

Practical Uses of Big Transportation Data for Cities and Municipalities

Penn State

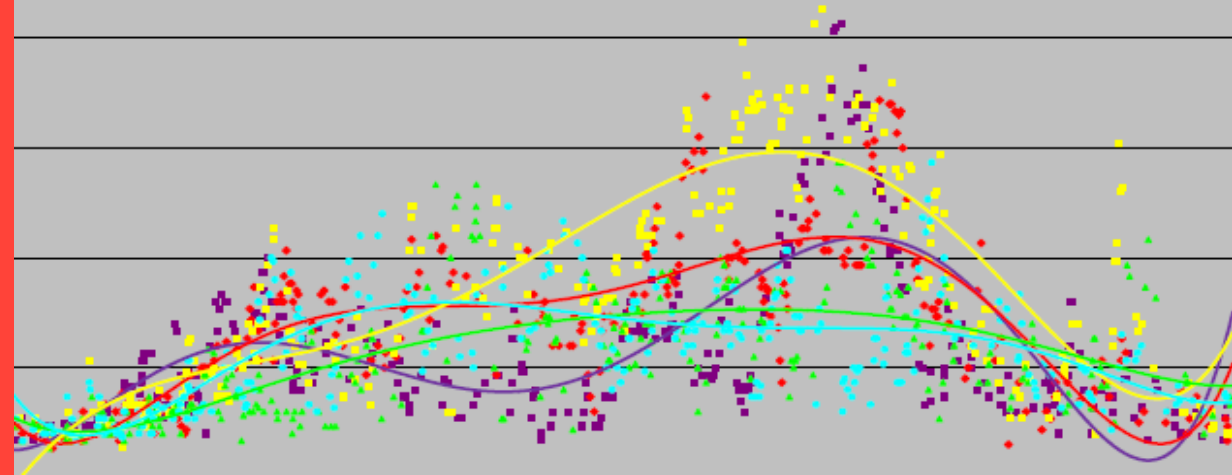
Traffic Engineering and Safety Conference

Stephen Buckley, P.E., AICP

Northeast Regional Manager
for Planning, Environment and Traffic

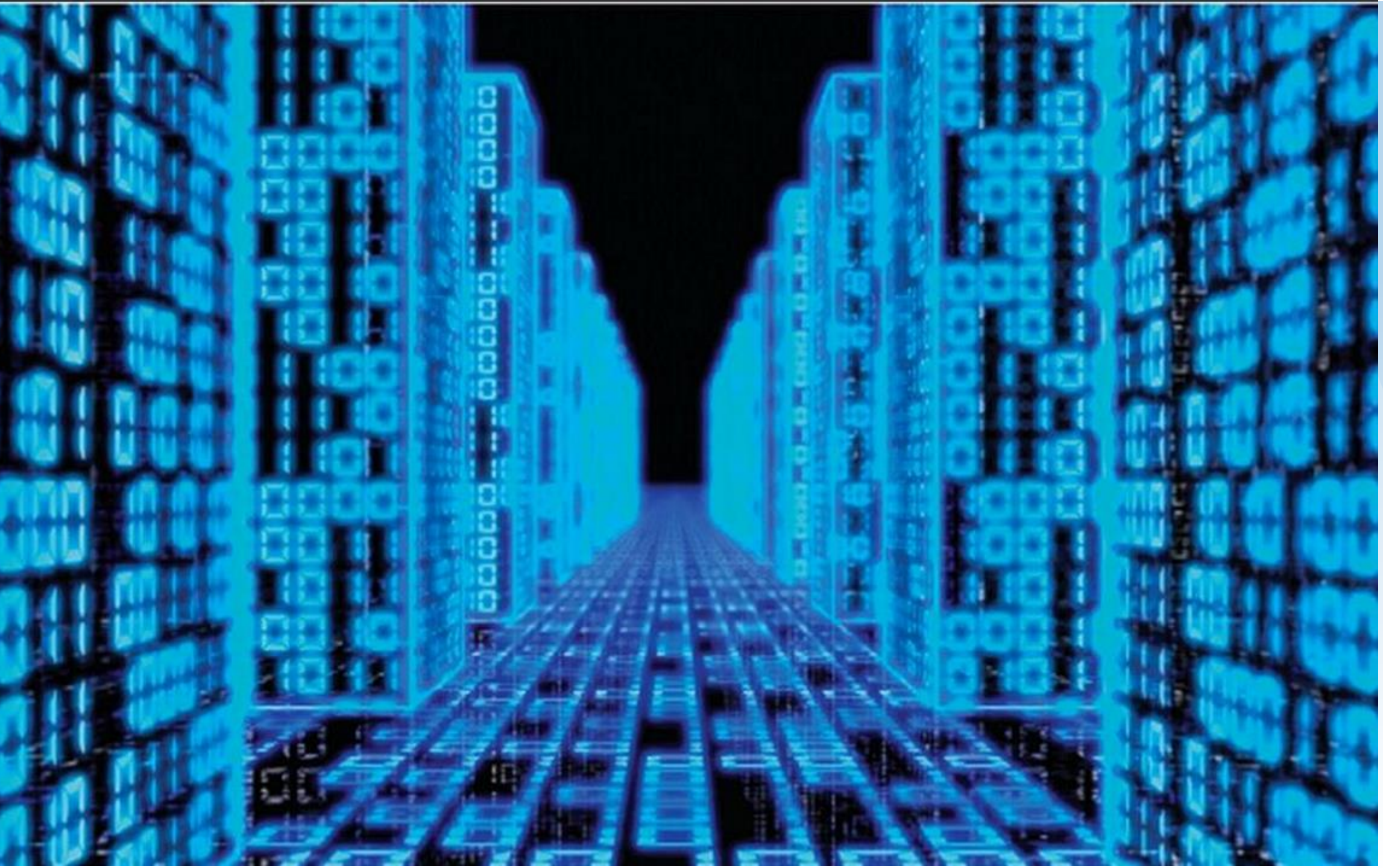
WSP

December 6, 2018










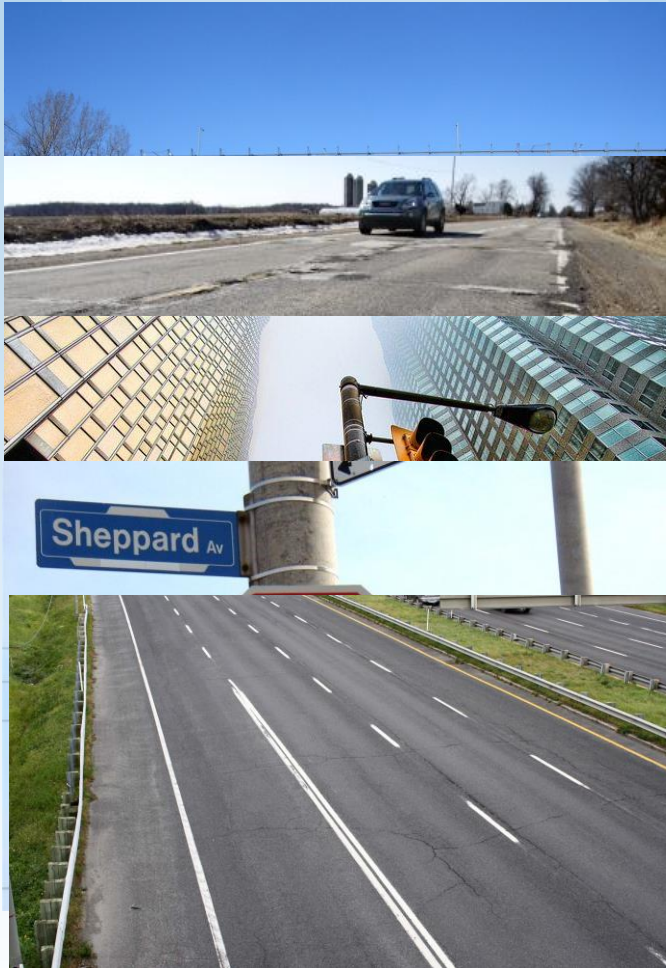




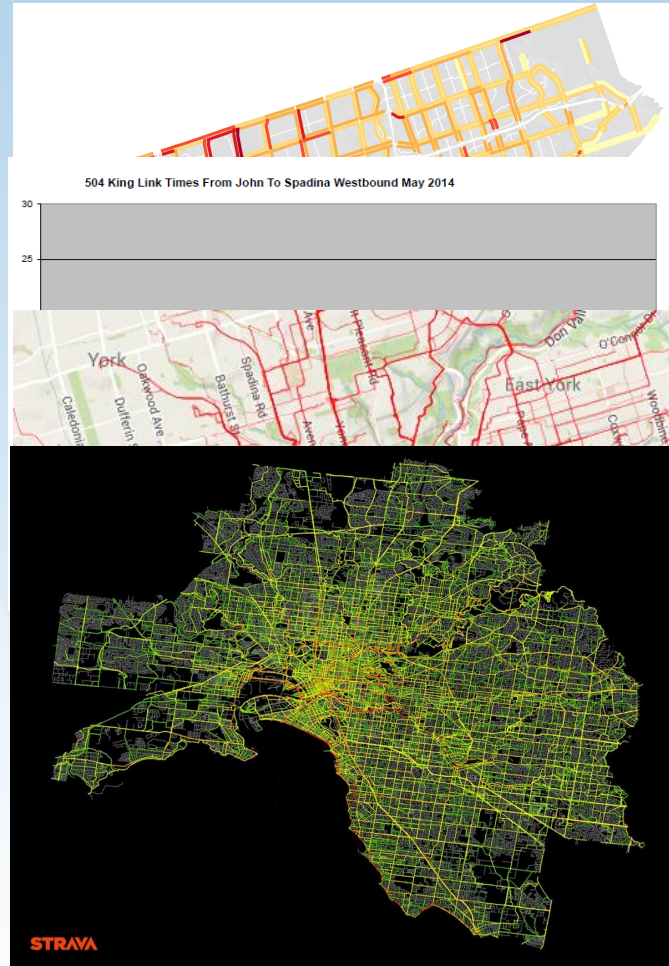
Practical Uses of Big Data in Transportation

Data in Transportation

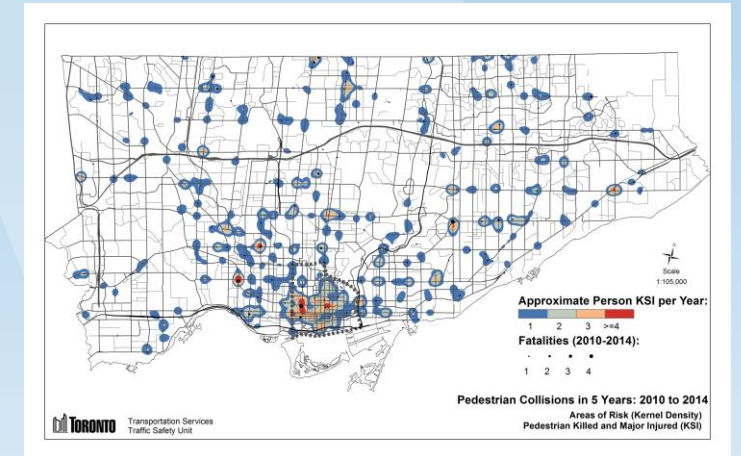
Asset Management



Mobility

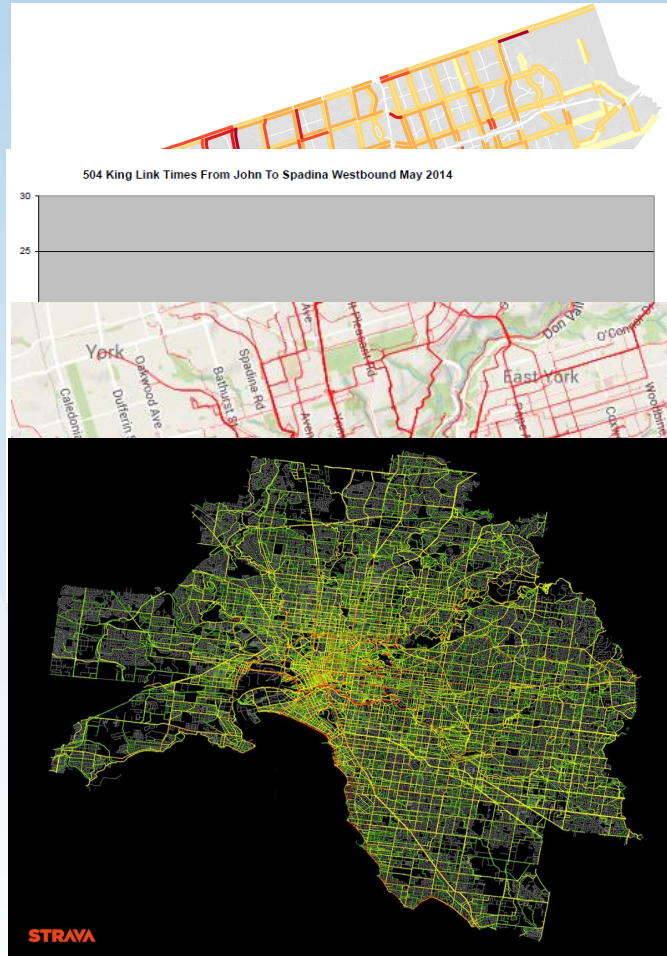


Safety

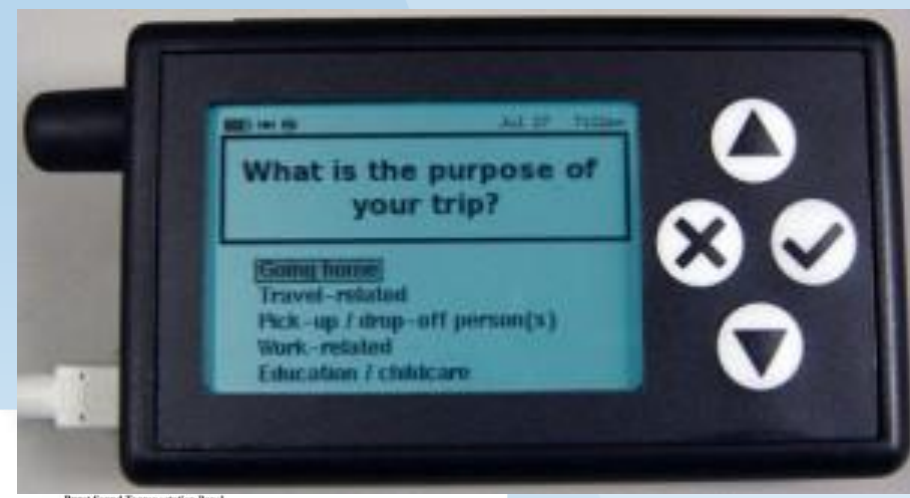


Data in Transportation

Mobility



Transportation Data Collection



DAY 1 page 1

Reasons for being there

Address for being there

IF HOUSE NOT GO ADDRESS OF THE DAY CHECK HERE

Day 1 Survey

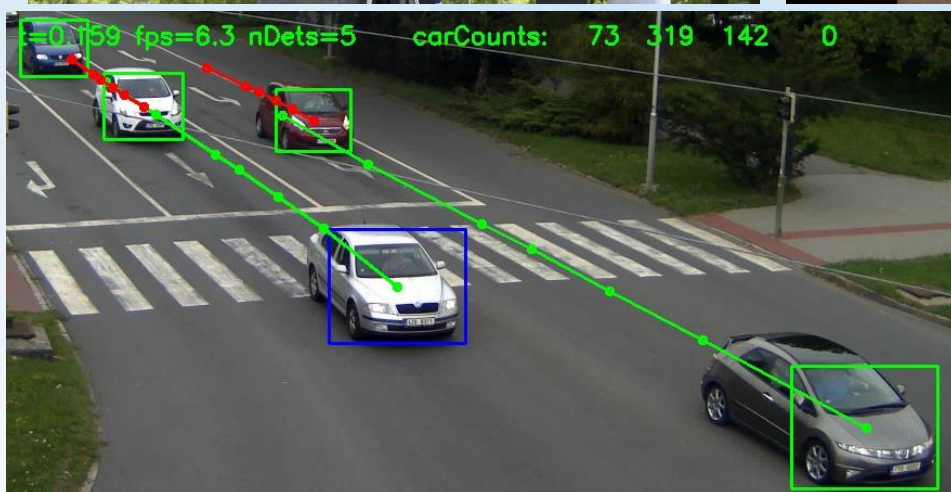
DATE	TIME	TRIP TO	TRIP TYPE	REASON FOR TRIP	MODE	TRIP GROUP	TRIP PURPOSE	TRIP DURATION	TRIP COST	TRIP COMMENTS
1	08:00	Home	Personal	Going home	Car	Family	Personal	15 min	\$0	
1	08:30	Work	Work-related	Work-related	Bus	Family	Work-related	30 min	\$2.00	
1	09:00	Childcare	Education / childcare	Education / childcare	Car	Family	Education / childcare	15 min	\$0	
1	09:30	Work	Work-related	Work-related	Bus	Family	Work-related	30 min	\$2.00	
1	10:00	Home	Personal	Going home	Car	Family	Personal	15 min	\$0	
1	10:30	Work	Work-related	Work-related	Bus	Family	Work-related	30 min	\$2.00	
1	11:00	Home	Personal	Going home	Car	Family	Personal	15 min	\$0	
1	11:30	Work	Work-related	Work-related	Bus	Family	Work-related	30 min	\$2.00	
1	12:00	Home	Personal	Going home	Car	Family	Personal	15 min	\$0	
1	12:30	Work	Work-related	Work-related	Bus	Family	Work-related	30 min	\$2.00	
1	13:00	Home	Personal	Going home	Car	Family	Personal	15 min	\$0	
1	13:30	Work	Work-related	Work-related	Bus	Family	Work-related	30 min	\$2.00	
1	14:00	Home	Personal	Going home	Car	Family	Personal	15 min	\$0	
1	14:30	Work	Work-related	Work-related	Bus	Family	Work-related	30 min	\$2.00	
1	15:00	Home	Personal	Going home	Car	Family	Personal	15 min	\$0	
1	15:30	Work	Work-related	Work-related	Bus	Family	Work-related	30 min	\$2.00	
1	16:00	Home	Personal	Going home	Car	Family	Personal	15 min	\$0	
1	16:30	Work	Work-related	Work-related	Bus	Family	Work-related	30 min	\$2.00	
1	17:00	Home	Personal	Going home	Car	Family	Personal	15 min	\$0	
1	17:30	Work	Work-related	Work-related	Bus	Family	Work-related	30 min	\$2.00	
1	18:00	Home	Personal	Going home	Car	Family	Personal	15 min	\$0	
1	18:30	Work	Work-related	Work-related	Bus	Family	Work-related	30 min	\$2.00	
1	19:00	Home	Personal	Going home	Car	Family	Personal	15 min	\$0	
1	19:30	Work	Work-related	Work-related	Bus	Family	Work-related	30 min	\$2.00	
1	20:00	Home	Personal	Going home	Car	Family	Personal	15 min	\$0	
1	20:30	Work	Work-related	Work-related	Bus	Family	Work-related	30 min	\$2.00	
1	21:00	Home	Personal	Going home	Car	Family	Personal	15 min	\$0	
1	21:30	Work	Work-related	Work-related	Bus	Family	Work-related	30 min	\$2.00	
1	22:00	Home	Personal	Going home	Car	Family	Personal	15 min	\$0	
1	22:30	Work	Work-related	Work-related	Bus	Family	Work-related	30 min	\$2.00	
1	23:00	Home	Personal	Going home	Car	Family	Personal	15 min	\$0	
1	23:30	Work	Work-related	Work-related	Bus	Family	Work-related	30 min	\$2.00	
1	24:00	Home	Personal	Going home	Car	Family	Personal	15 min	\$0	
1	24:30	Work	Work-related	Work-related	Bus	Family	Work-related	30 min	\$2.00	
1	25:00	Home	Personal	Going home	Car	Family	Personal	15 min	\$0	
1	25:30	Work	Work-related	Work-related	Bus	Family	Work-related	30 min	\$2.00	
1	26:00	Home	Personal	Going home	Car	Family	Personal	15 min	\$0	
1	26:30	Work	Work-related	Work-related	Bus	Family	Work-related	30 min	\$2.00	
1	27:00	Home	Personal	Going home	Car	Family	Personal	15 min	\$0	
1	27:30	Work	Work-related	Work-related	Bus	Family	Work-related	30 min	\$2.00	
1	28:00	Home	Personal	Going home	Car	Family	Personal	15 min	\$0	
1	28:30	Work	Work-related	Work-related	Bus	Family	Work-related	30 min	\$2.00	
1	29:00	Home	Personal	Going home	Car	Family	Personal	15 min	\$0	
1	29:30	Work	Work-related	Work-related	Bus	Family	Work-related	30 min	\$2.00	
1	30:00	Home	Personal	Going home	Car	Family	Personal	15 min	\$0	
1	30:30	Work	Work-related	Work-related	Bus	Family	Work-related	30 min	\$2.00	

DAY 1 page 2

Traffic Data Collection



Traffic Data Collection



Travel Data



A promotional graphic for the I-95 Vehicle Probe Project. The central focus is a map of the I-95 corridor in the United States, with the route highlighted in green. Above the map, the text "I-95 Vehicle Probe Project" is written in a large, bold, blue font. Below the map, a blue shield logo contains a white outline of the I-95 corridor. Underneath the shield, the text "I-95 CORRIDOR COALITION" is displayed. At the bottom of the graphic, there are several smaller elements: a "511" logo, a "here" logo, and an "INRIX" logo. To the right of these logos, there are images of a smartphone displaying a map, a white car, a yellow taxi, and a white truck. The background of the graphic is a blurred, yellow and blue gradient.

