-based microsimulation model)
Establishment characterization	Population, employment (by industry class), and land use of traffic zones	—	Establishment database with individual establishment attributes	Longitudinal data describing the changes in firm attributes (fleet acquisition, firm growth, firm location change)
Trip/tour/ shipment generation	Trip generation, employment, industry class for shippers, service providers, receivers	—	Tour generation, stop attributes and establishment attributes for shippers, service providers, receivers and carriers	Vendor selection data, carrier selection data, shipment generation, shipment frequency
Trip distribution/ stop location	Trip distribution parameters from Quick Response Freight Manual	Trip origins and destinations	Origin and destination of stops in sequence for each tour	Origin and destination of shipments
Trip assignment	Road network data	Road network data and value of time estimates	—	—
External gateway trips	Roadside survey	Roadside survey, survey of trucks at truck/rail and airport intermodal terminals	—	Provincial/ national commodity flow data
Special generation	—	Survey of large transportation intensive firms	Trip records of couriers and public sector fleets	—
Supply chain	—	—	—	Vendor/carrier selection data
Model calibration	Commercial Vehicle Road Counts	Commercial Vehicle Road Counts	—	—
Model validation	—	Previous year data including: establishment characteristics; external gateway trips; special generation and commercial vehicle road counts	—	—

Exhibit 4-3: Data collection for model development		
Data Requirements	**Existing Data**	**Additional Data Needed**
Phase I		
Population, employment and land use data	• Statistics Canada • Transportation Tomorrow Survey • Land use maps, e.g. from official plans	• Statistics Canada data acquired with employment data by industry class by traffic zone • Projections of population, employment, land use for specific projects
Survey of establishments in the GTHA • ***Shippers/receivers/ service providers***	• Region of Peel Commercial Travel Survey • Region of Durham Commercial Travel Survey	• Survey of small/medium size establishments across the GTHA, using same instrument as for Region of Peel and Region of Durham studies with minor adjustments • Partnership development and in-depth interviews with large size firms
Survey of establishments in the GTHA • ***Carriers***	• Transport Canada's Trucking Commodity Origin Destination Survey	• Survey of carriers using data collection technique that is compatible with that of survey of shippers/receivers/service providers
Survey of vehicle operators at external gateways to the GTHA	• MTO Commercial Vehicle Survey	• Additional roadside data collection sites at urban area boundaries to support model development • Additional roadside data collection sites at entrances to all truck/rail and airport intermodal terminals • Enhanced data collection for light commercial vehicles at data collection sites
Commercial vehicle road counts throughout the GTHA	• Cordon count program • MTO Traffic Volume Information System counts • COMPASS and RESCUE automated counts • Municipal intersection counts	• Extension of cordon count program to 24 hours • Improved consistency in counts of light trucks • Upgrade loop detector data processing to distinguish truck classification
Phase II		
Trip records of couriers/messengers	• Private datasets	• Request datasets as needed for project specific purposes with specific rationale
Trip records of public fleets	• Unknown	• Consolidate datasets
Phase III		
Longitudinal data showing changes in firm attributes over time	• Statistics Canada business registry	• Retrospective survey of major decisions of establishments
Vendor selection and carrier selection data	• Freight Market Interactions Survey (2011)	• Qualitative surveys leading to better understanding of the supply chain
Provincial/national commodity flow data	• Transport Canada Trucking Commodity Origin Destination Survey	• Consider a commodity flow survey or extend the proposed GTHA approach over the province/nation

Note: A preliminary, partial implementation of the data collection plan was undertaken within the scope of the framework development. This work included an establishment survey of a sample of 1,006 small and medium-size firms, and in-depth interviews conducted on a sample of twelve large firms. The survey included information about the establishment, detailed information about inbound and outbound shipments, and commercial vehicle trips and tours (for private fleets). The interviews gathered information on establishments, inbound and outbound shipments, commercial vehicle movements, and supply chain issues. These aspects of the framework were selected for implementation because they contribute to many of the performance measurement and modelling needs. Other data collection recommended for the framework is considered to be either less critical, more specific in focus, or more suitably collected by agencies with greater experience.

5. DATA MANAGEMENT

5.1 Description and rationale

Data management includes three major elements: data consolidation, privacy protection, and data sharing and dissemination. These elements are discussed in the following paragraphs.

Data consolidation involves bringing urban goods movement data into a single place, and preparing consistent formal documentation. Consolidation is an important part of data management because the diverse agencies that collect urban goods movement data for specific projects may not have the resources or expertise to disseminate the information while maintaining appropriate data protection. Consolidating data in one place also has the benefit of increasing stakeholder awareness of the information available, promoting its appropriate use, and facilitating collaborative stakeholder contributions of new data that are consistent with existing datasets. Data should be consolidated by an agency that has systems to ensure data protection and facilitate data dissemination, as discussed below.

