

STORMWATER CLIMATE CHANGE RISK ASSESSMENT

Climate Data Training Session
Chris Wolnik, Manager- Wastewater &
Stormwater Services



Global Issue-Municipal Impact



Aging
systems



More
regulatory
req'd



Flood
safety



Bowes Road & Rivermede.
July 2012

AGENDA

- Background
- Risk Assessment Process
 - Risk Identification
 - Vulnerability Assessment
 - Identify What if Scenarios
 - Risk Analysis
 - Establish Severity of Consequence & Likelihood
 - Risk Ranking
 - Risk Treatment
- Next Steps
- Summary



New climate in the York Region

Variable

2000-2009

OVERALL TREND

2040-2049

	Vaughan	Whitchurch – Stouffville	Richmond Hill	King Smoke Tree	Vaughan	Whitchurch - Stouffville	Richmond Hill	King Smoke Tree
Extreme Maximum Temperature	34.6°C	34.3°C	34.7°C	35°C	42.5°C	42.1°C	42.6°C	42.6°C
Extreme Minimum Temperature	-25.8°C	-27.8°C	-26°C	-27.2°C	-12.5°C	-14.8°C	-13.7°C	-14.2°C
Number of days less than or equal to 0°C	66.1	75.7	65.9	71.1	13.3	13.7	13.7	18.4
Number of days greater than or equal to 30°C	8.1	4	8.1	7	42.9	41.5	41.5	34.6
Extreme daily rainfall	80.7mm	102.9mm	98.3mm	79.1mm	155.4mm	116.1mm	136.3mm	84.4mm
Extreme daily snowfall	30.5cm	40.5cm	31cm	43.8cm	18.6cm	28.8cm	34.4cm	27.1cm
Number of days with rainfall greater than or equal to 50 mm	4.2	6.6	5.2	6.5	3.2	3.2	2.7	2.9

Climate Change Working Group:



Lake Simcoe
Region
Conservation
Authority



Goal:

- to share leading practices climate change management
- comment collaboratively on climate change issues
- provide mutual learning and networking

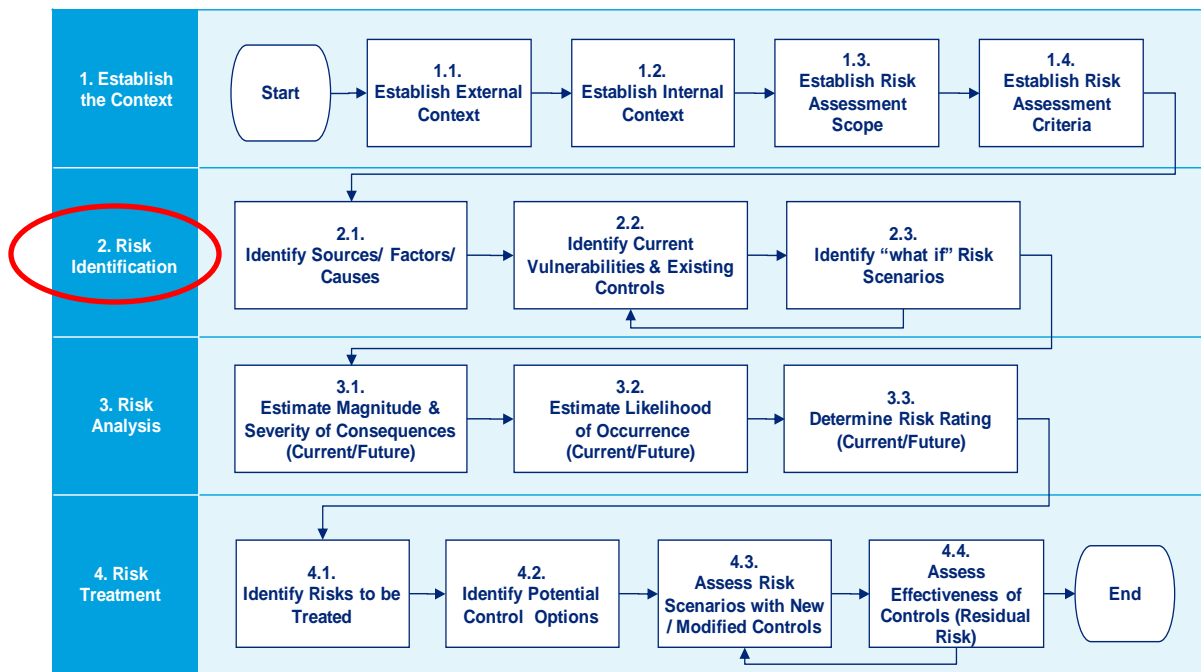
In 2014 a joint climate change risk assessment training was conducted for SW& WW assets using the City of Toronto Env. Risk Assessment Tool