So What Has Changed?



So What Has Changed?



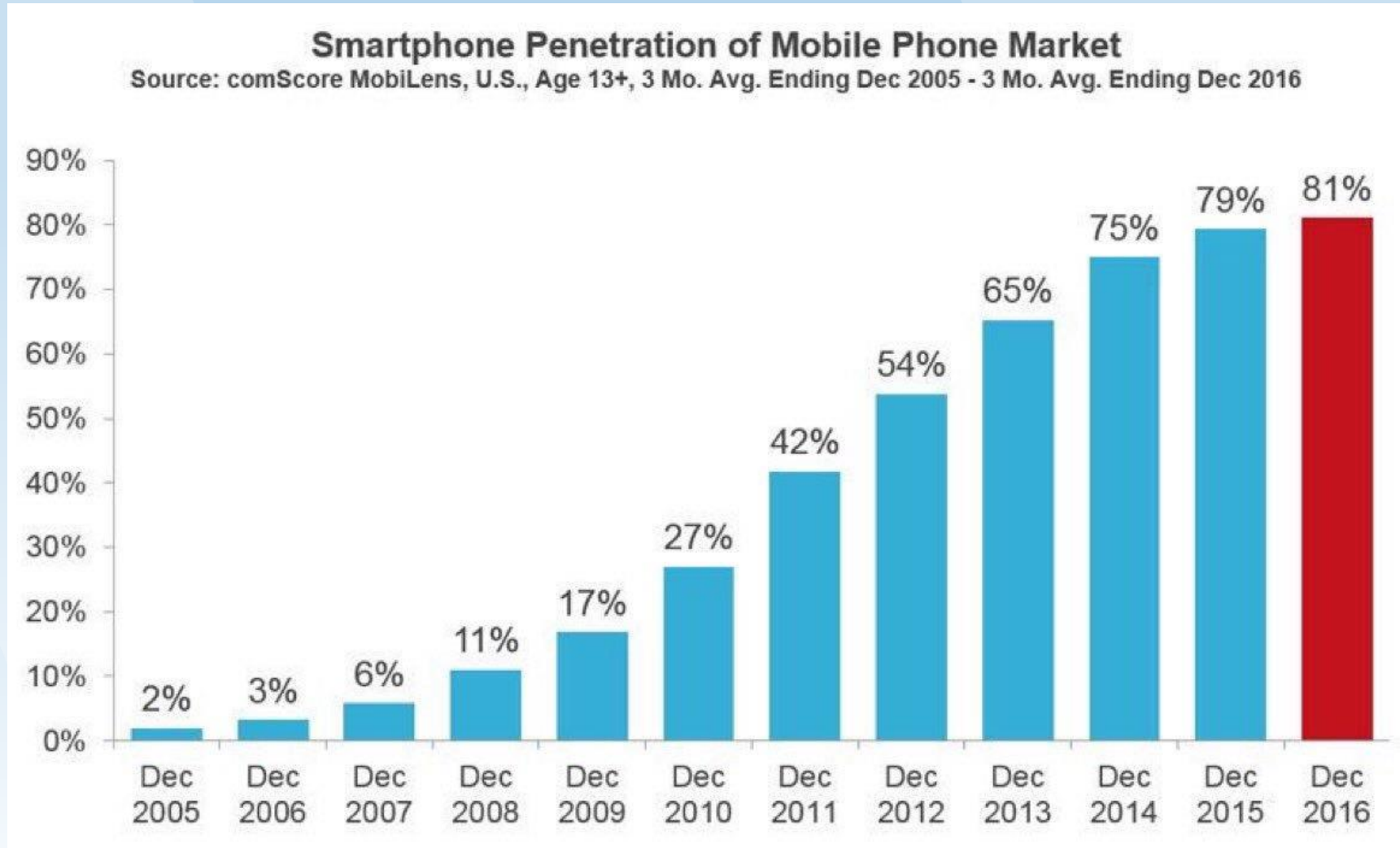
So What Has Changed?



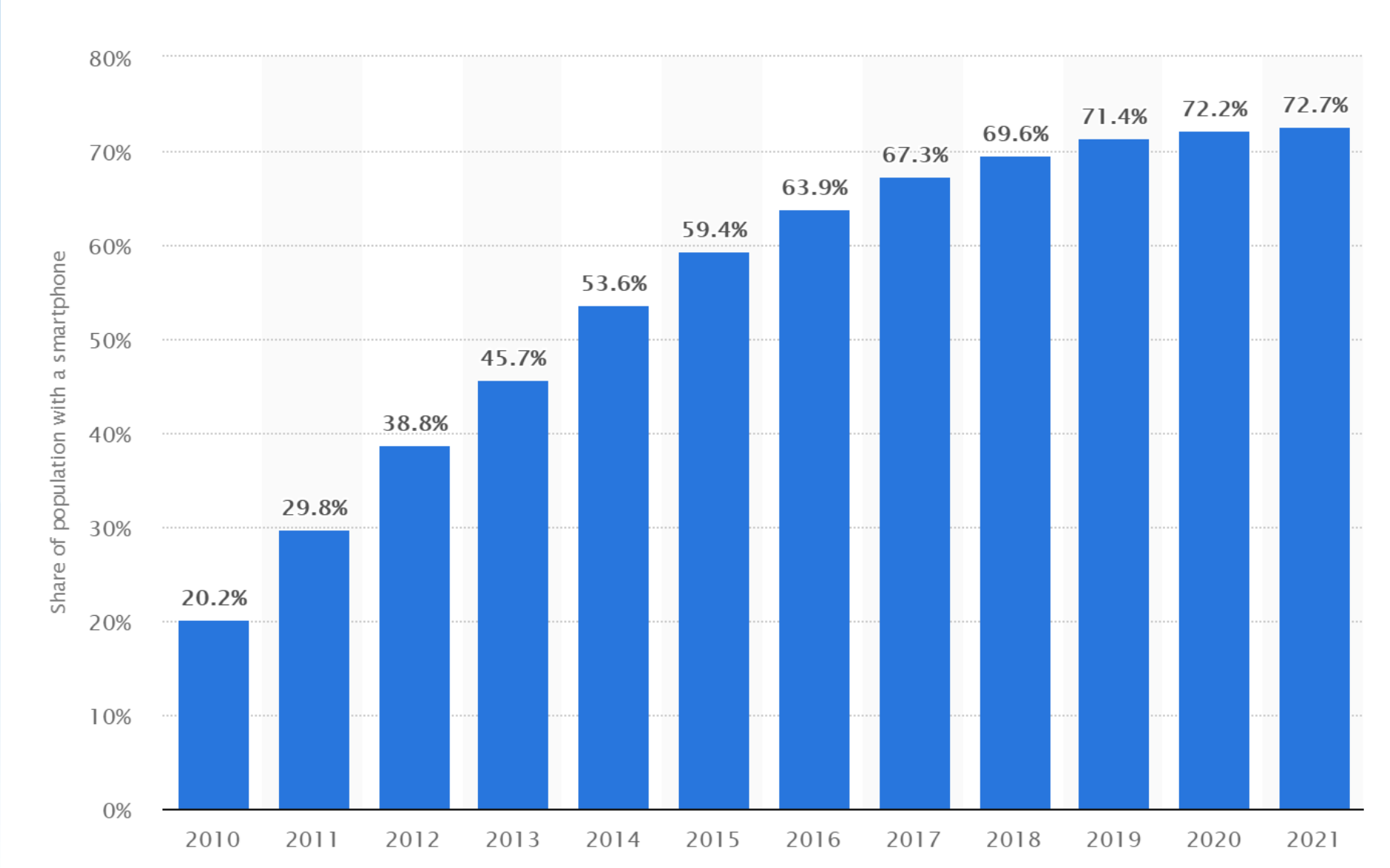
So What Has Changed?



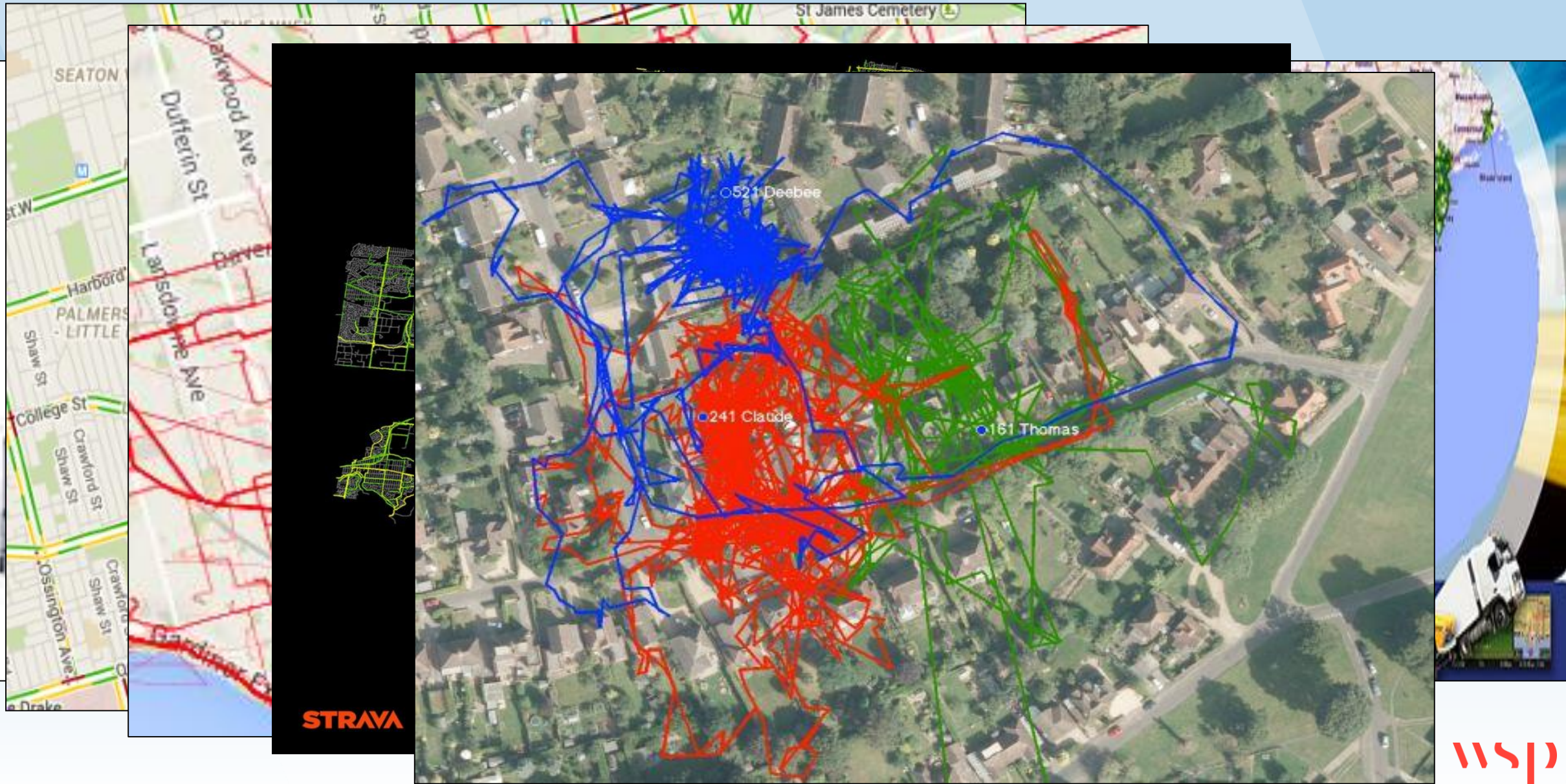
So What Has Changed?




So What Has Changed?



Travel Data





*So How Can We Use
Big Transportation
Data?*

How We Can Use Big Transportation Data?

Describing

- Understanding what is happening

Evaluating

- Measuring changes

Operating

- Identifying issues real-time

Planning

- Modelling

Predicting

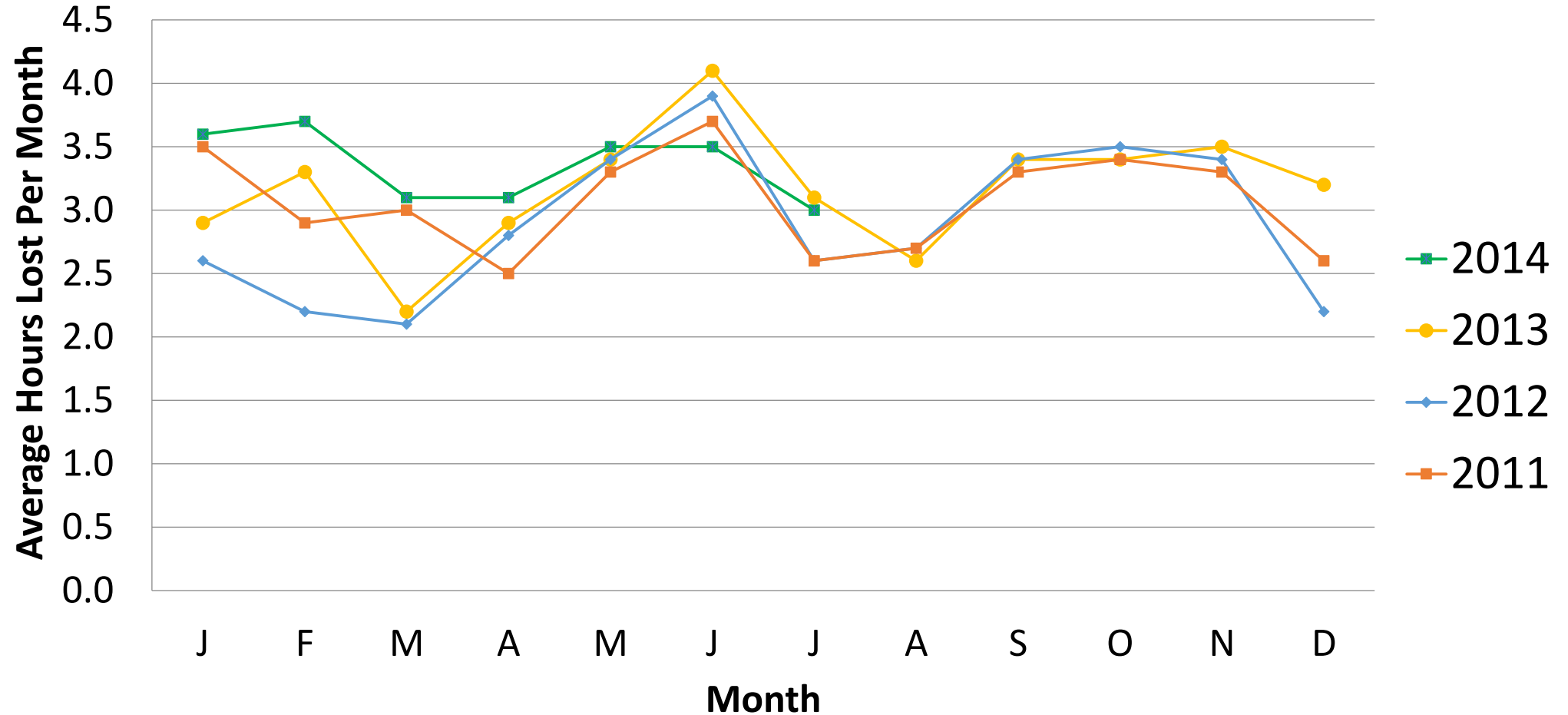
- Proactively communicating trip info



Describing

Changes in Congestion

Monthly Hours Lost Due to Congestion in the GTA



Source: Inrix



Toronto ranked last in survey of commuting times

-Toronto Star, March 29, 2010

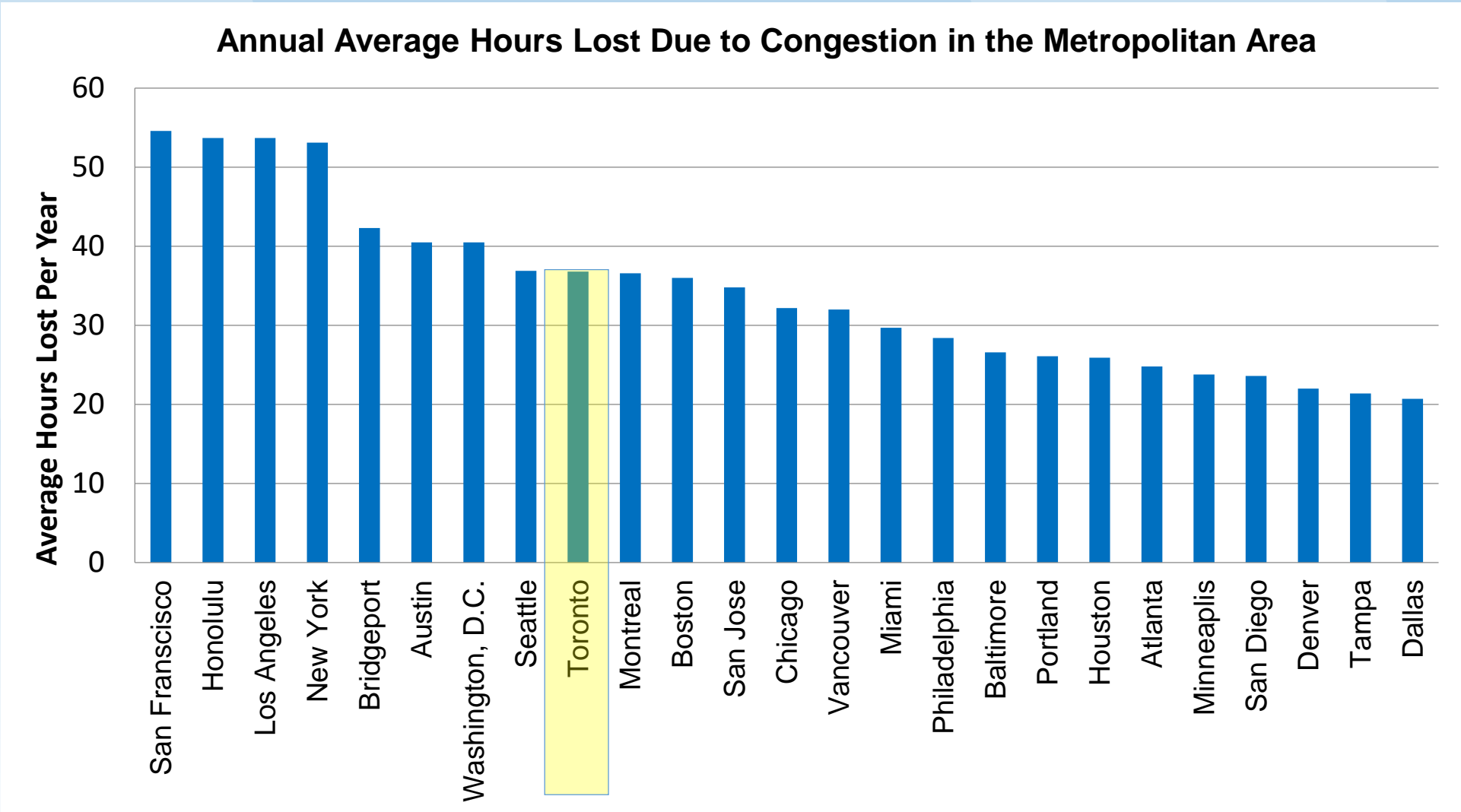
Gridlock a grind on Toronto's economy: report

- CBC News, June 28, 2011

Congestion cost may be up to \$11 billion for GTA, study says

- Toronto Star, July 11, 2013

How Does Toronto Stack Up?



Source: Inrix





McMaster University Research

The image shows the cover of a report titled "Congested Days in Toronto". The top half of the cover is a solid green rectangle with the title in white, bold, sans-serif font. Below this is a thin orange horizontal line. The bottom half of the cover is white. On the left side of this white section, the date "September 15, 2015" and the funding information "Funded by City of Toronto [20002856]" are printed in a small, black, sans-serif font. At the bottom left, there is a logo for the "McMaster Institute for Transportation & Logistics", which consists of a green square with white curved lines and an arrow pointing right, followed by the text "McMASTER INSTITUTE FOR TRANSPORTATION & LOGISTICS". To the right of this is a logo for "INRIX TRAFFIC", which features the word "INRIX" in a blue, stylized font above the word "TRAFFIC" in a smaller, blue, sans-serif font. The right side of the white section is a solid black vertical bar.