Privacy protection preserves the confidentiality of survey respondents. Three methods can help ensure that information on individual business establishments cannot be extracted from the disseminated data:

- *Aggregation* can be applied so that database queries return summaries of information from multiple business establishments at the same time. For example, reporting aggregate sales revenue for 20 retail businesses in a planning district would not allow an analyst to identify the sales volume of any single establishment.
- *Suppression* withholds the results of queries that provide enough information to identify individual respondent information. Suppression can be applied in cases where so few individual records exist in a particular category that, even with aggregation, individual business establishments could be identified. For example, where there are only two retail businesses in a neighbourhood, reporting aggregate sales for those two establishments would allow either business to calculate their competitor's sales volume.
- *Alteration* involves changing data in minor ways to prevent individual respondents from being identified. For example, Statistics Canada maintains the confidentiality of count statistics by randomly rounding small counts. The drawback of random rounding is that inaccuracies are introduced into the dataset.

Data sharing and dissemination allow transportation planning agencies, universities and other organizations to conduct evidence-based research and planning studies using data collected by other agencies. Data sharing reduces data collection overlap and the wasting of resources. Data sharing and dissemination should provide appropriate access while fully complying with data privacy considerations described above. For this reason, dissemination methods should have several key attributes:

- *Data security* – Private data (in particular micro-level information in which respondents can be identified) must be held on secure, tamper-proof computing facilities, with appropriate firewalls to prevent unauthorized access.
- *Access control* – Differential access should be considered for different data users (for example, university researchers and government agencies may be permitted to have greater access to more detailed information than the general public). A robust data dissemination system must be capable of providing differential access.
- *Data availability* – Non-private information should be shared and disseminated broadly, to maximize the value of public investments in data collection.
- *Ease of use* – Data sharing should be convenient, timely and inexpensive. Duplication of dissemination efforts should be avoided.
- *Mutual benefit* – Because data collection requires substantial investment, reciprocal transfers of data should be encouraged wherever possible. Data sharing arrangements are more likely to be successful than one-way "data giving" arrangements.
- *Flexibility* – Users should have flexibility in how data are represented, since there are a variety of different potential uses of the data (e.g. different modelling approaches, performance indicator analysis, or simple visual summaries to gain an understanding of urban goods movement).
- *Documentation of use* – Uses of data should be properly documented to articulate the benefits (i.e. the return on investment) for the agency collecting the data. Proper documentation of the benefits increases the chances of a sustained data collection program.

5.2 Current status

There are two existing data management programs that work to consolidate, protect and disseminate transportation data in the GTHA.

Data Management Group (DMG). The DMG at the University of Toronto collects, protects and disseminates household travel data from the Transportation Tomorrow Survey (TTS) and consolidates and disseminates traffic count data from the GTA cordon count program. TTS survey data summaries from 1986 through 2006 are currently available through the DMG's Internet data retrieval system, and cordon count data are available through the DMG's cordon count data retrieval system. Both systems allow authorized users to log in and conduct dynamic queries to obtain customized data summaries.

Data protection is paramount for the Data Management Group. All queries on TTS data (which can access household, person or trip-level datasets) are aggregated geographically to a system of traffic zones, thereby precluding any identifiable information about individual respondents. Individual survey records from the TTS are suppressed to maintain confidentiality. Cordon count data do not involve private information, so no such privacy controls are necessary. All private data at the DMG are protected by strong firewalls.

MTO iCorridor System. The iCorridor system consolidates and disseminates information collected on provincial highways and other major roads within the province, including historical data, real-time data and future predictions (see **Exhibit 5-1** for a full list of iCorridor data related to urban goods movement). The system is accessible through a web interface, where users select data using a drop-down menu and sidebar for graphical presentation in a browser window. Public access is currently available for users who agree to the system's terms and conditions of use, and the system is being upgraded to provide advanced data security and analytical functions.

Exhibit 5-1: Freight-related data available through iCorridor
Historical passenger/commercial vehicle travel speeds
Road performance measures: • Buffer time index for passenger/commercial vehicles • Travel time index for commercial vehicles
MTO Commercial Vehicle Surveys leading to estimates of: • Annual average daily truck traffic (2006, 2008) • Equivalent single axle loads (2006, 2026)
Border crossing information for all Canada-United States border crossings
Ontario highway traffic forecasts: • Annual average daily traffic (2031) • Level of service (2006, 2031)
Ontario-Quebec continental gateway data: • Congestion duration index
MTO traffic volume information system data: • Annual average daily traffic (1988, 1998, 2008)
Real-time traffic information: • Closures and restrictions • Traffic and road information • Traffic cameras • Carpool lots • Service centres
Provincial highway expansion prioritization • Annual average daily traffic (2008) • Annual average daily truck traffic (2008) • Value of goods (2008)
North America-wide truck travel speed (July 2011)
Regional summaries of provincial highway performance • Census division level • Census sub-division level