RISK ASSESSMENT PROCESS

Climate Change Risk Assessment for City of Vaughan – Storm water

The City of Toronto Tool Process



Risk Identification – Sources

Climate Change indicator	Frequency(1981-2010)	Frequency (2035 – 2065)	Project Threshold
Extreme Heavy 1-Day Total Rainfall	52.5mm in 1 day	77.9 mm average throughout the year	>100 mm
Heavy 1-Day Total Rainfall	22.5mm in 1 day	32.5mm average throughout the year	> 50 mm
Heavy 5-Day Total Rainfall	81.9mm in 5 days	129mm average throughout the year	5 day period >100 mm total
Rain Frequency (of at least 2 Consecutive Wet Days, where total precip > 1mm)	38 times per year	31 times per year	Number of days with >10 mm of rainfall
Days with rainfall >100mm	0 times per year	0.0 times per year	Days with rainfall >100mm
Days with rainfall >30mm	0.83 times per year	0.86 times per year	Days with rainfall >30mm
Number of days with >10mm of rain	22.7 times per year	27.8 times per year	Number of days with >10mm of rain
Winter Rain / Rain-on Snow (Total Precip > 25mm and Average Temperature Ranges between -2C and +2C)	2.4 times per year	0.1 times per year	> 25mm and Average Temperature Ranges between -2C and +2C)

Vulnerability Assessment Results

- aimed to generate a list of identified and prioritized climate change vulnerabilities for storm water assets owned and operated by the City of Vaughan
- Over 22 maps were created from the assessment