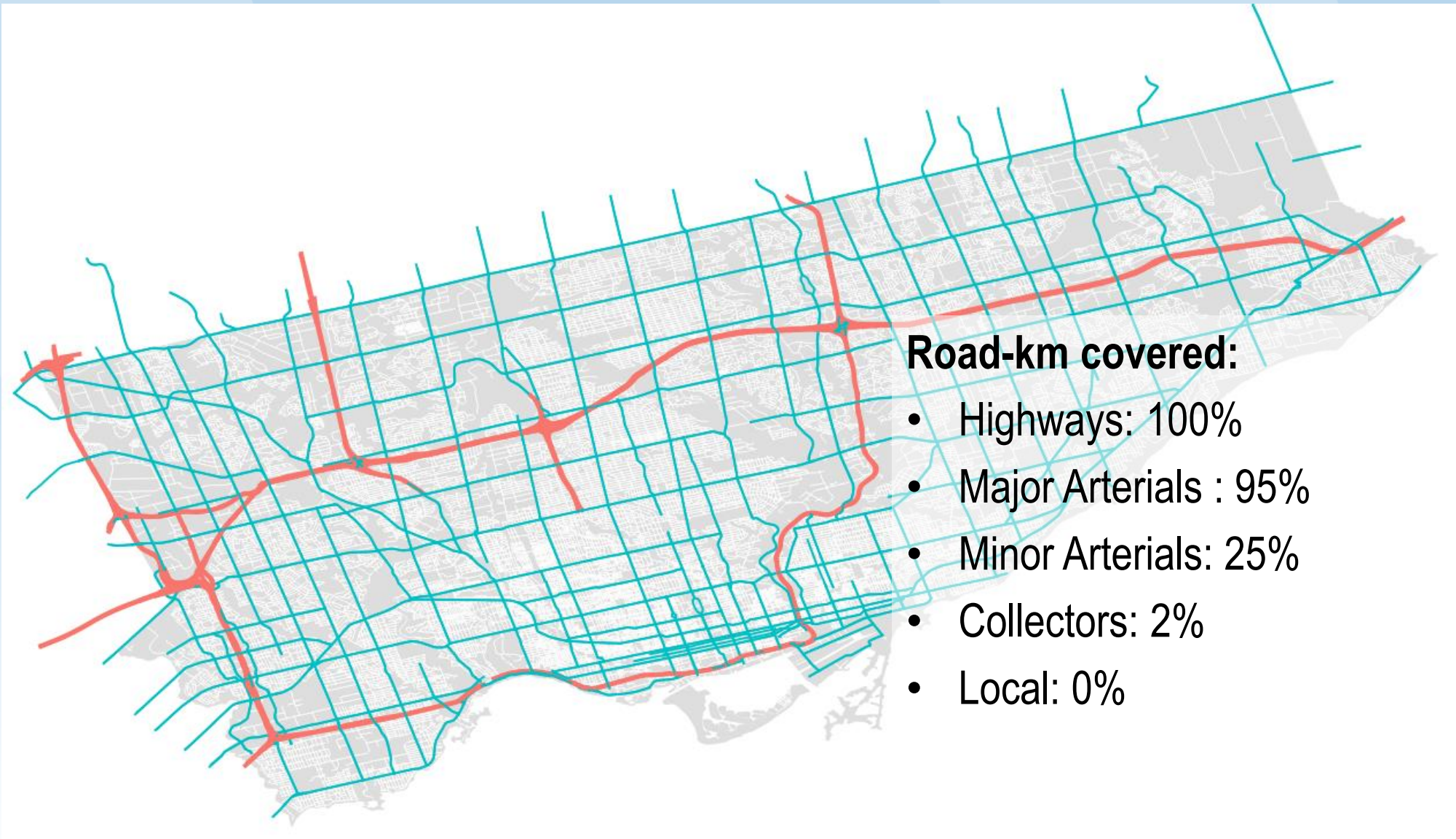
Congested Days in Toronto

September 15, 2015
Funded by City of Toronto [20002856]

 McMASTER INSTITUTE FOR
TRANSPORTATION
& LOGISTICS

 POWERED BY
INRIX
TRAFFIC

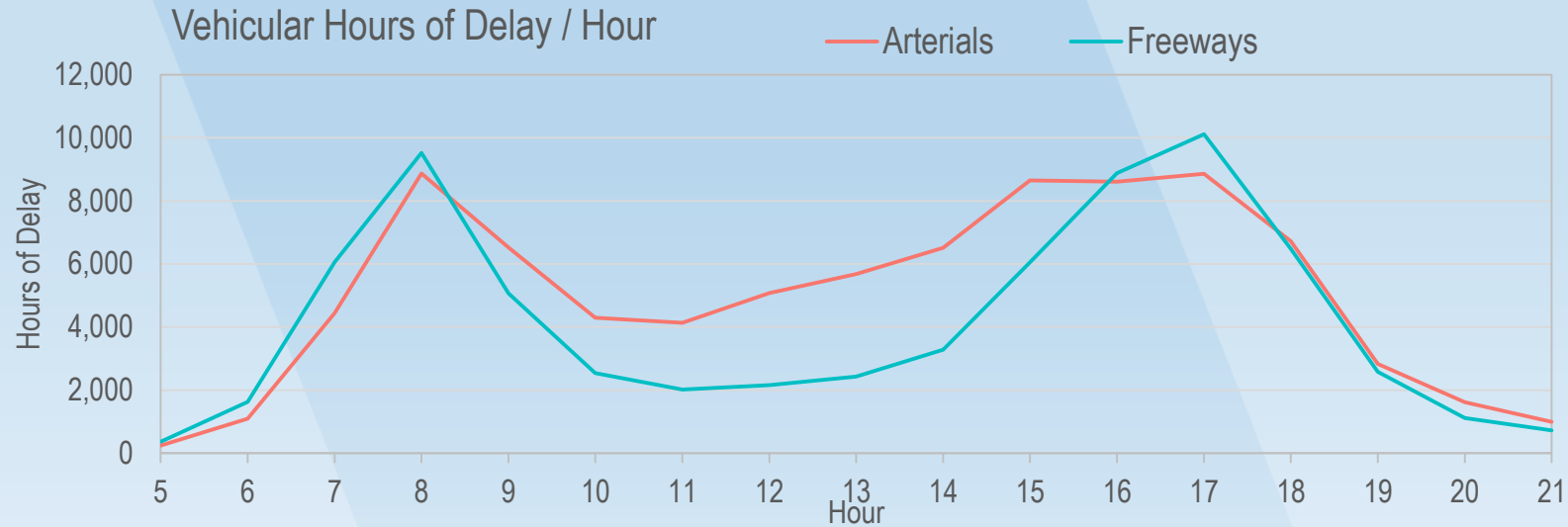
Study Coverage



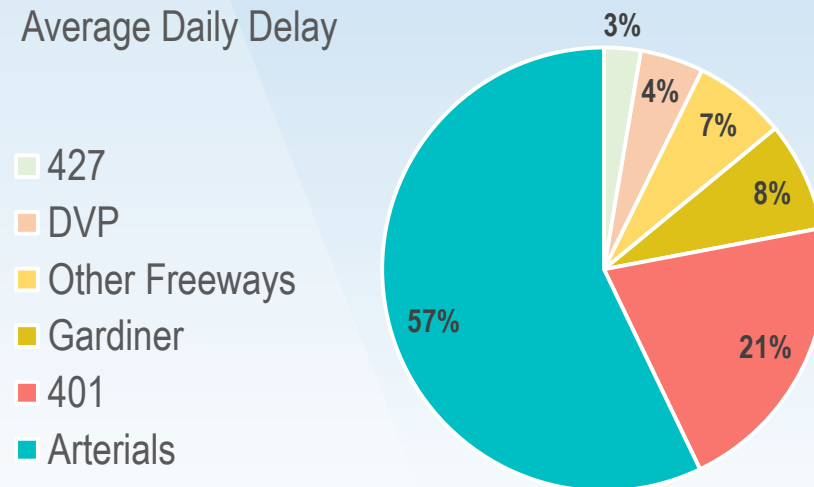
Data Companies

The logo for INRIX, featuring the word "INRIX" in a bold, blue, serif font with horizontal lines above and below the letters.The logo for TomTom, featuring the word "TomTom" in a bold, black, sans-serif font, followed by a red and white globe icon with two red hands.The logo for here, featuring the word "here" in a white, lowercase, sans-serif font, tilted upwards, with a small teal triangle pointing to the left.The logo for Cellint, featuring the word "Cellint" in a bold, sans-serif font, with "Cell" in black and "int" in yellow, separated by a vertical black bar.

Where and When is Delay Occurring?



Average Daily Delay



**BEST/WORST
CONGESTED
DAYS
(all days)**

10 SLOWEST DAYS

NEXT 20
SLOWEST DAYS

10 FASTEST DAYS

NEXT 20 FASTEST
DAYS

January

SUN	MON	TUE	WED	THU	FRI	SAT
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	

February

SUN	MON	TUE	WED	THU	FRI	SAT
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	

March

SUN	MON	TUE	WED	THU	FRI	SAT
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31					

April

SUN	MON	TUE	WED	THU	FRI	SAT
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30			

May

SUN	MON	TUE	WED	THU	FRI	SAT
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31

June

SUN	MON	TUE	WED	THU	FRI	SAT
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30					

July

SUN	MON	TUE	WED	THU	FRI	SAT
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

August

SUN	MON	TUE	WED	THU	FRI	SAT
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31						

September

SUN	MON	TUE	WED	THU	FRI	SAT
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30				

October

SUN	MON	TUE	WED	THU	FRI	SAT
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	

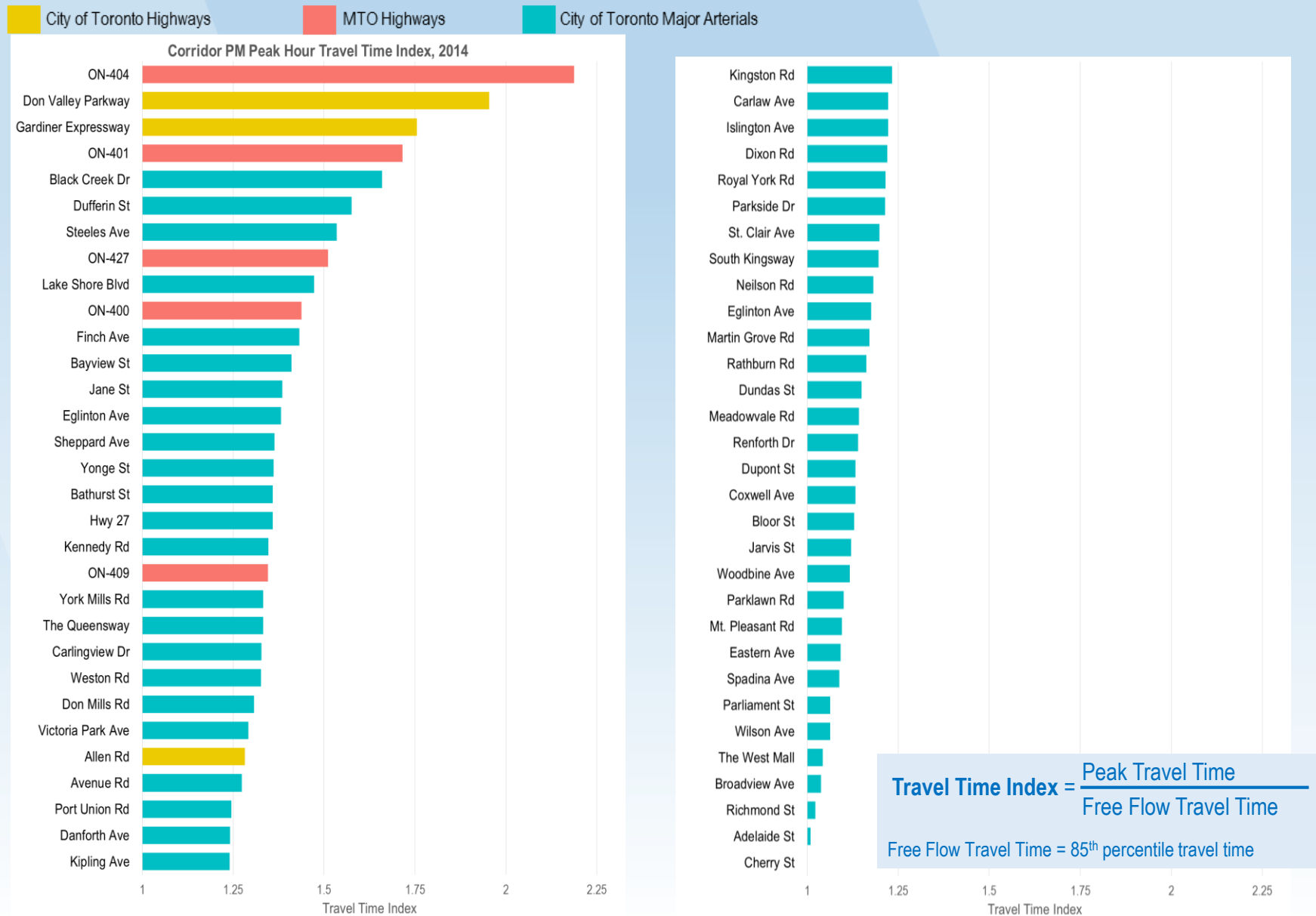
November

SUN	MON	TUE	WED	THU	FRI	SAT
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30						

December

SUN	MON	TUE	WED	THU	FRI	SAT
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

Quantifying Congestion



Corridor Report Cards

Yonge St. (SB)

Steeles Ave. to Queens Quay

Key Performance Indicators		2011	2013	2014	Change (2011-2014)
Speed (km/h)	AM Peak	28	28	25	- 3
	PM Peak	30	30	27	- 3
Travel Time Index	AM Peak	1.41	1.38	1.57	+ 0.16
	PM Peak	1.32	1.32	1.43	+ 0.11
Delay Hours	AM Peak	279	265	403	+ 124
	PM Peak	156	156	214	+ 58
Planning Time Index		1.23	1.10	1.28	+ 0.05
Buffer Time Index		1.20	1.08	1.14	- 0.06



Travel Time Index: ratio of average to uncongested travel times. AM Peak: 8-9AM, PM Peak: 3-6PM
 Delay: average peak-hour vehicular delay per weekday (in hours)
 Planning Time Index: ratio of 95th percentile slowest to free-flow travel times, PM peak
 Buffer Time Index: ratio of the 95th percentile slowest to average travel times, PM peak

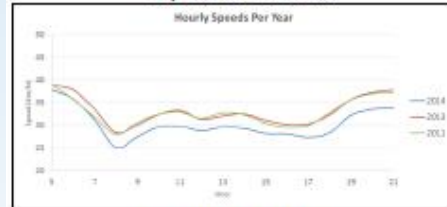
Daily Variations, 2014



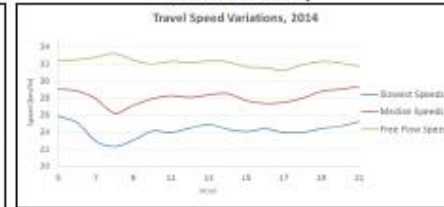
Yonge St. - Southbound

Length	17.8km
Key Alternative Routes	Avenue Rd, Mount Pleasant Rd/Jarvis St
TTC Surface Routes	97, 60F, 53
Major Cross Streets	Queen St, Bloor St, St. Clair Ave, Eginton Ave, Finch Ave
Share of Weekday Congestion	1.43%
Worst Days: AM Peak (Tue & Thu), PM Peak (Thu & Wed)	

Daily Variations 2011-2014



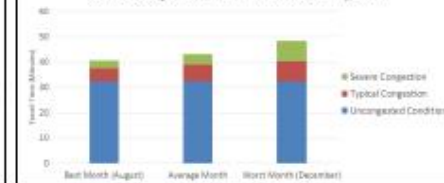
Network Unreliability



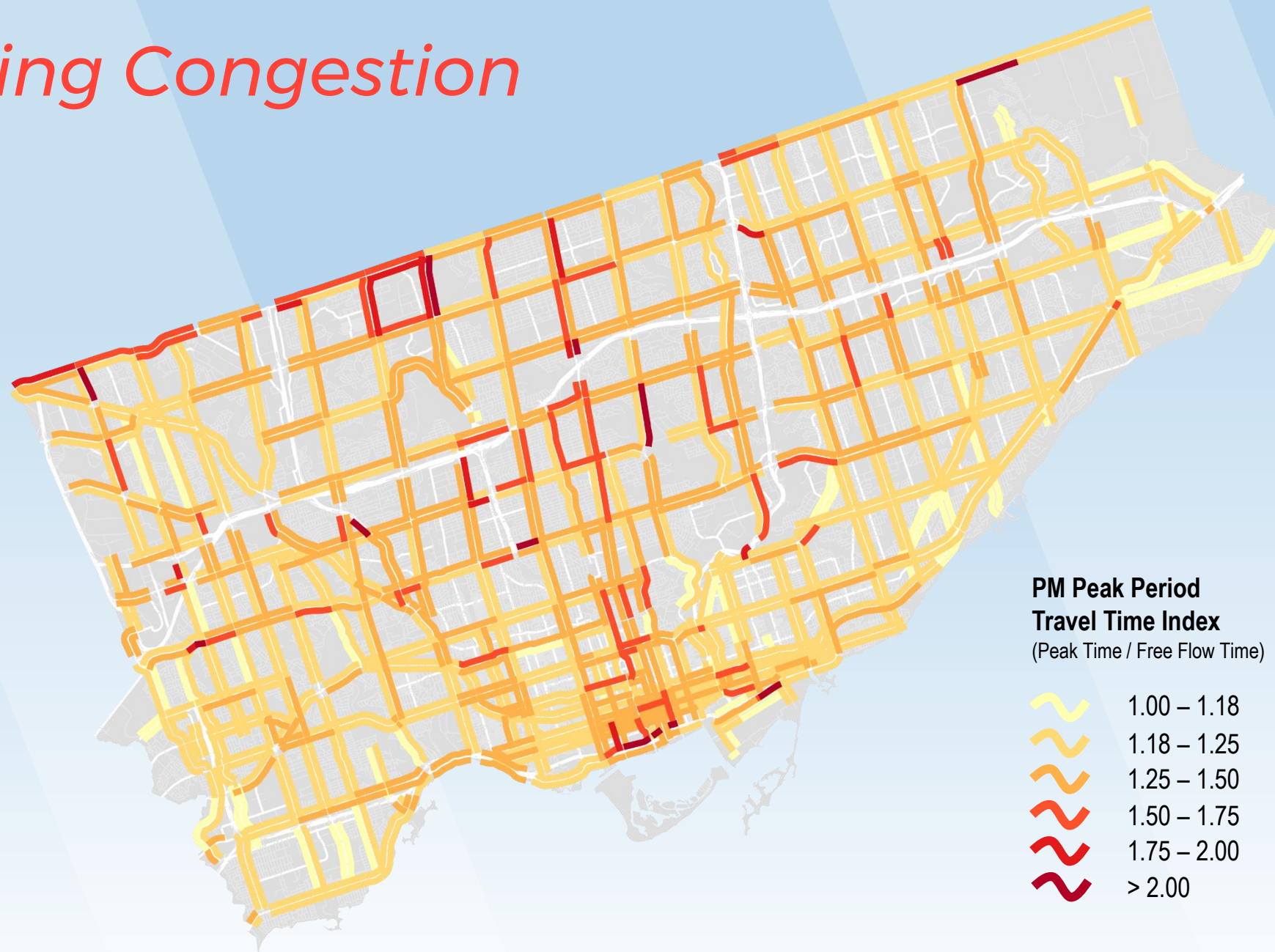
Seasonal Variations, 2014



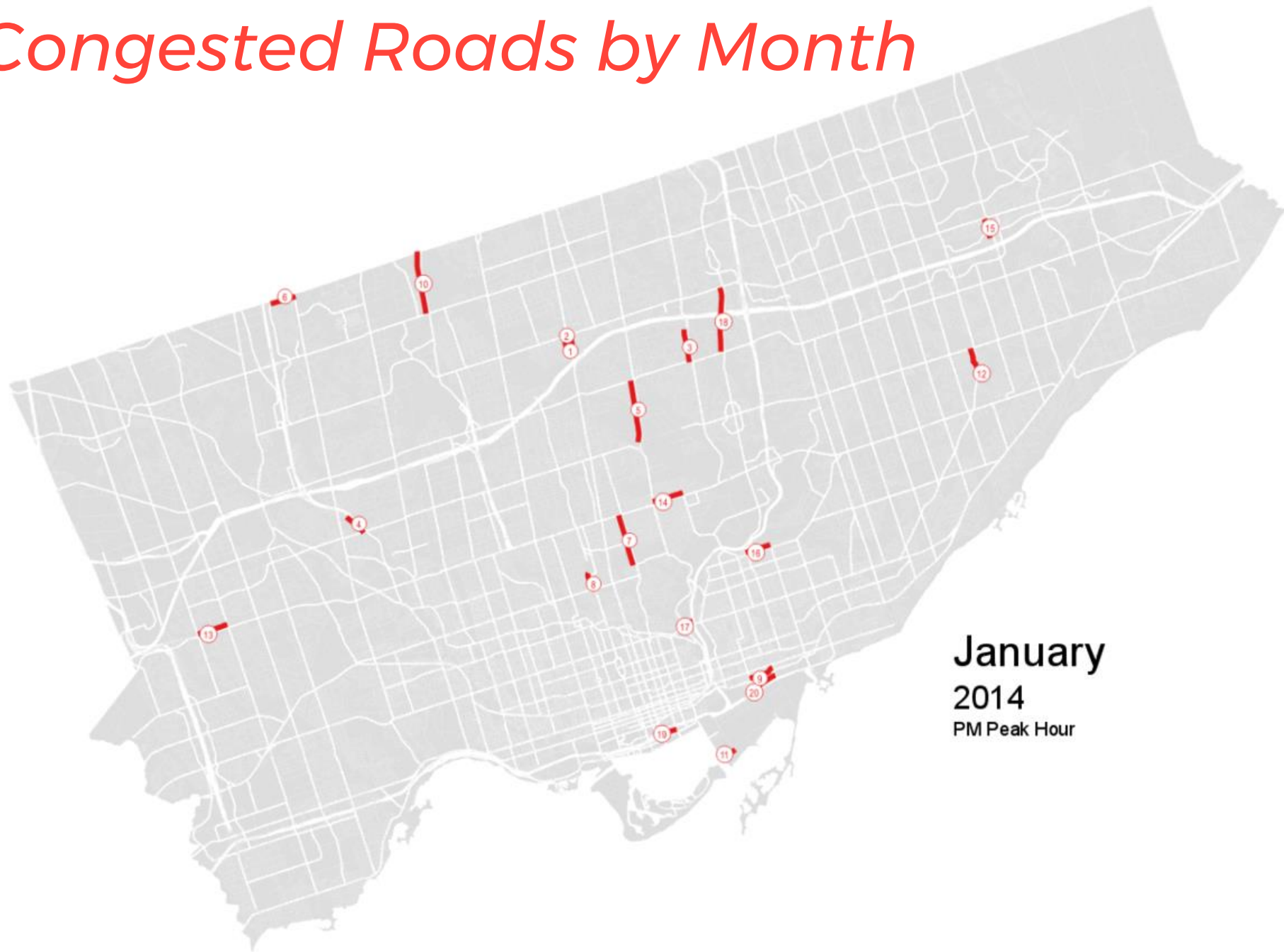
Corridor Congestion & Travel Time Uncertainty, 2014