5.3 Recommendations

Use of MTO's iCorridor data management system

It is recommended that urban goods movement data be consolidated, protected and disseminated using the iCorridor data management system. This approach is recommended for several reasons:

- iCorridor is maintained by MTO's Systems Analysis and Forecasting Office, which has experience with data collection, analysis and modelling. The Office is a prime user of urban goods movement data and has an interest in high-quality data management.
- iCorridor already consolidates a variety of urban goods movement data, including:
  - MTO Commercial Vehicle Survey data
  - Truck GPS-based road performance measures
  - Annual average daily traffic summaries based on traffic counts
  - Border crossing information
  - Congestion measures
  - Highway expansion priorities
- iCorridor provides data security, and is supported by an IT/data security team that is well-positioned to prevent breaches of data privacy.
- iCorridor has a system for password-protected access control that allows different levels of access for different users.
- iCorridor is easy to use and provides flexibility. Its GIS-based mapping engine allows flexible visualization of geographic information. While current data are generally accessed as road-based attributes (e.g. traffic volume or speed for each roadway segment), it is also possible to display location-based information (e.g. truck trips generated from a specific planning district).

The TTS data retrieval system is also secure, provides strong access control and is maintained by the University of Toronto's qualified and experienced Data Management Group. However, it has not been used to accumulate and disseminate freight data, and its querying system is not easily adaptable to datasets other than household travel as generated by the TTS. It also does not provide a mapping engine for online visualization.

The iCorridor system is not designed to support dynamic online querying (i.e. user-defined queries that directly access the microdata, as can be done with TTS data). Given the current iCorridor system design, all available summaries must be generated in advance and stored. This limitation does reduce flexibility, but protects against inadvertent breaches of privacy that could occur in a system that supports dynamic online querying.

Consolidation of establishment data

The iCorridor system has already consolidated several of the urban goods movement data sources, as shown in Exhibit 5-1. All new urban goods movement data recommended in this framework should continue to be consolidated in iCorridor. The first priority should be to integrate the following databases that would be of greatest benefit for urban goods movement modelling:

- The 2007 Region of Peel Commercial Travel Survey (597 establishments in the Region of Peel)
- The 2010 Goods Movement Survey of Durham Region's Long Term Transit Strategy (500 establishments in the Durham Region)
- The 2012 GTHA Commercial Travel Survey (1,006 establishments across all regions of the GTHA, collected during development of this framework as noted at the end of Section 4.3)

Dissemination of establishment data

It is recommended that data be disseminated from the three establishment-based data sources outlined in the previous section. Four types of data summary should be disseminated through iCorridor:

- *Summary statistics* including the count, total, mean or standard deviation of variables in the database. Summary statistics should be disaggregated by geographic location, number of employees and industry class of the establishment, commodity type or vehicle type. If disaggregated on the basis of geographic location, maps could be an outcome of these queries.
- *One-dimensional frequency distributions* summarizing the total number of records (e.g. establishments, shipments or trips) or the shipment weight or value, against one of many available disaggregation attributes. These frequency distributions are useful for developing control totals for origin-destination tables and other two-dimensional cross tabulations (see the next point). If disaggregated on the basis of geographic location, maps could be an outcome of these queries.
- *Two-dimensional cross tabulations* summarizing the number of survey records (e.g. establishments, shipments or trips) or the shipment weight/value for each cross-classification of two selected attributes. Examples include origin-destination trip tables or origin-destination commodity flow tables. Such tabulations also include cross-sectional analysis outputs, such as number of trips by industry class and number of employees.
- *Data documentation* to precisely define all variables in the dataset, including classification schemes and non-response codes.

Protection of establishment data

Data aggregation is recommended as the means of preserving data privacy. Establishment data summary statistics should be aggregated by four important attributes:

- Geographic location – by planning district (of which there are 46 across the GTHA)
- Number of employees – 1 to 4, 5 to 9, 10 to 49, 50 to 99, and 100 or more
- Industry type – using the two-digit 2012 North American Industry Classification System
- Commodity type – using the classification system from the GTHA Commercial Travel Survey

Integration of other urban goods movement data

It is recommended that other urban goods movement data that are collected should be integrated into iCorridor as they become available. The form of dissemination would depend on the type of data, the type of dissemination format, and the measures necessary to ensure data protection. **Exhibit 5-2** suggests means of disseminating different types of data.