Map 1: Historical Flood Calls & Known Pipe Defects

Map 2: Low Lying Areas & Regional Storm Floodlines

Map 3: Catch Basins Overlaid with Depth to the Water Table

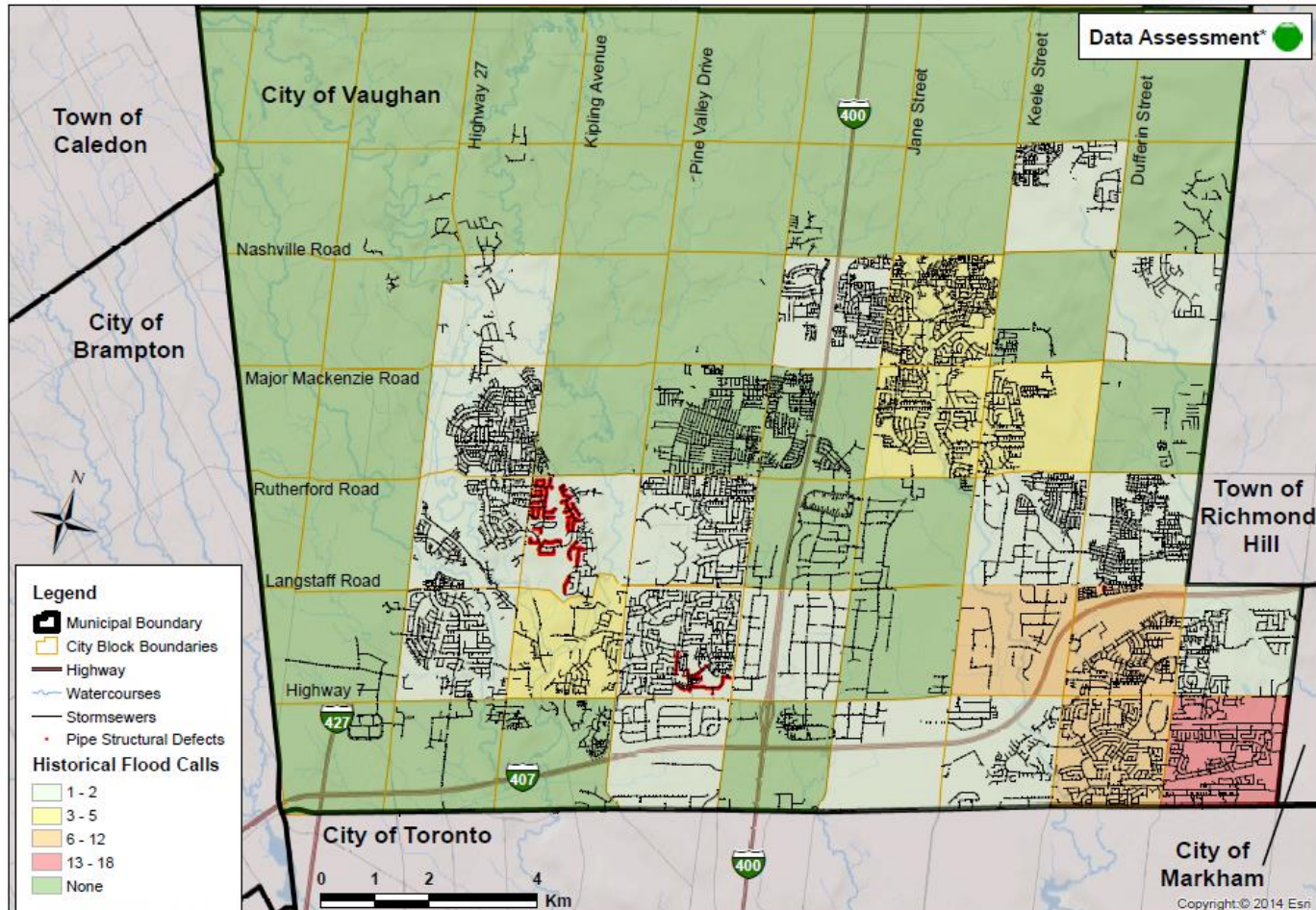