Mapping Congestion



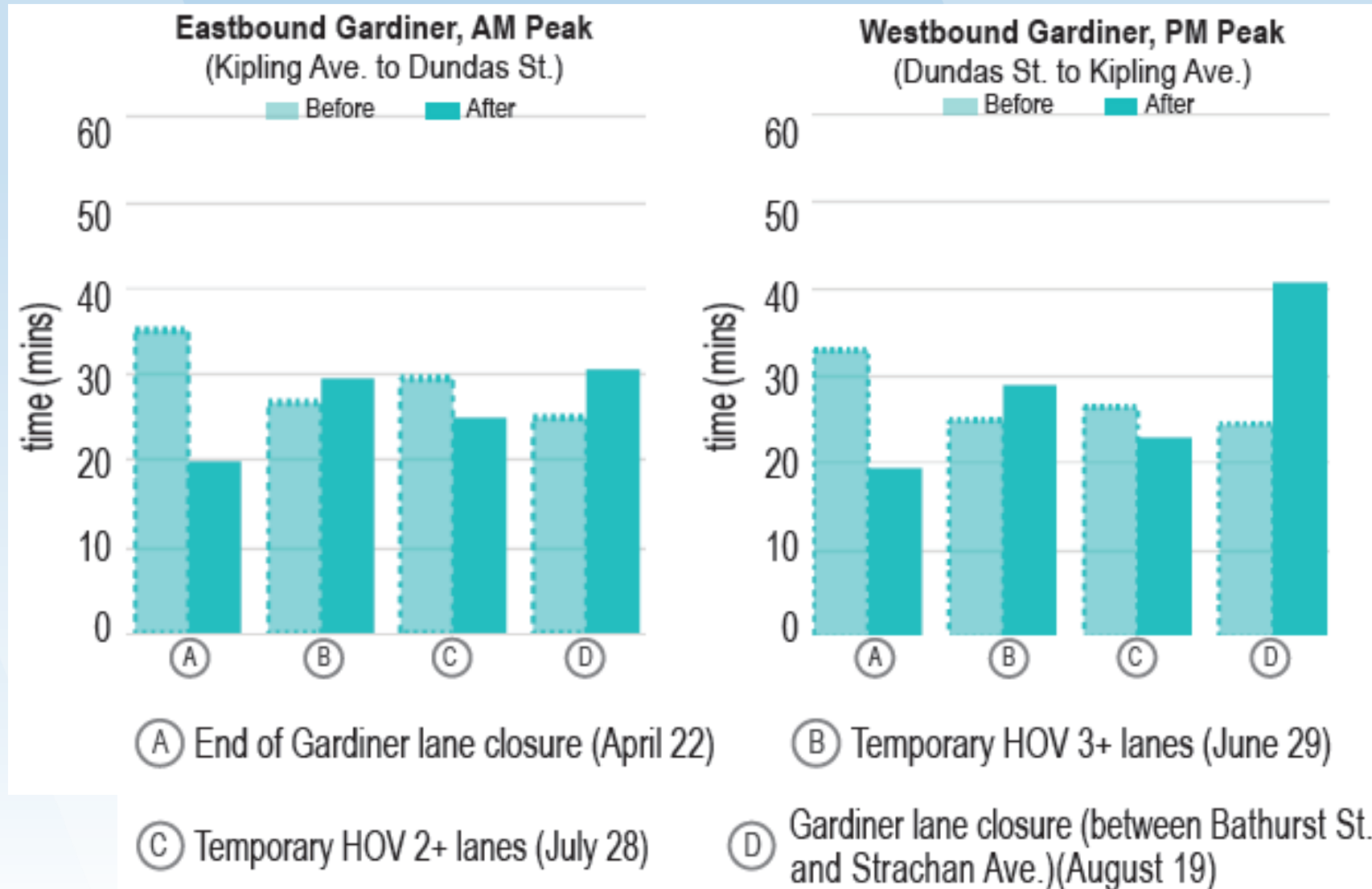
Most Congested Roads by Month



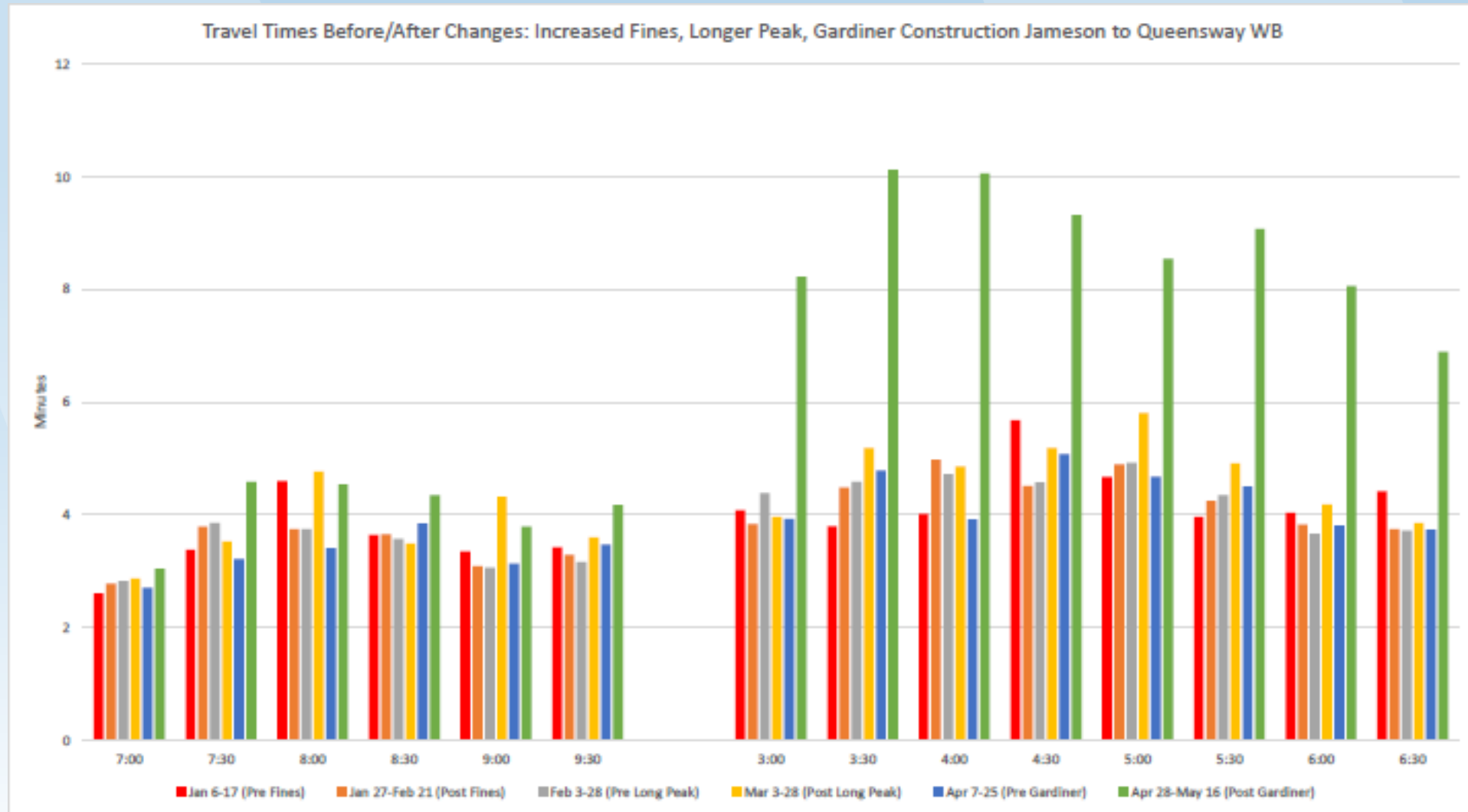


Evaluating

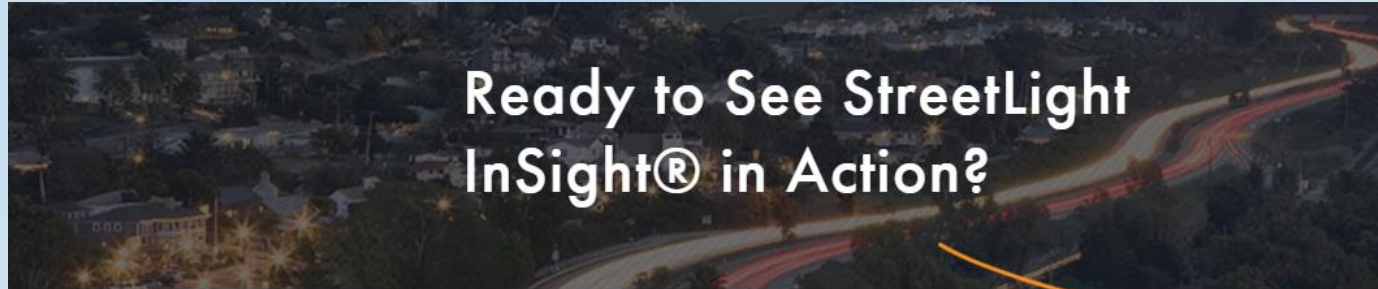
Before and During Gardiner Construction/Pan AM HOV



TTC AVL Data



Real Time Monitoring of Travel Patterns



StreetLight InSight is an online platform that offers the best Big Data resources for understanding travel patterns - and the processing software that makes Big Data useful.

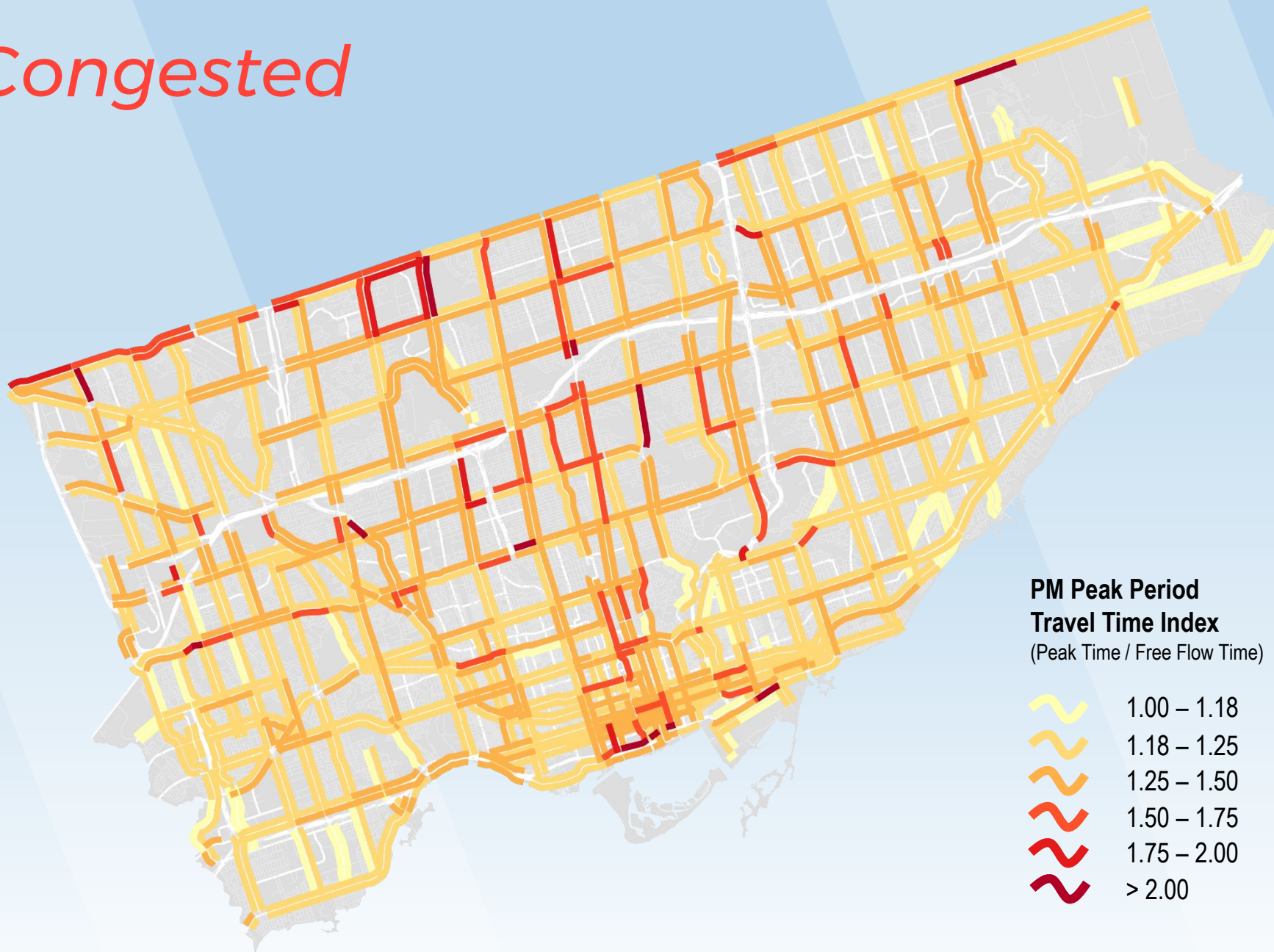
Fill out this form to watch **all of our demo videos**.



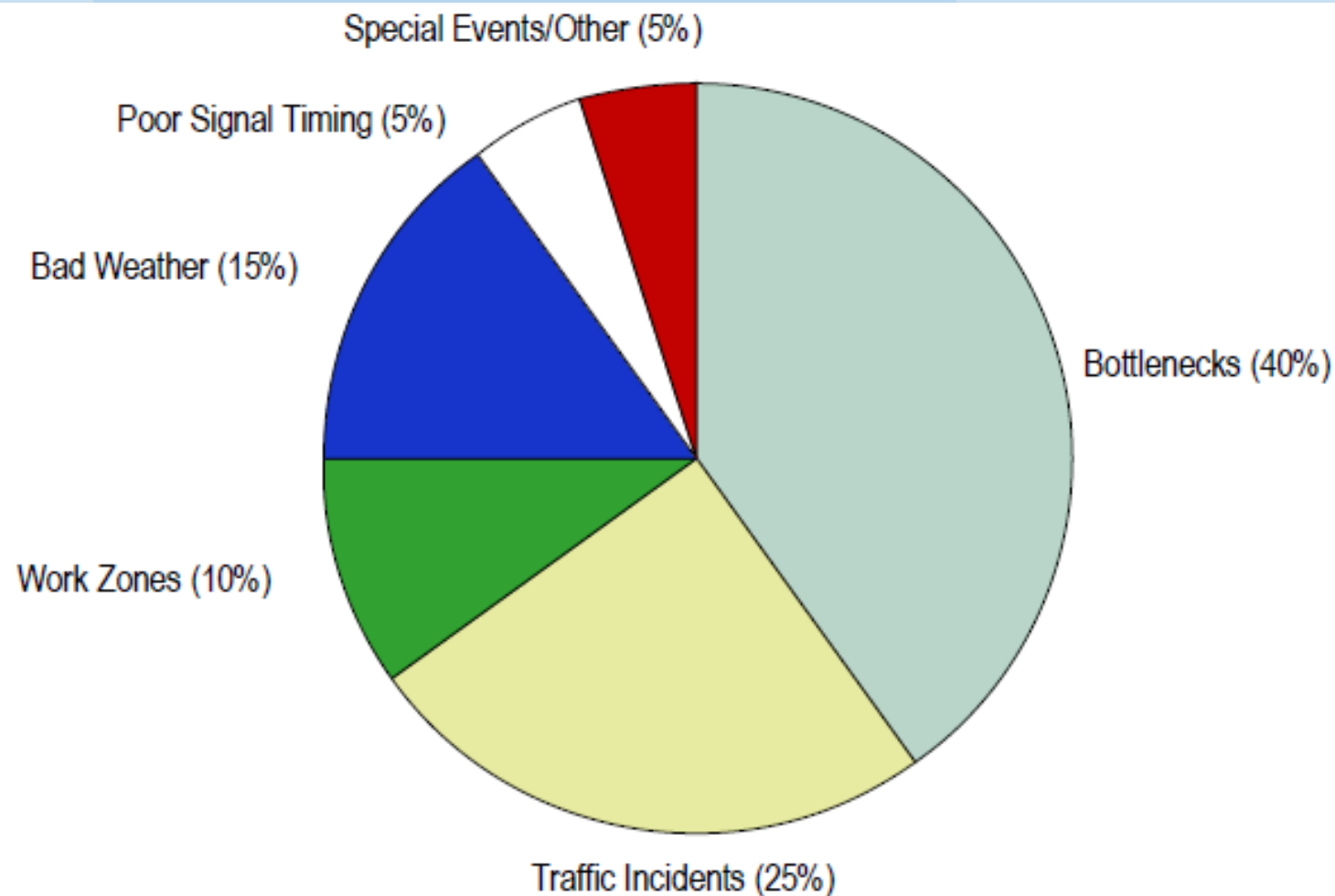


Operating

Most Congested



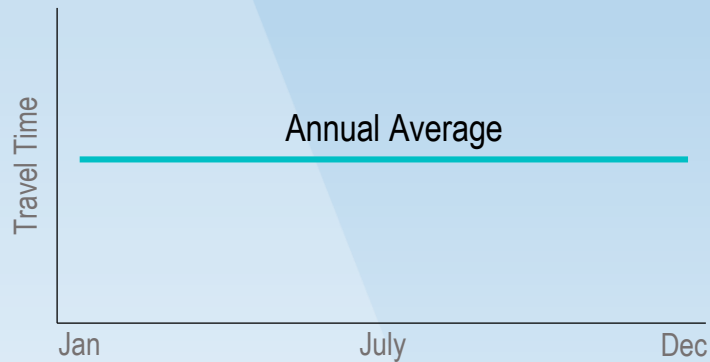
Causes of Congestion



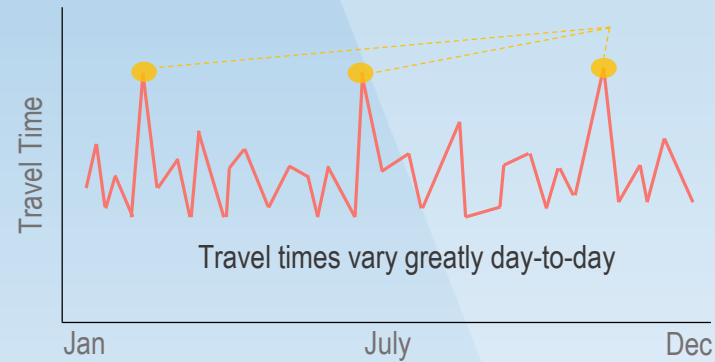
Source: FHWA (2005).