Exhibit 5-2: Data dissemination recommendations

Type of data	Dissemination method
Population, employment (by industry class) and land use data (by traffic zone)	Present data as thematic maps, showing zonal population, employment, by industry class and land use data for each zone of the GTHA.
Commercial vehicle road counts throughout the GTHA	After harmonization, the most effective means of presenting count data should be researched and applied. Counts could be effectively disseminated as an attribute of a roadway segment represented in the iCorridor road network, but could be usefully provided in tabular format. Counts should be disseminated by time of day, by vehicle classification, by direction, with specific information about the date of the count, and documentation of the counting method and any adjustments that have been made as part of a harmonization procedure. Cordon count data are already effectively disseminated through the Data Management Group's cordon count data retrieval system.
Trip records of public fleets	Depending on confidentiality requirements, the number of trips on each roadway segment could be provided for each fleet of public vehicles (e.g. garbage collection, parks and recreation) for each applicable time period.
Trip records of couriers/messengers	Raw data are unlikely to be disseminated because of confidentiality issues. Dissemination of aggregated data would depend on the nature of the data.
Longitudinal data showing changes in firm attributes over time	
Vendor selection data	
Carrier selection data	
Provincial/national commodity flow data	Dissemination could proceed in a similar manner to that discussed in Section 5.3 for establishment data.

6. IMPLEMENTING THE FRAMEWORK

Implementation of this framework would markedly improve the state of urban goods movement data in the GTHA. It would enable performance measurement and model development that would ultimately provide a much stronger information platform for supportive public policy.

6.1 Governance

Three bodies are required to guide the implementation of this plan:

- A steering committee
- An implementation committee
- A stakeholder group

A steering committee should be formed to provide strategic direction and oversight. This committee should represent the key government agencies and institutions that are responsible for urban goods movement data, modelling, analysis and policy including Metrolinx, MTO, Transport Canada, the Cities of Toronto and Hamilton, the Regions of Durham, Halton, Peel and York, and academic institutions involved in urban goods movement analysis in the GTHA. The steering committee should review the framework regularly (e.g. every five years), and ensure that it responds to and evolves with advances in data collection methodology, modelling methods, technology, government policy, and significant changes in business and logistics practices. The steering committee should be responsible for selecting priorities and organizing the necessary funding for framework implementation.

An implementation committee should include members of the same agencies as the steering committee, and should be responsible for implementing the priorities established by the steering committee. It should:

- Ensure that data collection takes place in accordance with the recommendations of this report and the direction of the steering committee
- Collaborate to harmonize the data collection and modelling among agencies, and to promote common definitions, methods, survey instruments and modelling techniques
- Ensure that data are integrated into the data dissemination system for protection and sharing
- Report regularly to the steering committee and stakeholder group on progress and outcomes in data collection and model development

A stakeholder group (e.g. the GTHA Urban Freight Forum) should be regularly informed of the implementation and development of the framework, and of progress towards achievement of regional and provincial urban goods movement policies.

6.2 Next steps

Implementation plan

A more detailed plan should be developed to confirm a schedule and budget for implementation of this framework. The implementation plan should include:

- Identification of stakeholders responsible for coordinating delivery of the different program components across the GTHA, and any new partnerships
- Valuation of the data collection components to understand the costs and benefits of each data collection exercise, and to identify those that provide greatest value
- Detailed costing for prioritized items including data collection, modelling improvements, performance measurement analysis, maintaining existing data sources, and managing newly collected data
- An approach to ongoing and appropriately distributed funding for continued implementation of the framework
- A schedule for implementing improvements to the performance measurement program and model upgrades, considering timelines of associated inputs and any dependencies
- A schedule for data collection to support these improvements

Scope and quality control standards for performance measurement and model development

The Steering Committee should research and provide recommendations on the scope and quality control standards for performance measurement and model development.

For performance measurement, the Steering Committee should:

- Identify the scope of a comprehensive and regularly updated system of performance measurement, with effective means of data summarization and visualization
- Prioritize the performance indicators providing greatest support for specific urban goods movement policy needs
- Identify the most effective means of data summarization and visualization
- Identify sample sizes and frequencies of data collection suitable for robust and timely performance measurement

For model development, the Steering Committee should:

- Determine the preferred study area of the urban goods movement model
- Develop detailed model specifications, calibration and validation techniques, based on the investigation of model calibration and validation methods beyond the use of truck counts (e.g. using external estimates of total regional vehicle-kilometres travelled from fuel sales data, GPS data or other sources)
- Develop calibration and validation quality standards to be met in model development

- Ensure integration of the urban goods movement model with provincial and national forecasting approaches, forecasting of freight flows at marine, intermodal or border-crossing ports, and regional population and employment growth forecasts
- Identify potential methods for data fusion to integrate data sources for modelling
- Promote continued investigation of emerging urban goods movement modelling methods such as agent-based methods, the use of GPS data for model development, and supply chain models
- Conduct a formal analysis of sample size for each data collection technique to adequately support each phase of model development