Map 4: Stormwater Pond Construction Date Overlaid with Storm Sewers

Map 5: Culverts Age and Rehabilitation Vulnerability

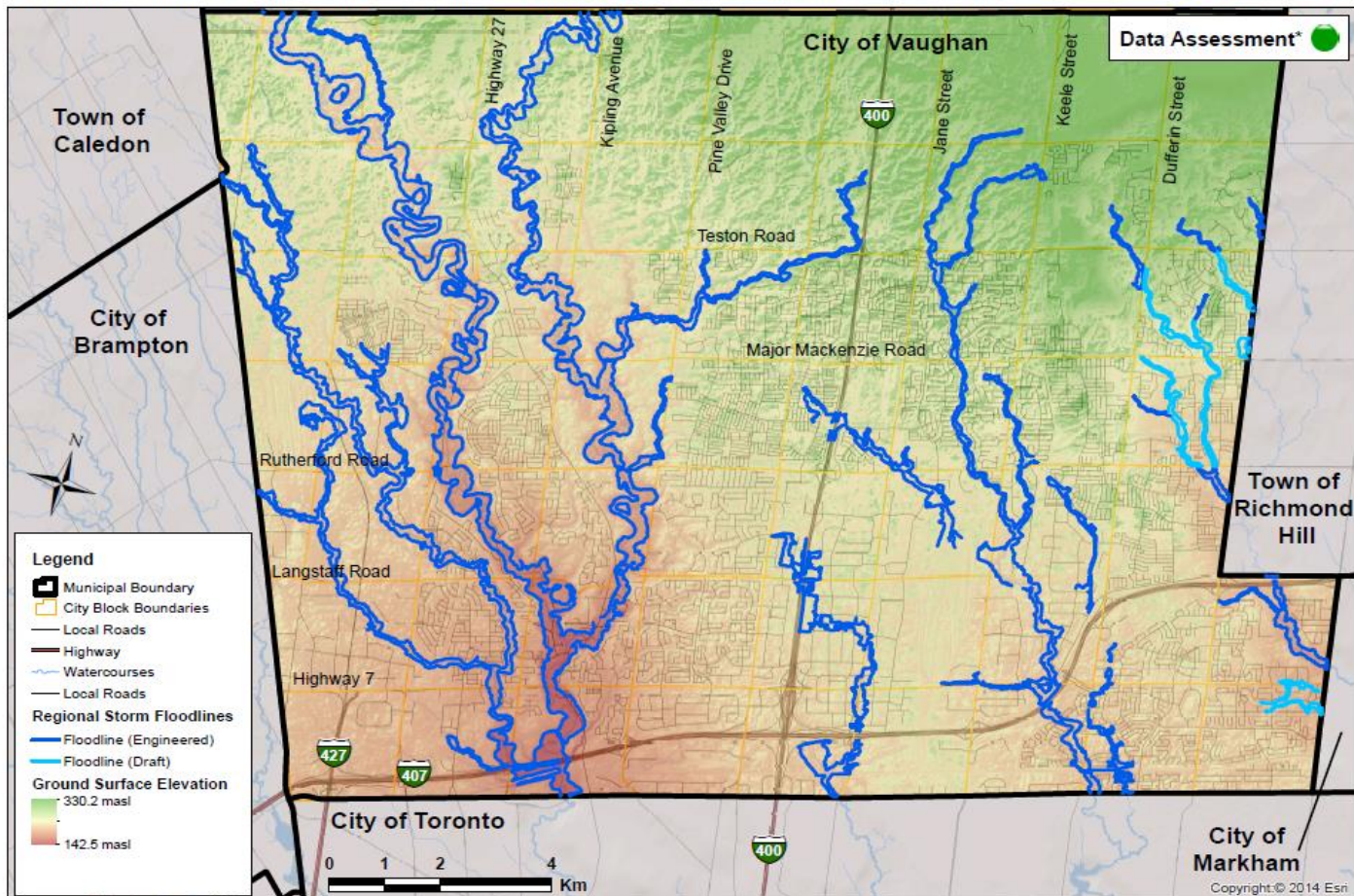
The categories of stormwater management assets that were assessed:

- Ponds
- Storm pipes (<450mm and >450mm)
- Ditches
- Culverts

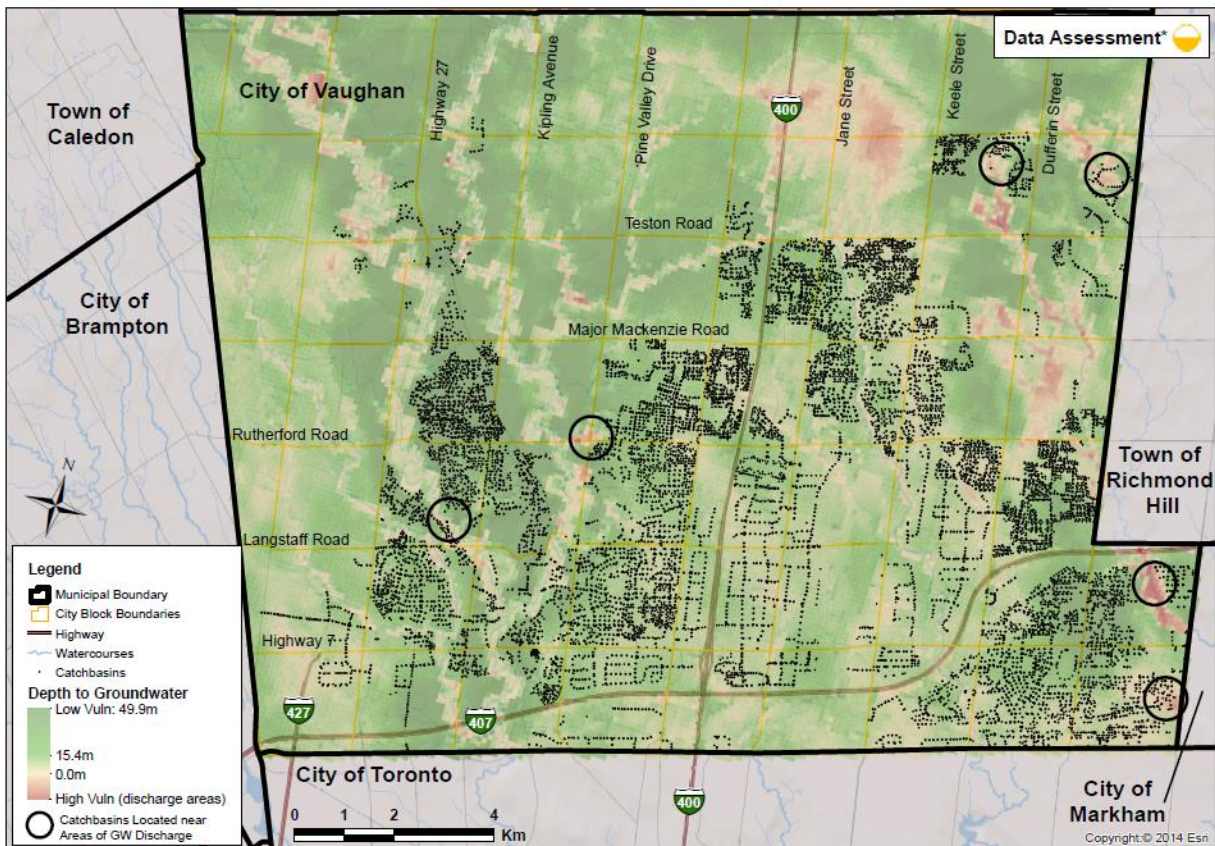
Asset Category	Map Title	Vulnerability Indicator	Vulnerability Factors
Stormwater System in General	Vaughan City Blocks with Identified Stormwater System Issues	Location	Location
	Low Lying Areas with Floodlines and Local Roads	Low Lying Areas (Potential for Higher Flows)	Local Topography
	Vaughan Land Use (Regional Zones)	Proximity to Residential Area	Proximity to Residential Area
Stormsewers	Stormsewer Vulnerability - Years Left in Asset Life (based on Material Lifespan & Construction Date)	Age and Pipe Material Index	Age
			Pipe Material (strength)
	Stormsewers in Low Lying Areas with Floodlines	Low Lying Areas (Potential for Higher Flows)	Local Topography