Perception of Congestion

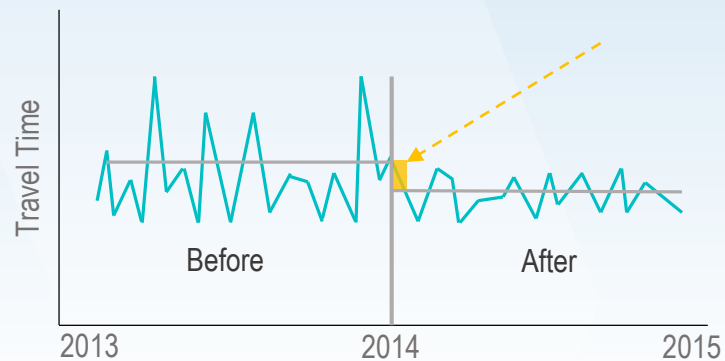
How traffic conditions have been communicated



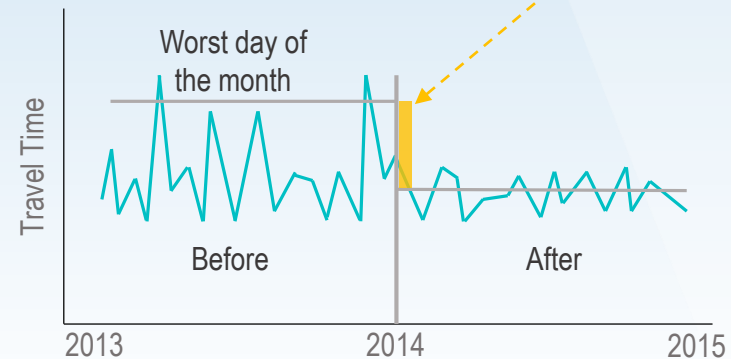
What travellers experience...



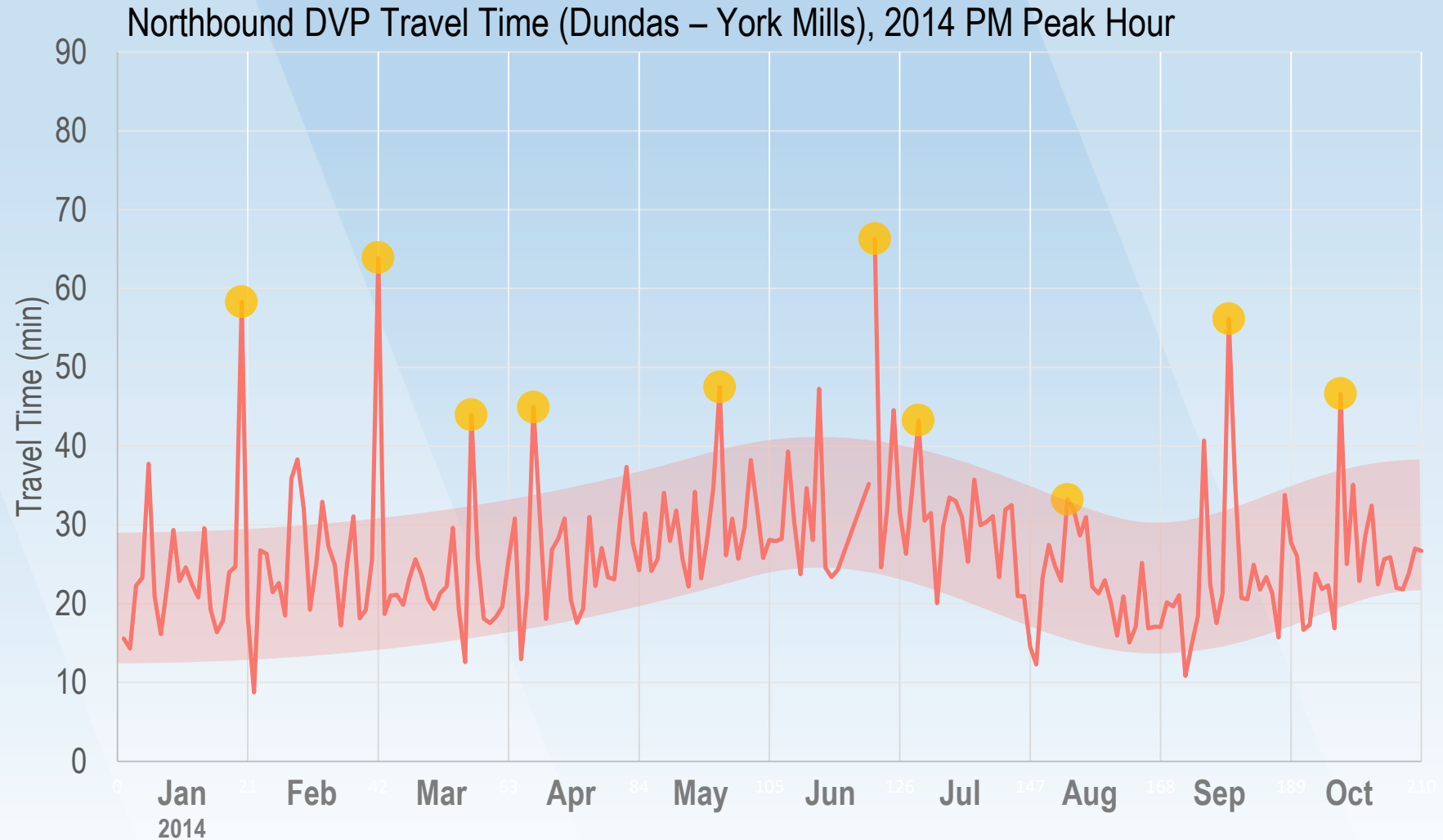
Small improvement in average travel time



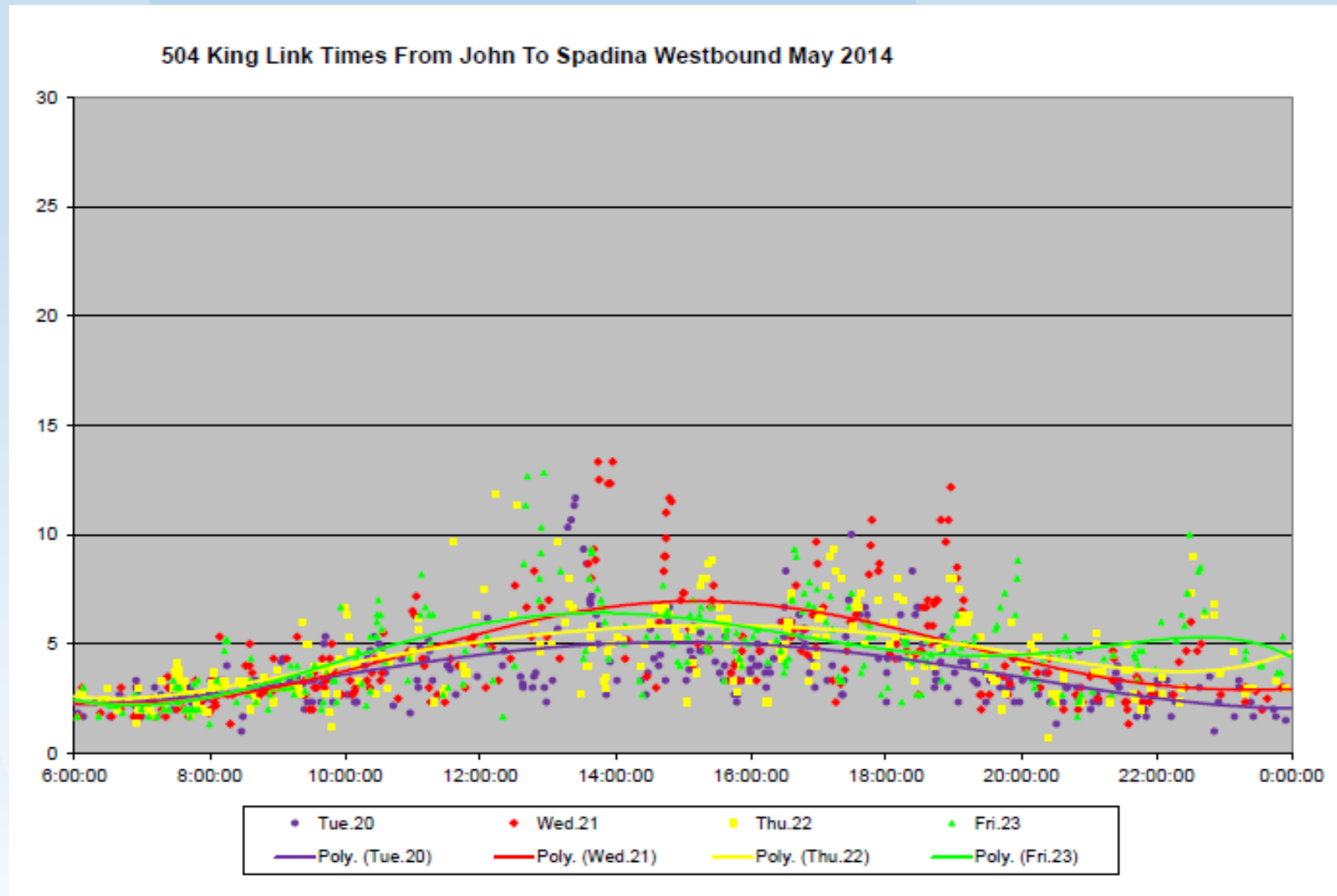
Large improvement in travel time reliability



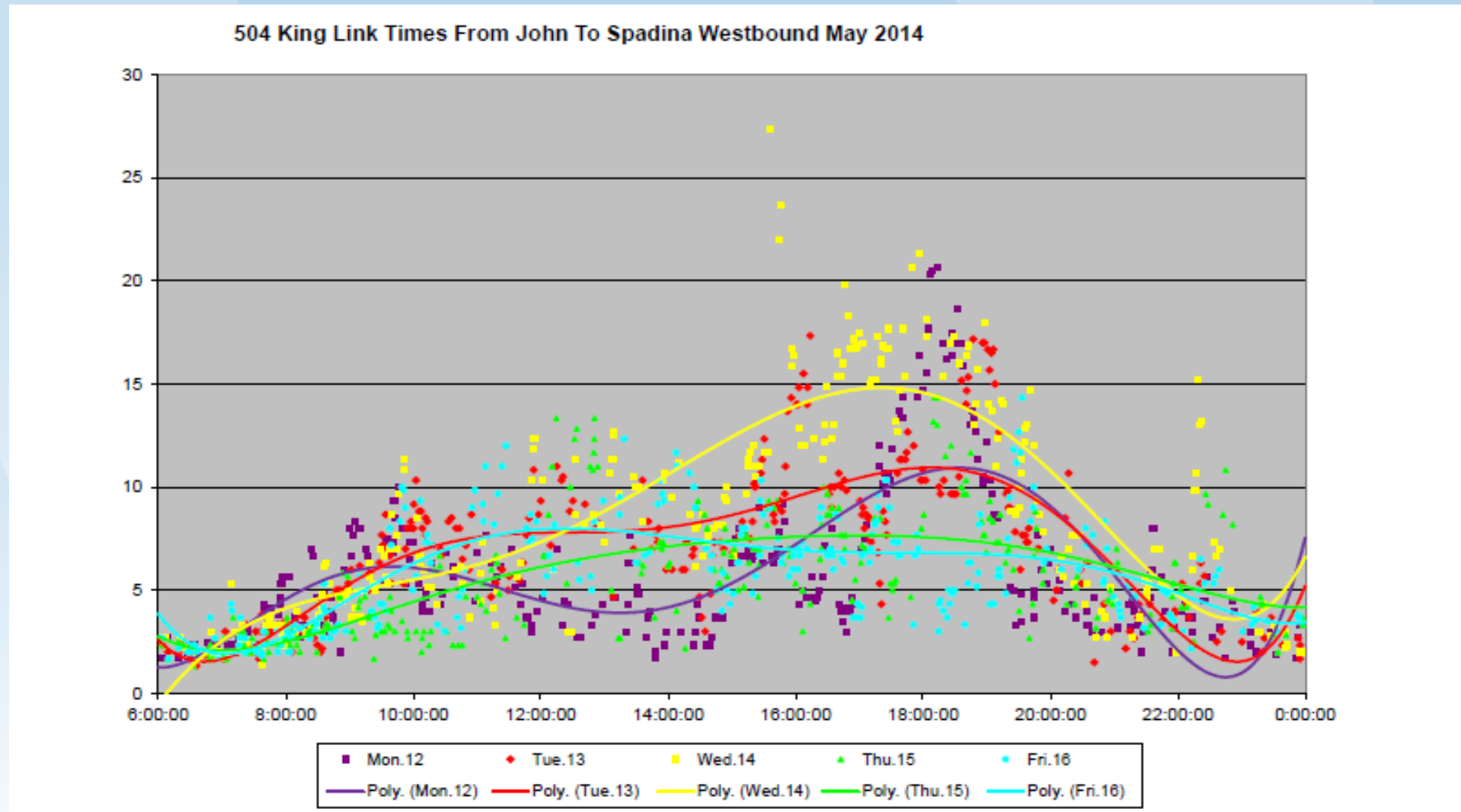
What we were seeing in Toronto



TTC AVL Data



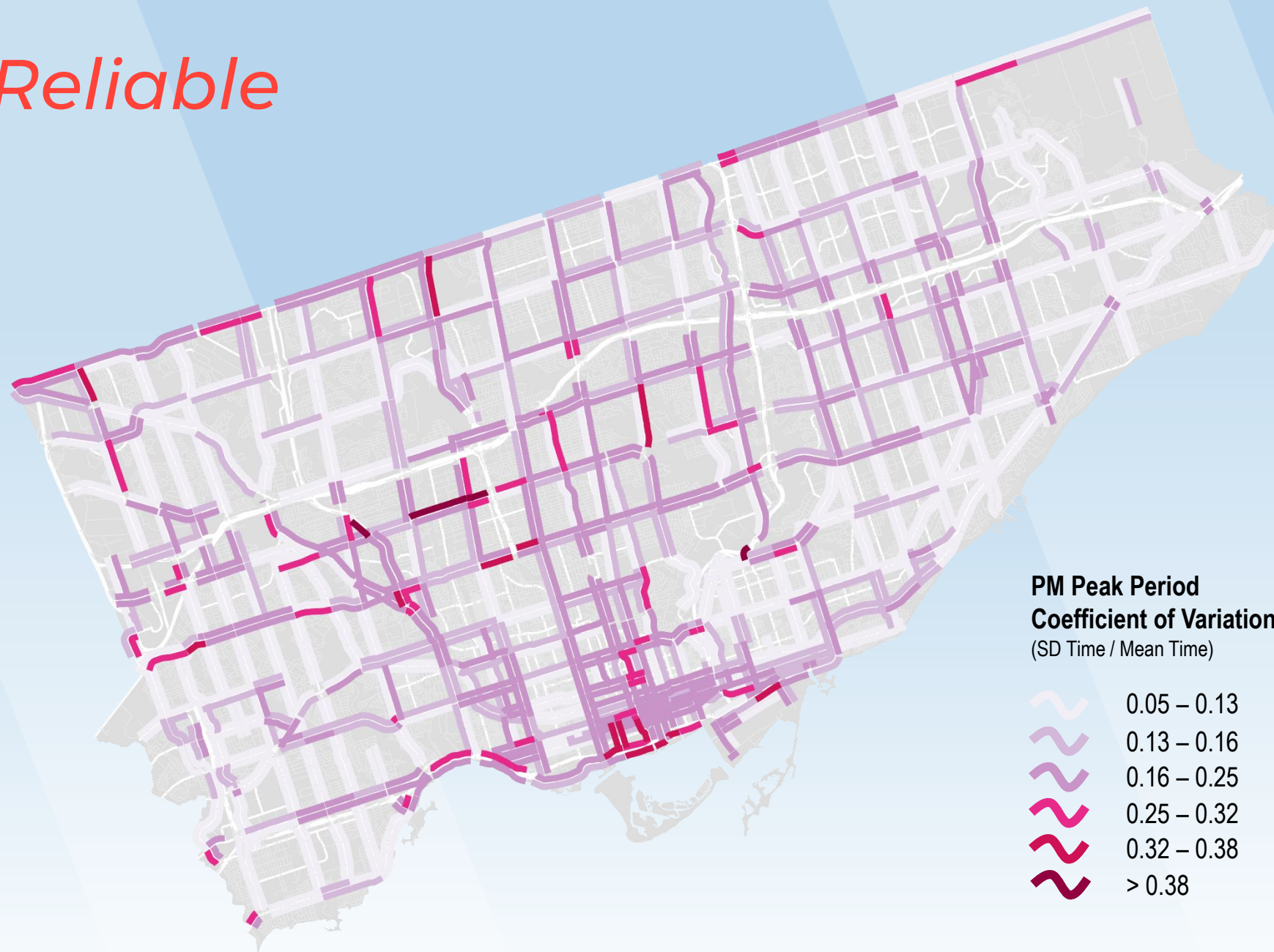
TTC AVL Data



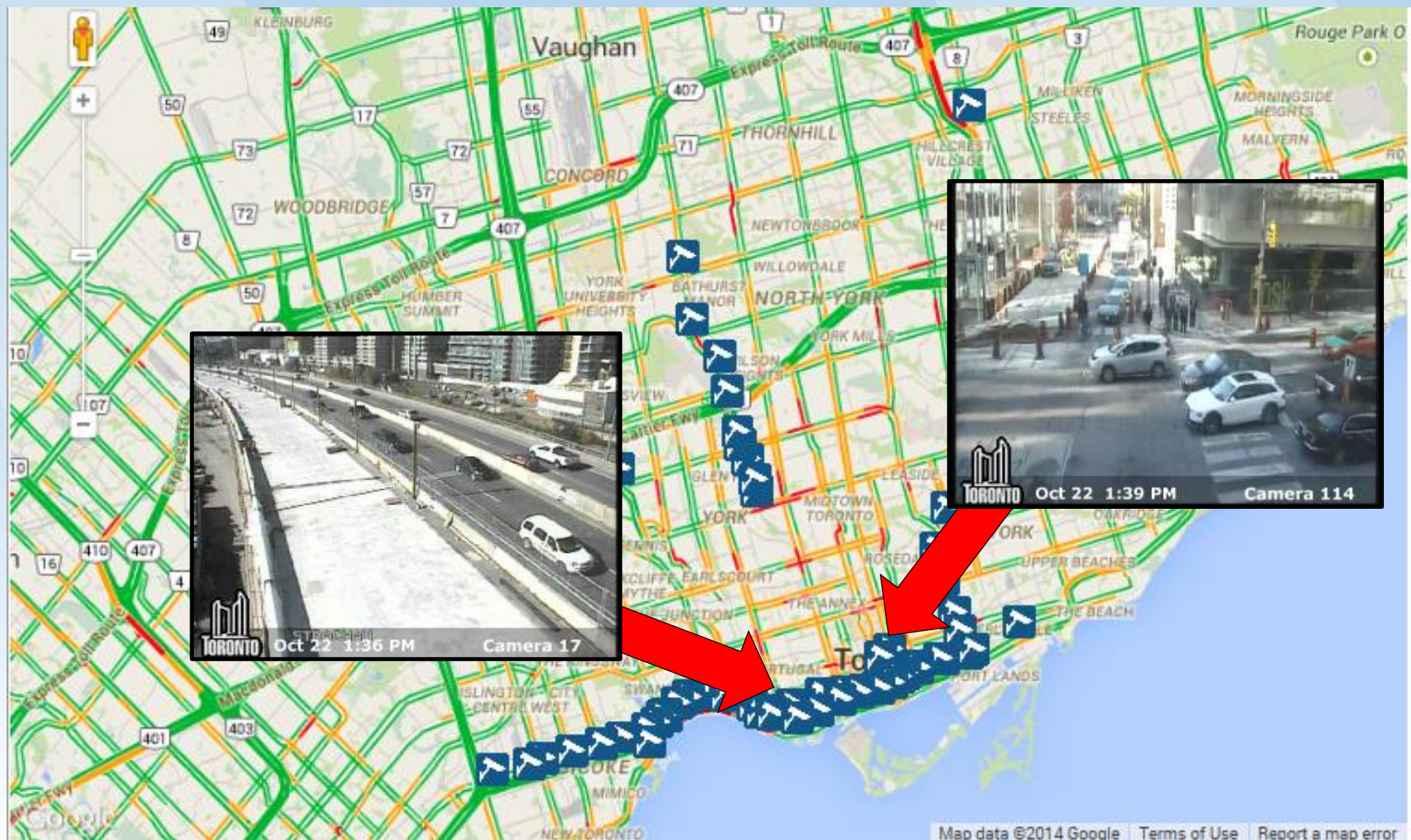
Factors Impacting Congestion and Variability

- Regional Growth
- Private Sector Construction
- Public Sector Construction
- O&M (repairs, winter maintenance, new connections, etc.)
- Rise of On-Demand Delivery
- Ride-hailing

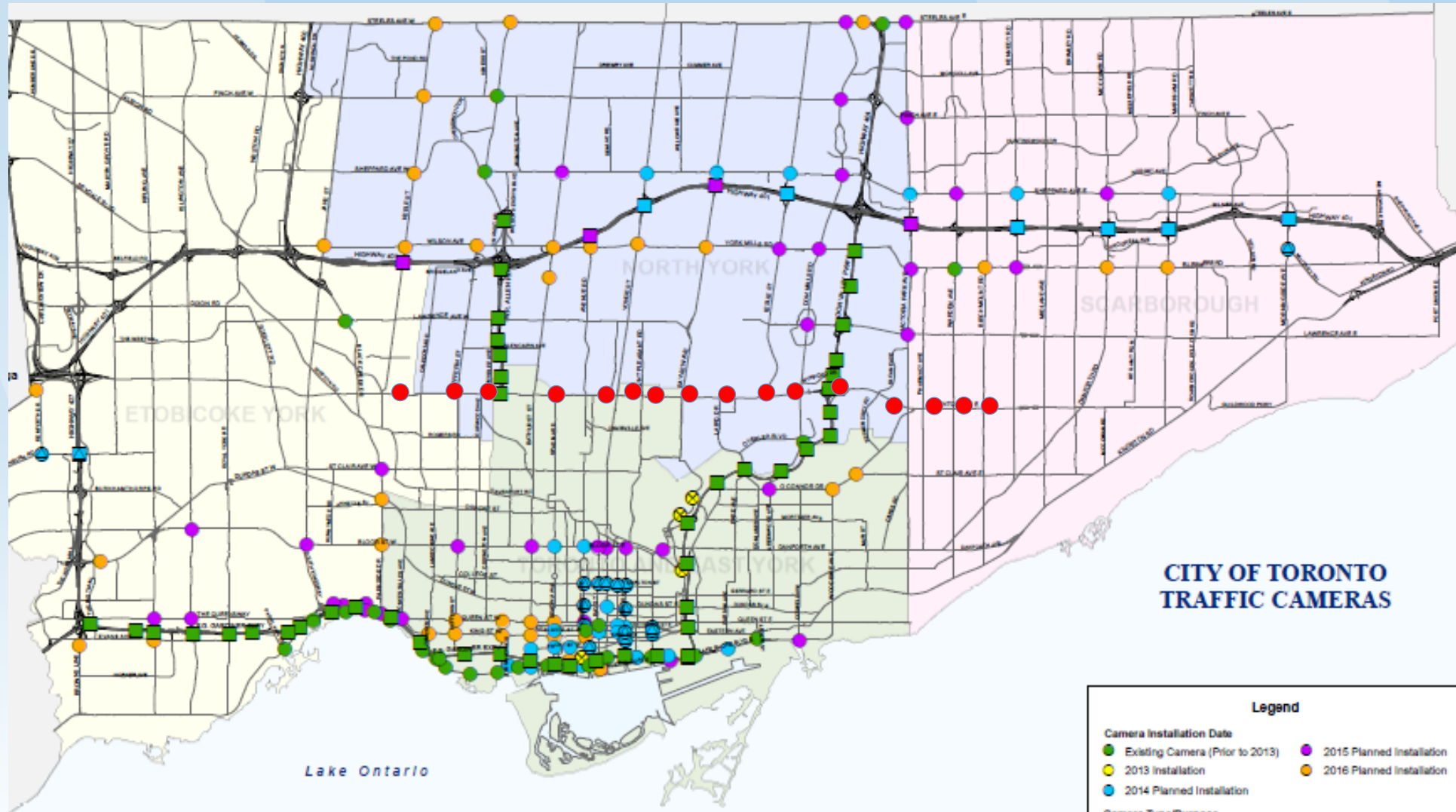
Least Reliable



Operations



Arterial Camera Program (2016 Build-out)



**CITY OF TORONTO
TRAFFIC CAMERAS**

Legend

Camera Installation Date

- Existing Camera (Prior to 2013)
- 2013 Installation
- 2014 Planned Installation
- 2015 Planned Installation
- 2016 Planned Installation

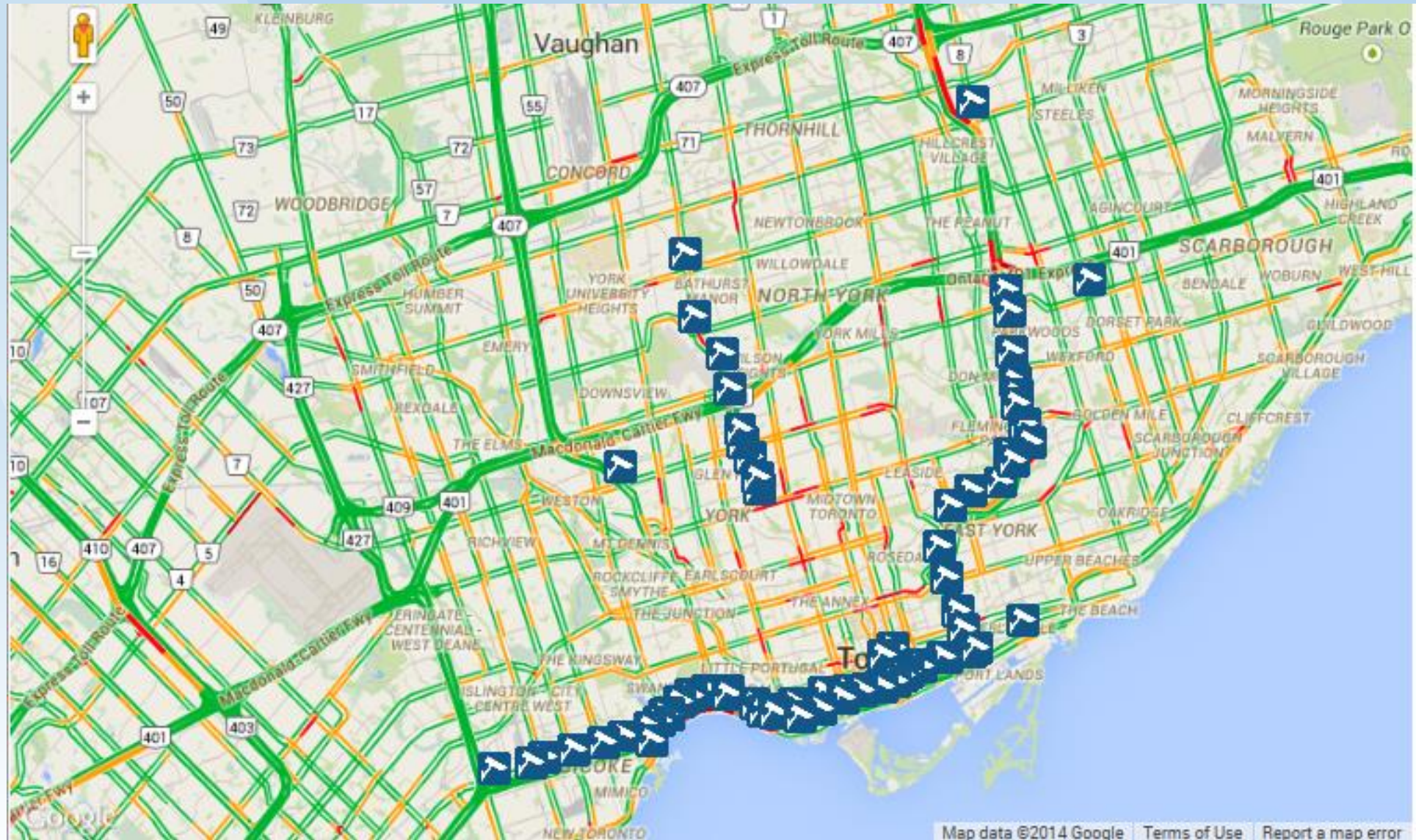
Camera Type/Purpose

- Expressway Camera
- Arterial Camera
- Flood-Prone Area
- Pan-American Games
- 10 Most Congested Locations

Transportation Operations Centre



Not Speed....but “Different from Normal”