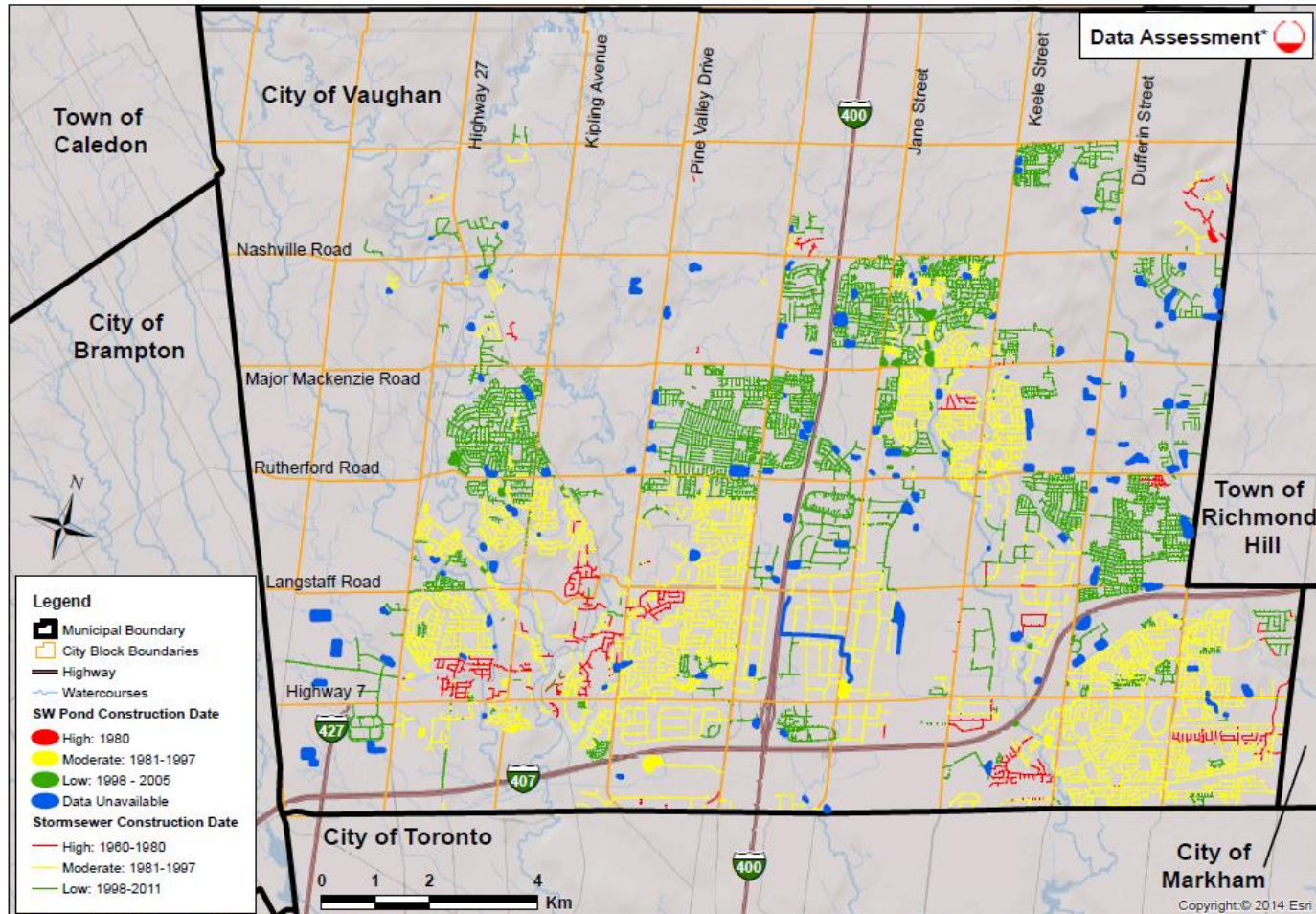
*The results of an assessment of the data are illustrated in terms of its 1) Level of Completeness (the 'fill' of the circle as low, medium or high) and 2) Level of Confidence as the colour of the circle in green (high), yellow (medium), and red (low).