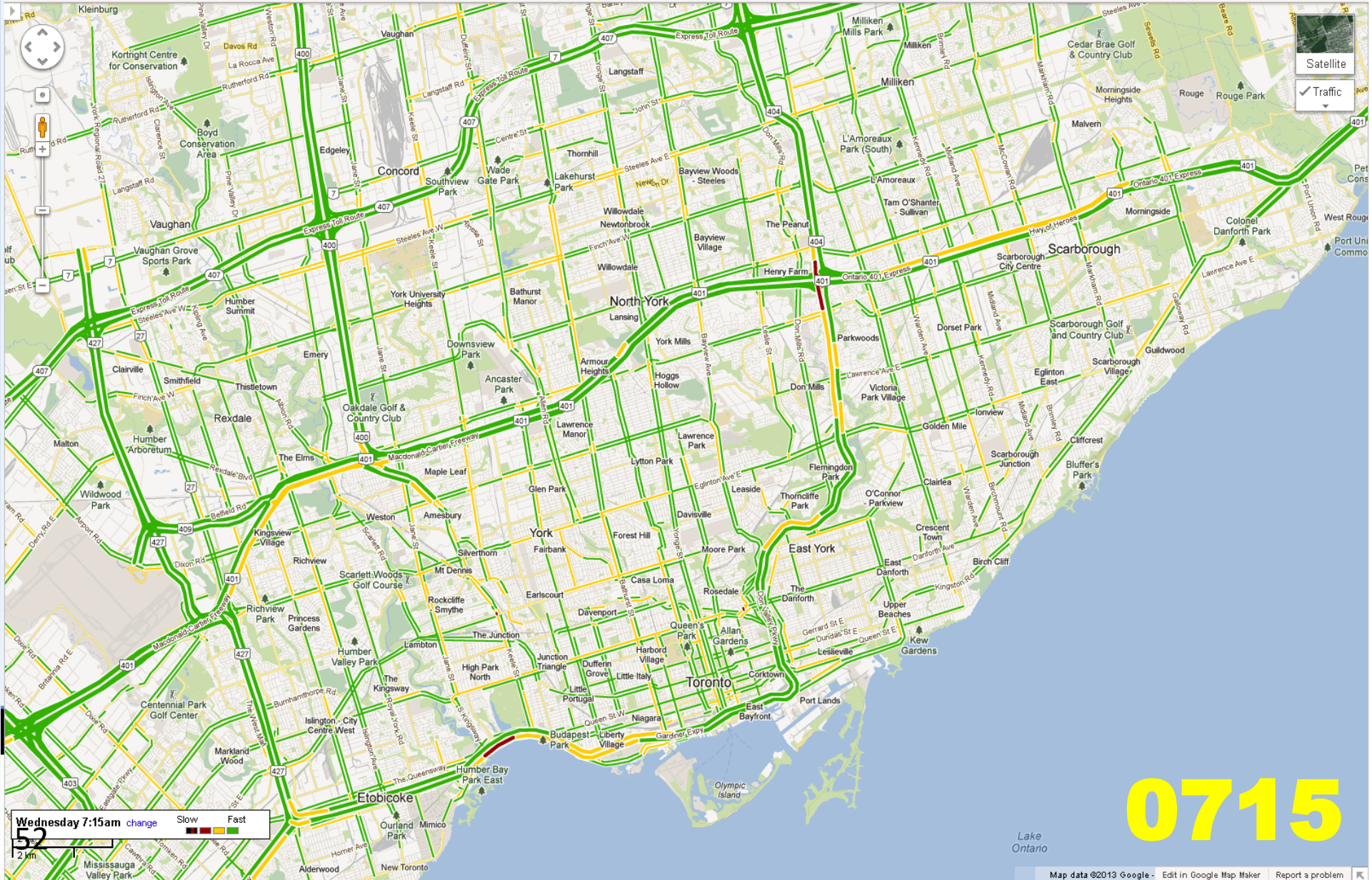




Search bar with microphone icon

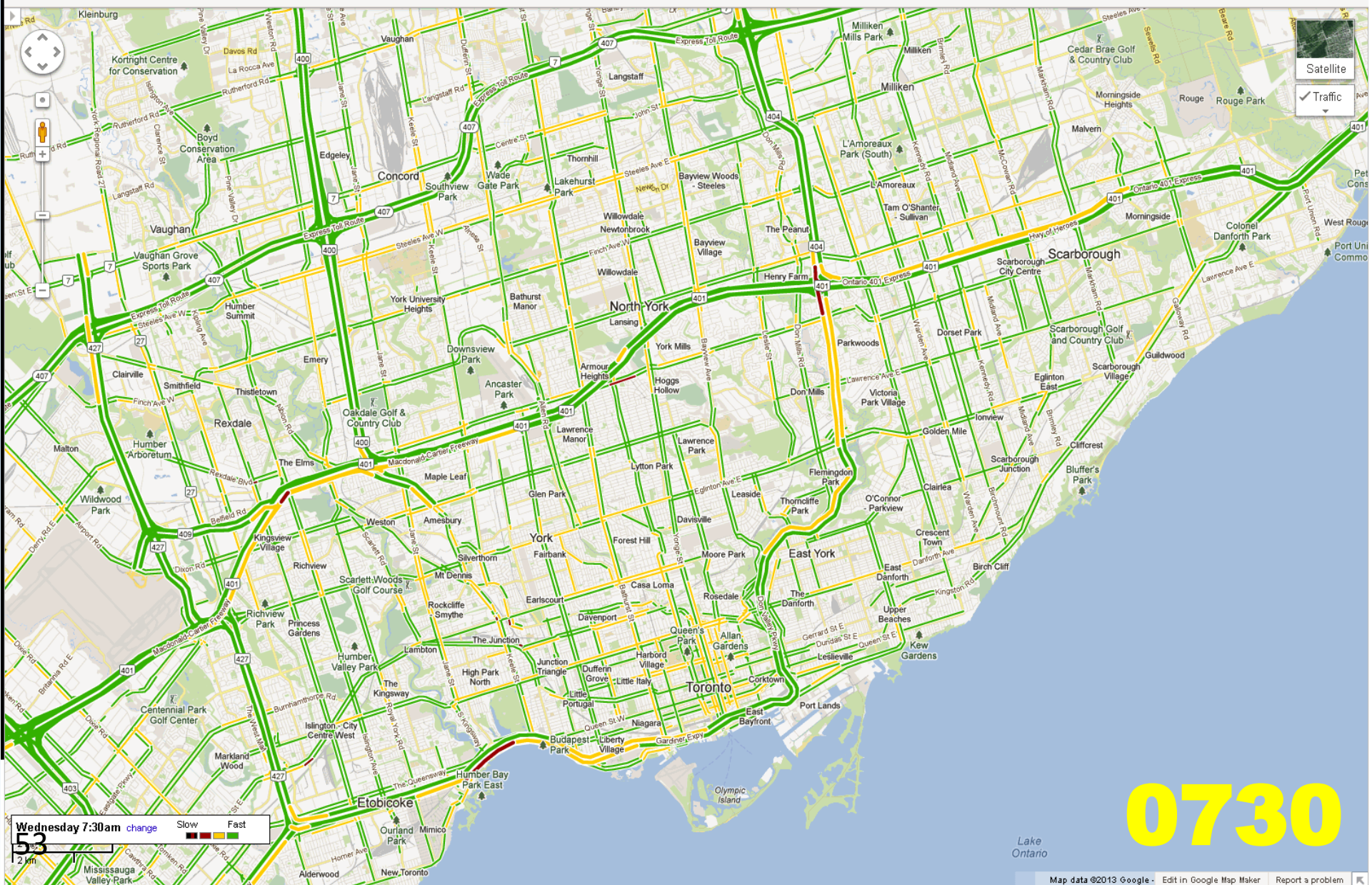


SIGN IN

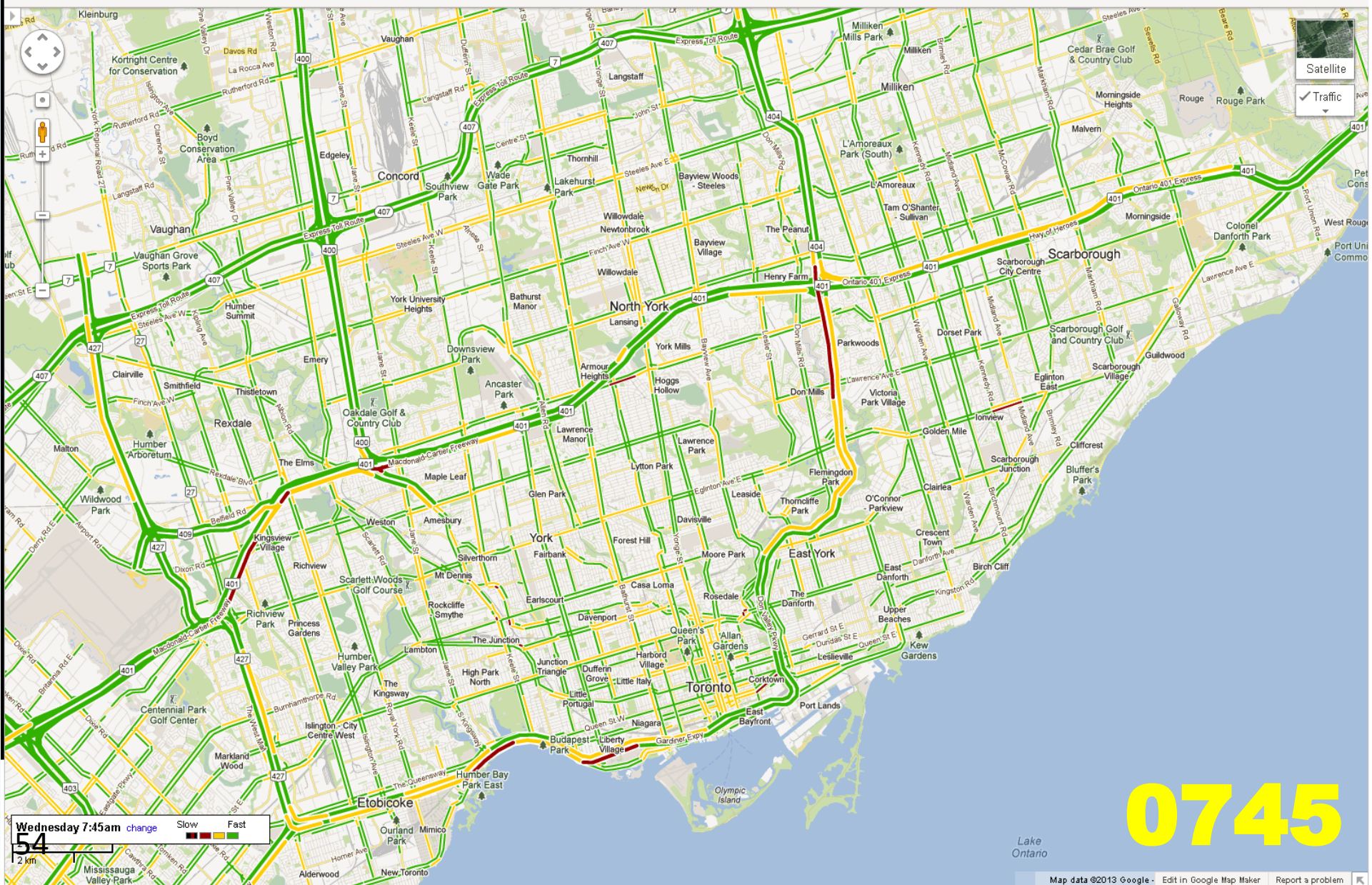


0715

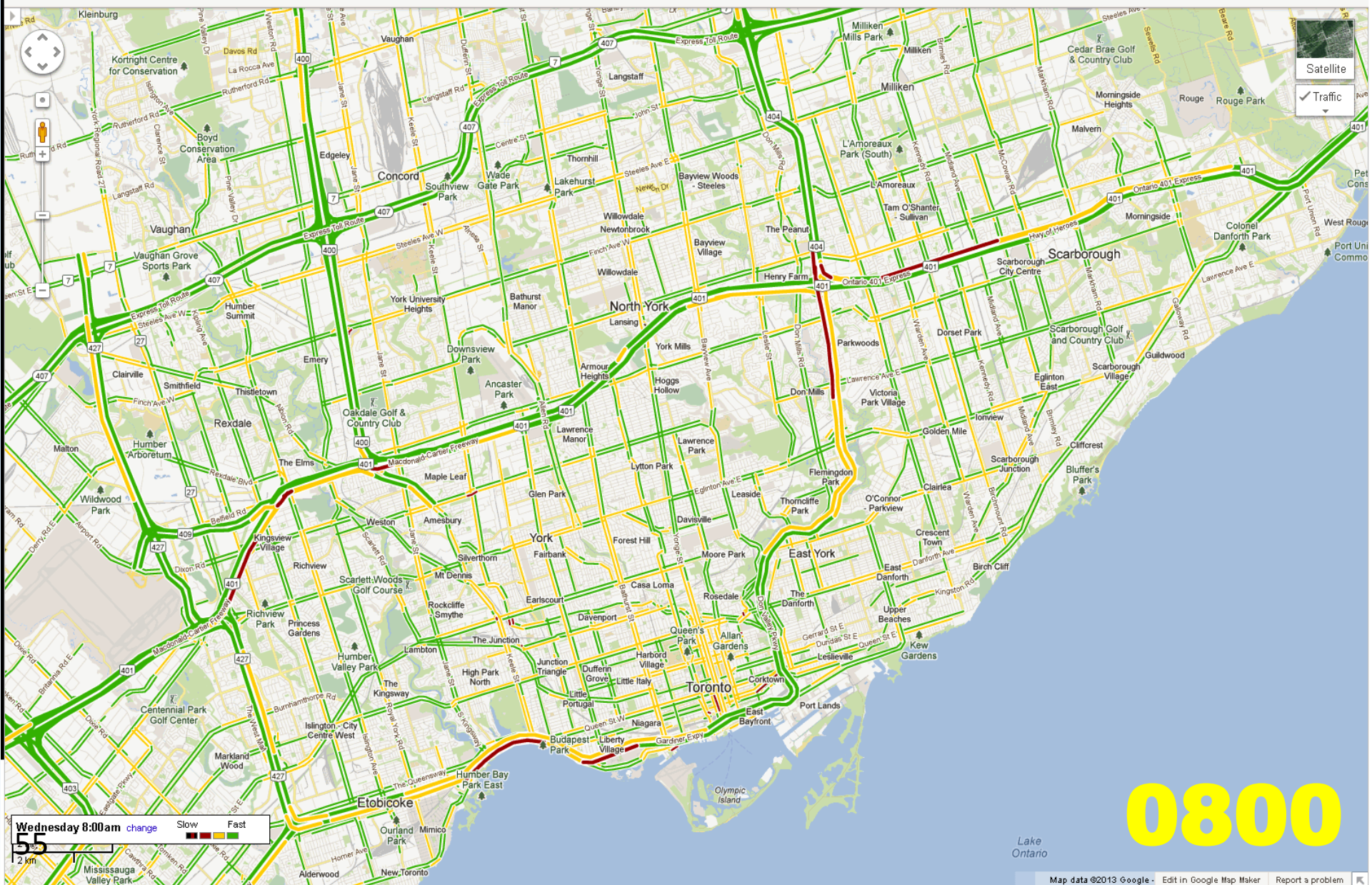
Lake Ontario

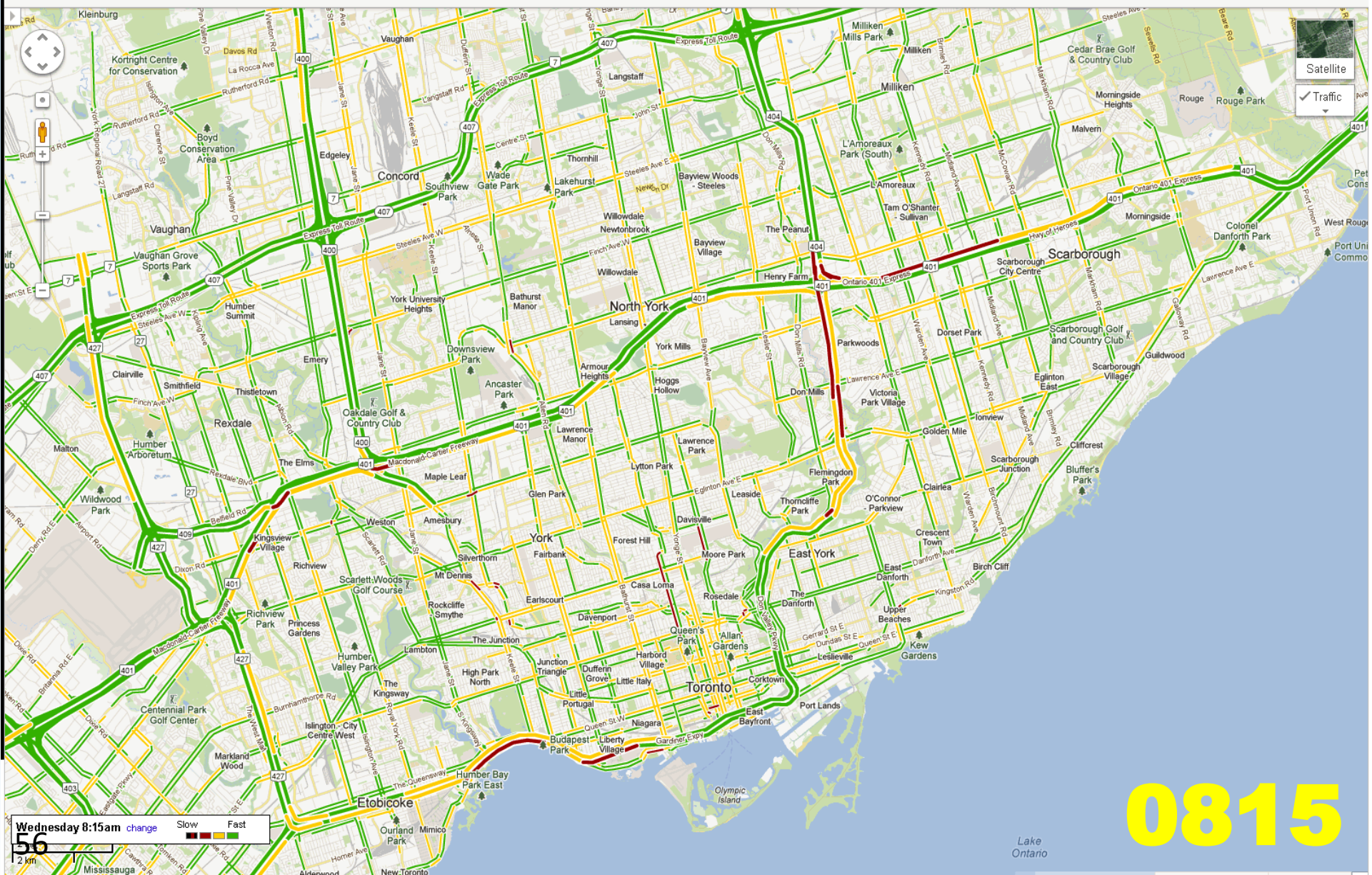


0730



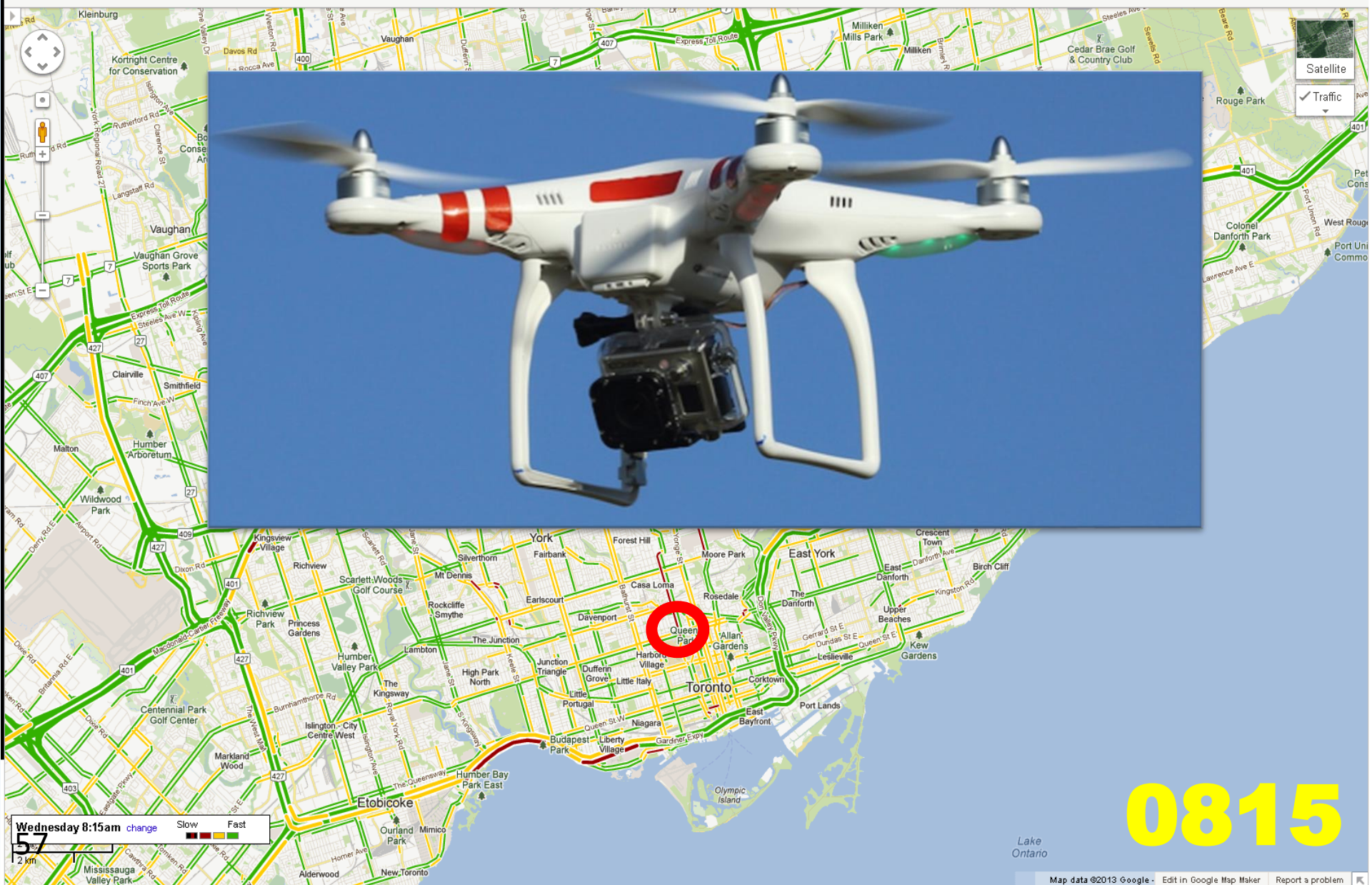
0745





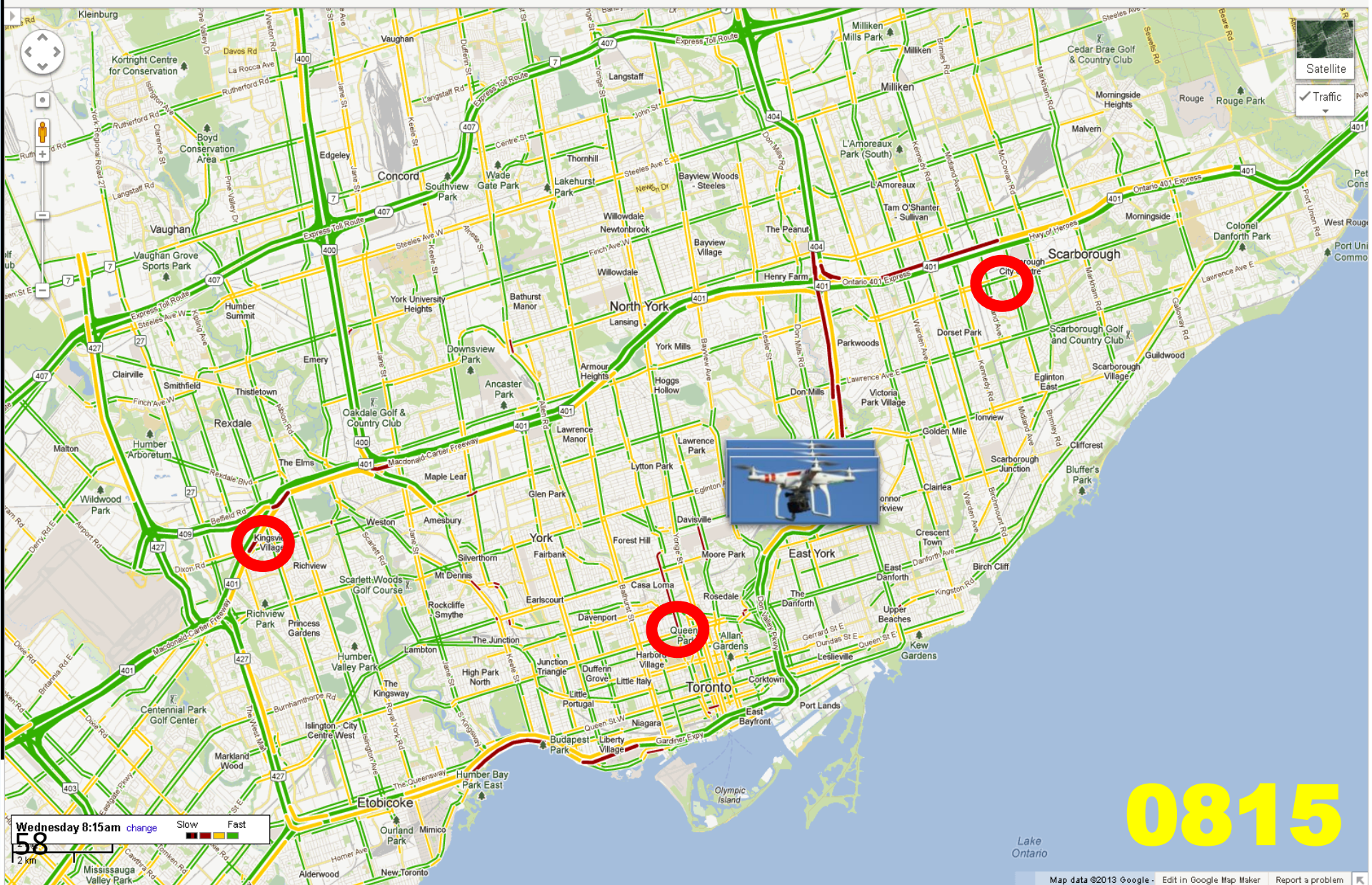
0815

Lake Ontario



0815

Lake Ontario



0815

Lake Ontario

UAV Demo



UAV Demo



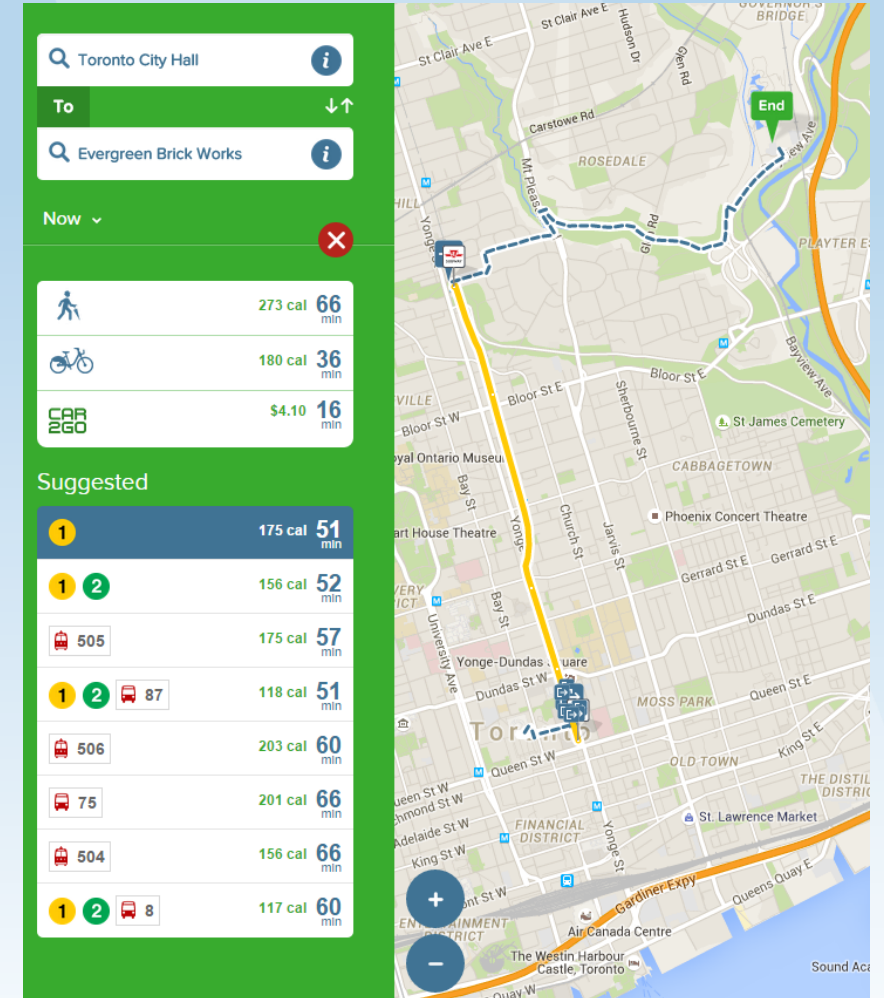
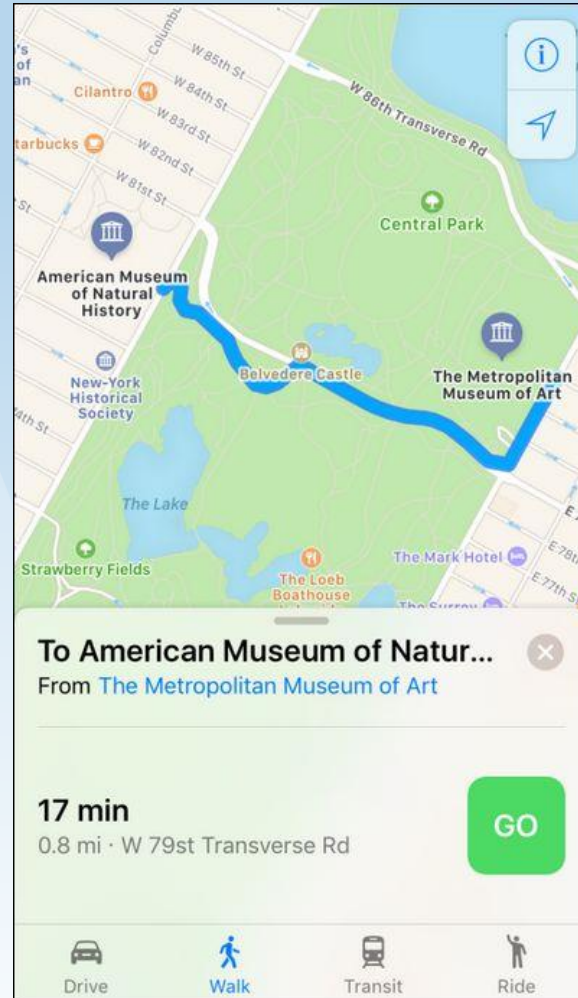
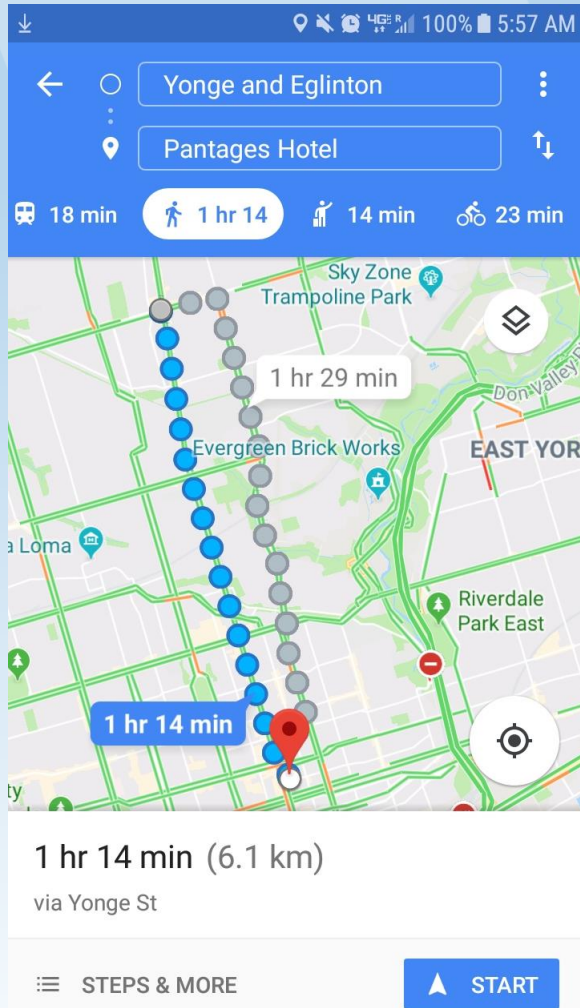
UAV Demo





Predicting

Predictive Tools



Predictive Tools



waze



Google
Maps

GreenO₂OWL
mobile



Actionable Information

1 Data Sources

PROBE



Cycling App



TTC AVL



Bluetooth Probe



GPS Probe

COUNT



Cycle & Ped Counts



RESCU Detectors



Traffic Counts

EVENT



Weather



Road Closures



Collisions / Incidents

2 Projects

1. VALIDATING

- Validating GPS Probe Data

2. DESCRIBING

- Measuring Congestion
- Measuring Reliability
- Impact of Incidents
- Non-Recurring Congestion

3. EVALUATING

- Peak Hour Clearance
- Before/After Studies
- Incident Response Time

4. OPERATIONAL

- Arterial Monitoring
- Positioning Emergency Response

3 Key Questions

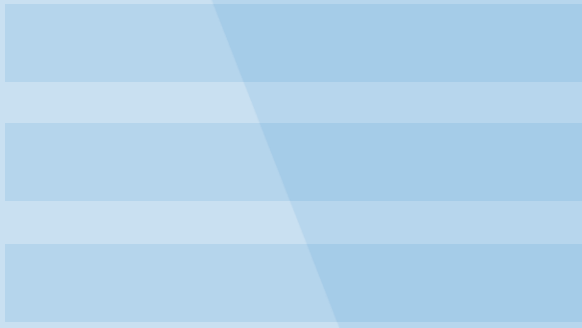
- What questions can be addressed under each project?

4 Potential Actions

- What actionable information will these projects supply?

2. DESCRIBING

PROBE



GPS Probe

COUNT

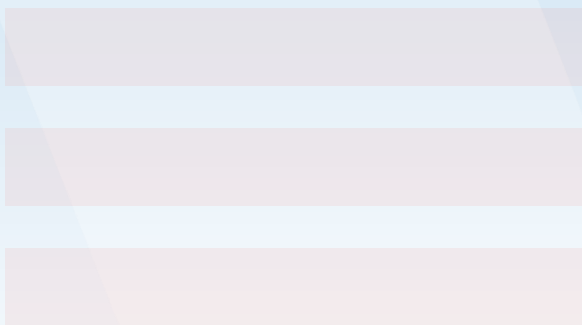


RESCU Detectors



Traffic Counts

EVENT



1. VALIDATING

- Validating GPS Probe Data

2. DESCRIBING

Measuring Congestion

- Measuring Reliability
- Impact of Incidents
- Non-Recurring Congestion

3. EVALUATING

- Peak Hour Clearance
- Before/After Studies
- Incident Response Time

4. OPERATIONAL

- Arterial Monitoring
- Positioning Emergency Response

Key Questions

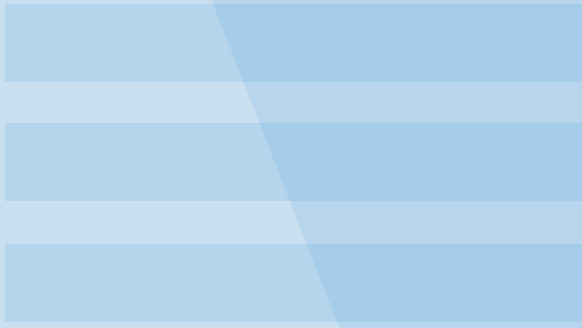
- How is congestion changing?

Potential Actions

- Ability to communicate congestion to the public
- Better understanding for policy, planning and operational decisions
- Audits of segments and intersections for bottlenecks

2. DESCRIBING

PROBE



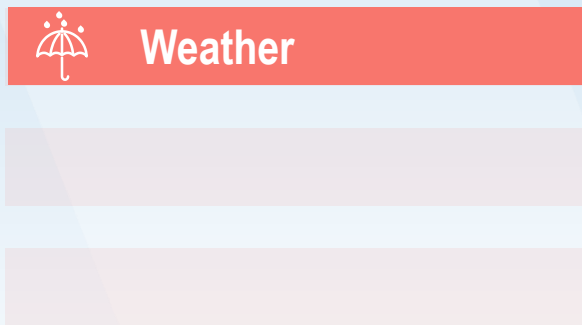
GPS Probe

COUNT



RESCU Detectors

EVENT



Weather

1. VALIDATING

- Validating GPS Probe Data

2. DESCRIBING

- Measuring Congestion



Measuring Reliability

- Impact of Incidents
- Non-Recurring Congestion

3. EVALUATING

- Peak Hour Clearance
- Before/After Studies
- Incident Response Time

4. OPERATIONAL

- Arterial Monitoring
- Positioning Emergency Response

Key Questions

- What are the least reliable roads? And why?

Potential Actions

- Warn the public of anticipated impacts
- Target traffic management resources more effectively

2. DESCRIBING

PROBE

 **Bluetooth Probe**

 **GPS Probe**

COUNT

 **RESCU Detectors**

EVENT

 **Collisions / Incidents**

1. VALIDATING

- Validating GPS Probe Data

2. DESCRIBING

- Measuring Congestion
- Measuring Reliability

 **Impact of Incidents**

- Non-Recurring Congestion

3. EVALUATING

- Peak Hour Clearance
- Before/After Studies
- Incident Response Time

4. OPERATIONAL

- Arterial Monitoring
- Positioning Emergency Response

Key Questions

- What are the impacts of incidents / collisions on travel times?

Potential Actions

- Make the case for better incident response

CANADA November 6, 2017 9:17 am Updated: November 6, 2017 1:44 pm

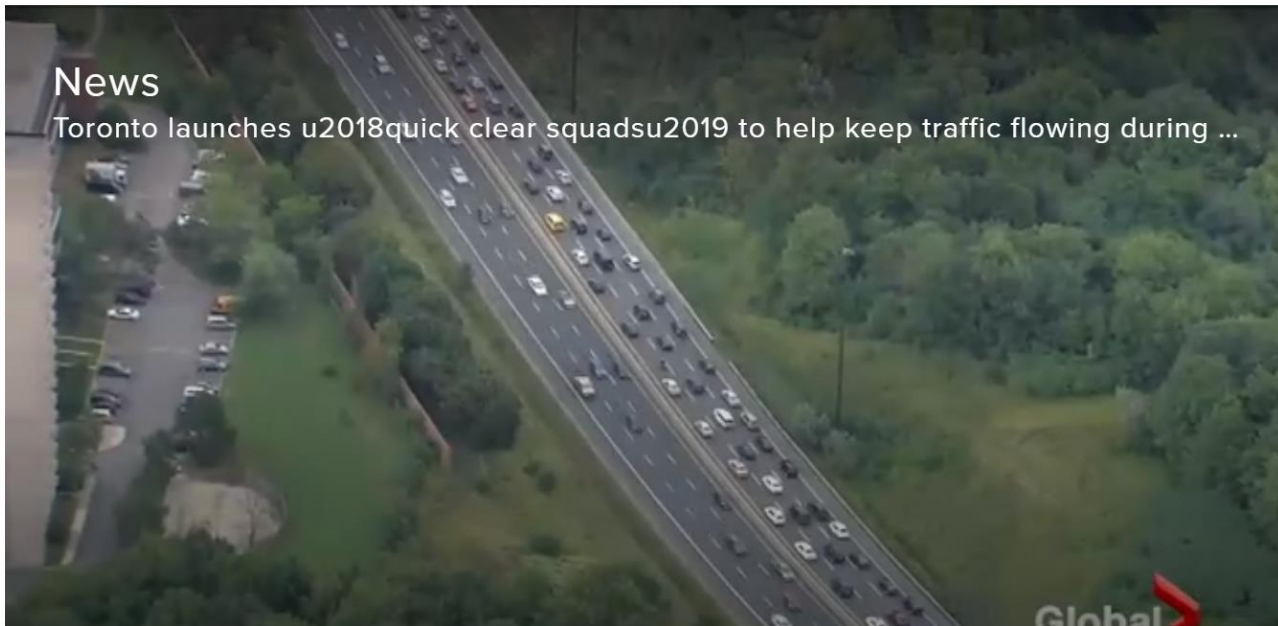
'Quick clear squad' pilot project on DVP, Gardiner receives positive reviews



By David Shum

Digital Broadcast Journalist Global News

- Comments
- Facebook 24
- Twitter
- Email
- Print
- ...



WEATHER Toronto, ON 📍

2°
Hi 11°
Lo 5°

Weather Few Clouds ➤

Traffic Travel times & Incidents ➤

Grooming Tips for The Everyday Gentleman ✓

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Building Capacity

Integration of Skill Sets

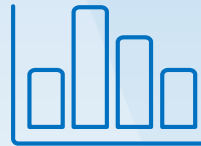
Statistics / Data Analysis



Computer Science



Design & Visualization



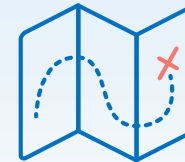
Database / Data Management



Transportation



Cartography / GIS



Technology and Analytics Team

- Build capacity and embed within your organization
- Dedicate resources
- Establish partnerships with academia
- Build a pipeline through internships
- Ensure a strong champion

Transportation

- Road Safety
- Winter Maintenance
- Traffic Conditions and Restrictions
- Maintenance and Traffic Management
- Cycling
- Walking
- Beautiful Streets
- StreetARToronto
- Graffiti Management
- Parking Permits
- Street Events
- Construction Permit Information

Transportation Share 3



Big Data Innovation

The Big Data Innovation team was created in 2015 with the mission of leveraging emerging transportation datasets together with existing City data to develop a new understanding of transportation issues across all modes in the City. The focus of the Big Data Innovation Team will be on conducting practical analyses of transportation data to be able to more easily measure the impact and benefits of policies and solutions. The team will be partnering with researchers and will focus on providing excellence in the communication and visualization of findings.


The Innovation Team will begin by building on some current work being conducted by Transportation Services, including:

- Partnering with McMaster University to analyze historical travel data on city

Contact Us

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 Toronto, ON M5H 2N2
 E: jcolema3@toronto.ca

Google: Toronto Big Data Innovation



Metro

- Going Metro >
- Projects >
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- Comments
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- Accessibility

Office of Extraordinary Innovation

[Extraordinary Innovation](#) [Initiatives & Interests](#) [Who We Are](#)

The Source

[SIGN UP FOR OUR NEWSLETTER](#)

We live in extraordinary times. While Los Angeles presents some of the toughest mobility challenges in America, the world is experiencing levels of transportation innovation unprecedented in recent memory. And these changes are in turn redefining what an agency like Metro should be.

To take advantage of the promise offered by these opportunities, Metro has set a goal to be the most innovative transportation agency in the country, ensuring that we are using every tool at our disposal to help improve mobility in LA County.

With that in mind, **the Office of Extraordinary Innovation** was established to explore new ways to move LA by finding and testing leading-edge ideas that have potential to improve mobility for the people in the region. From public private capital partnerships to cutting edge new technologies, OEI is tasked with identifying, evaluating, developing, and implementing these new approaches. These efforts may be undertaken by Metro on its own or jointly in collaboration with private sector firms through [public-private partnership](#)

Newsletter Archive ^

- February 2018
- September 2017
- January 2017
- October 2016
- August 2016

Off Peak Podcast v

OEI in the News v






Whitepapers v

P3 Resources v

Internal Consulting v

Advisory Board v

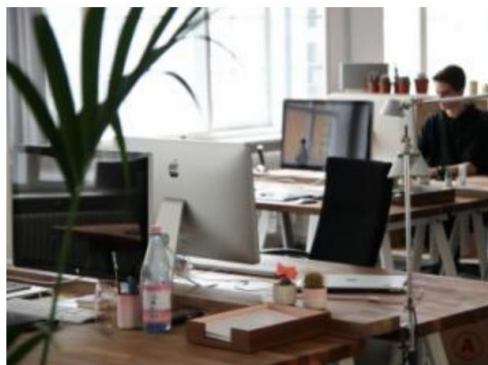
Contact v





Public Procurement Technology Innovation Labs Launching in Los Angeles via Public Spend Forum's Collaboration with the Los Angeles Mayor's Office

May 09, 2018



Public Spend Forum which is a market intelligence platform and community for public sector buyers and suppliers is collaborating with the **Los Angeles Mayor's Office** to launch a new lab that showcases new and disruptive approaches and technologies in government called the Public Procurement Technology and Innovation Labs. The Innovation Labs will serve to connect emerging and established procurement technology firms, experts, and entrepreneurs with

government agencies when it launches on June 6th, 2018. The **Shatter Fund** which invests capital in

TRANSPORTATION

< BIG DATA / >

FOR BIG CITIES CONFERENCE
JUNE 12 - 15 / TORONTO, CA

The Big Transportation Data for Big Cities Conference will enable city transportation officials, technical staff, academics, and public sector and industry leaders from **18 big cities across North America** to commence dialogue on the practical and actionable use of urban transportation data. The platform will provide an opportunity for

- City transportation officials to engage and educate the industry about city transportation data wants and needs;
- Cities to share knowledge, experiences, and best practices with each other;
- Academics to show how to blend cutting edge data with pragmatic solutions and ideas;

<http://bigdatabigcities2016.org/>

DC Mobility Report

d.

GOVERNMENT OF THE DISTRICT OF COLUMBIA
MURIEL BOWSER, MAYOR

District Mobility: Multimodal Transportation in the District

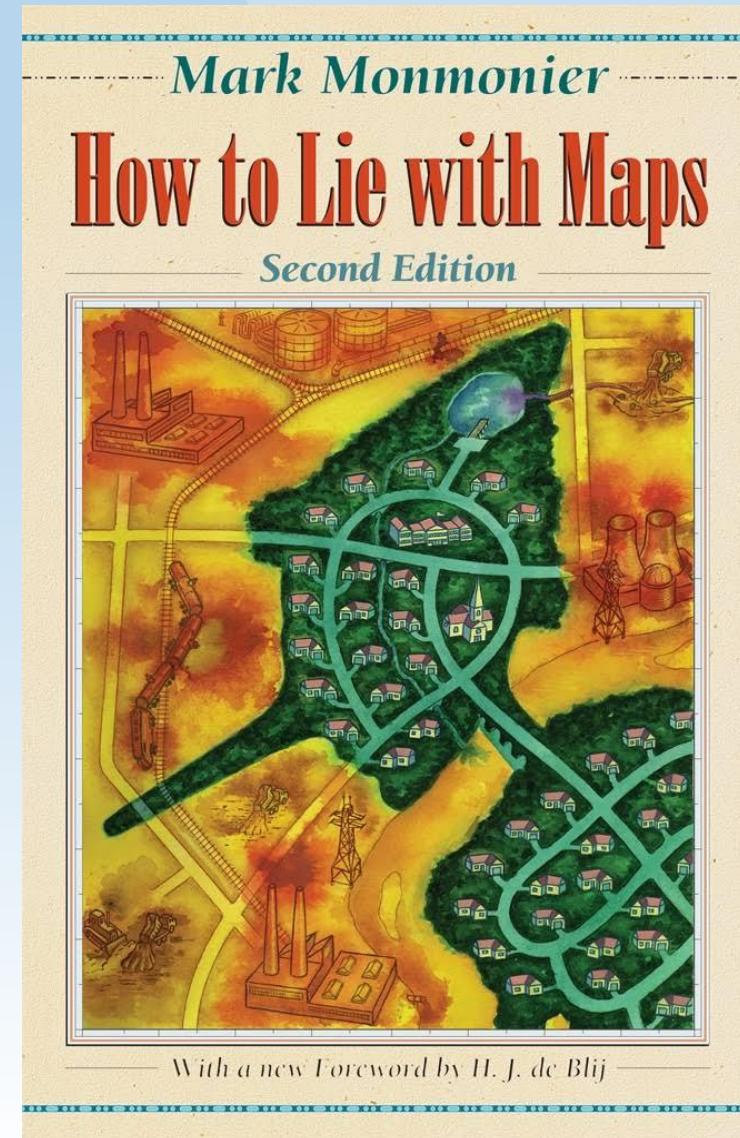
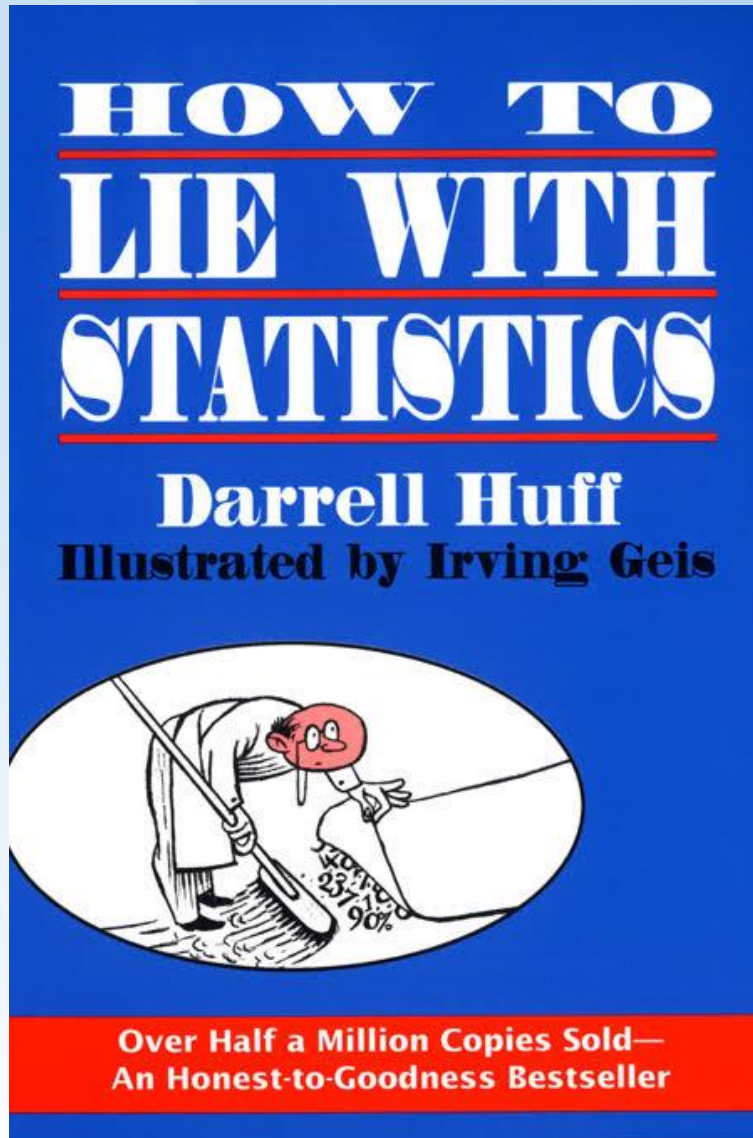
START EXPLORING

Severns, Kelley
Meeting Forward Notification: Skype Session on Use of Bi...
Tuesday, April 18, 2017 12:00 PM-1:00 PM (UTC-05:00) Eas...
Skype Call

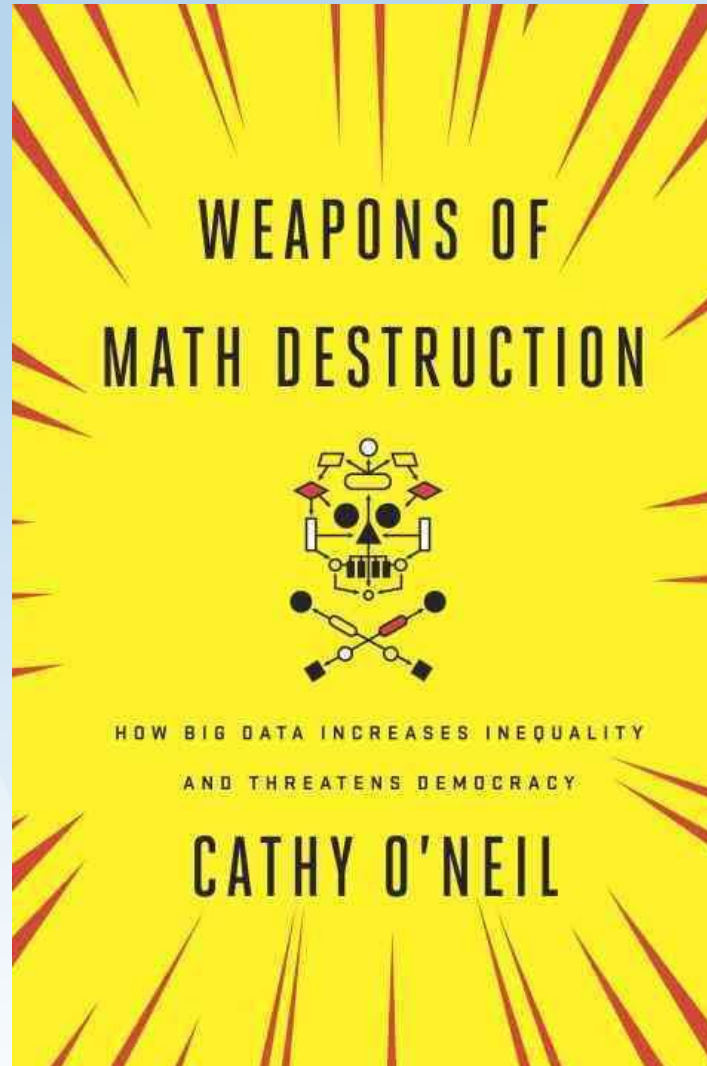
Getting Started

- Partner with an institution that can support you
- Prepare an inventory of existing City data sets
- Develop your “making the case” strategy for generating support
- Conduct research on existing and new data sets, including opportunities & limitations
- Develop a data improvement strategy; Investigate data procurement
- Avoid getting into primary data collection; consider purchasing information
- Identify quick win projects to show value
- Borrow liberally (R&D program)
- Perfect is the enemy of really good, but understand limitations!
- Manage the expectations of your senior leadership

Offense through Defense



Understanding the Dangers of Data-Driven Models



Practical Uses of Big Transportation Data for Cities and Municipalities



Stephen Buckley, P.E., AICP
stephen.buckley@wsp.com