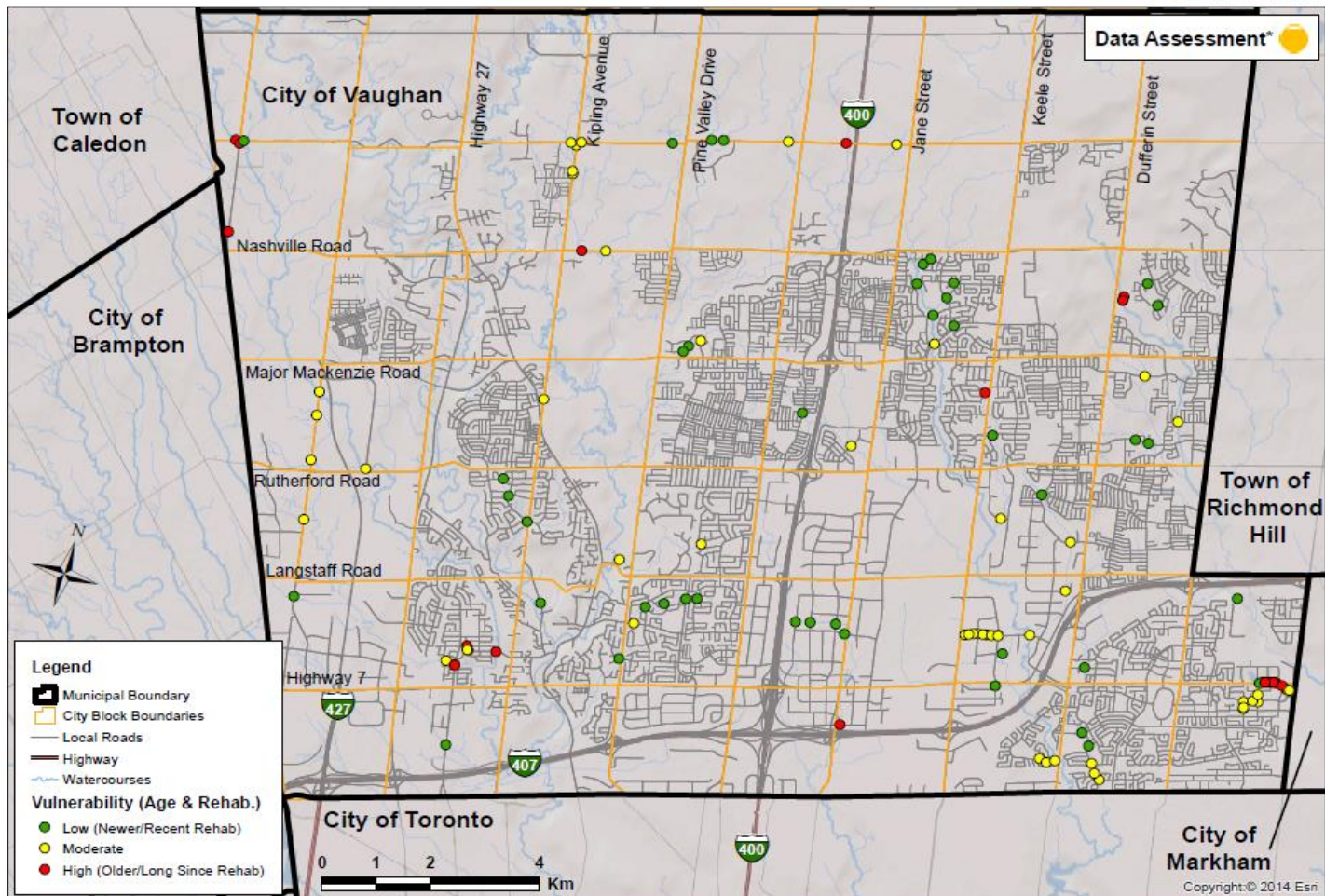
*The results of an assessment of the data are illustrated in terms of its 1) Level of Completeness (the 'fill' of the circle as low, medium or high) and 2) Level of Confidence as the colour of the circle in green (high), yellow (medium), and red (low).



*The results of an assessment of the data are illustrated in terms of its 1) Level of Completeness (the 'fill' of the circle as low, medium or high) and 2) Level of Confidence as the colour of the circle in green (high), yellow (medium), and red (low).



*The results of an assessment of the data are illustrated in terms of its 1) Level of Completeness (the "fill" of the circle as low, medium or high) and 2) Level of Confidence as the colour of the circle in green (high), yellow (medium), and red (low).

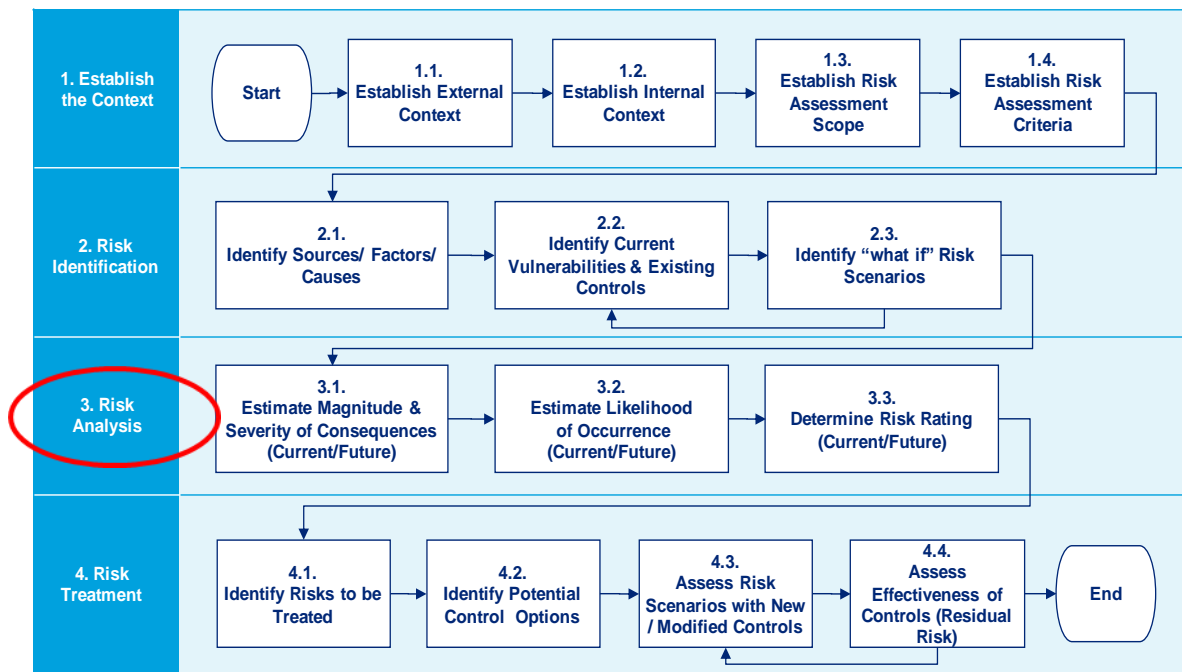


*The results of an assessment of the data are illustrated in terms of its 1) Level of Completeness (the 'fill' of the circle as low, medium or high) and 2) Level of Confidence as the colour of the circle in green (high), yellow (medium), and red (low).

RISK ASSESSMENT PROCESS

Climate Change Risk Assessment for City of Vaughan – Storm water

The City of Toronto Tool Process



Risk Analysis

- Take one risk source/climate change indicator and determining what the impact would be
- Determines likelihood
- Exercise would be completed for all asset categories and all 10 risk sources

Asset	Risk Source (Climate Indicator)	Impacts				Historical (1981-2010) Climate Indicator Value	Current Scenario Likelihood
		First Order	Second Order	Third Order	Fourth Order		
Stormwater Main	Extreme Heavy 1-Day Total Rainfall	Increased Volume of Runoff	Surcharging	Overflow	Flooding	52.5mm in 1 day	Likely – the risk could occur
	Heavy 1-Day Total Rainfall	Increase in Volume of Runoff	Surcharging	-	-	22.5mm in 1 day	Rare – the risk will occur only in exceptional circumstances
	Heavy 5-Day Total Rainfall	Increase in Volume of Runoff	Surcharging	Overflow	Flooding	81.9mm in 5 days	Very Likely – the risk will probably occur

Category	Insignificant	Minor	Moderate	Major	Catastrophic
	(1)	(2)	(3)	(4)	(5)
Premises / Infrastructure / Assets	<ul style="list-style-type: none"> No or very limited loss of physical assets Isolated assets affected 	<ul style="list-style-type: none"> Limited loss of physical assets Isolated or a few assets affected 	<ul style="list-style-type: none"> Loss of large but replaceable physical assets Most assets affected but impact on broader system / network is moderate 	<ul style="list-style-type: none"> Loss of significant physical assets System / network wide impact leading to some loss of infrastructure / premises/ asset function 	<ul style="list-style-type: none"> Loss of key physical assets System / network wide impact leading to total loss of infrastructure / premises/ asset function
Cost / Time (including Reputation)	<ul style="list-style-type: none"> Costs / damages incurred represent <1% capital / operating budget variance No or very minor media attention 	<ul style="list-style-type: none"> Minor costs / damages incurred representing 1-5% capital / operating budget variance Localized community/ interest group/ stakeholder concern and some media attention 	<ul style="list-style-type: none"> Moderate costs / damages incurred representing 5-10% capital / operating budget variance Localized community/ interest group/ stakeholder concern and moderate media attention 	<ul style="list-style-type: none"> Significant costs / damages incurred representing 10-25% capital / operating budget variance Significant loss of confidence in City products and services and considerable media attention Public / media outcry for removal of government official 	<ul style="list-style-type: none"> Massive costs / damages incurred representing >25% capital / operating budget variance Complete loss of confidence in City products and services and sustained media attention Public / media outcry for change in administration and council
Environment	<ul style="list-style-type: none"> Very minor, non-permanent environmental release promptly contained / damage requiring no clean-up measures No regulatory action 	<ul style="list-style-type: none"> Small uncontained release below legal limit Non-permanent environmental damage requiring very limited clean-up efforts Regulatory warning or order 	<ul style="list-style-type: none"> Moderate environmental damage with moderate clean-up required, no permanent damage. Permit violation Charges leading to fines 	<ul style="list-style-type: none"> Major environmental damage / extended clean-up required/ some permanent damage Charges leading to fines and/or criminal liability 	<ul style="list-style-type: none"> Irreparable, significant damage to environment Criminal charges and/or civil liability

Category	Insignificant	Minor	Moderate	Major	Catastrophic
	(1)	(2)	(3)	(4)	(5)
People (Staff, and Clients of City Services)	<ul style="list-style-type: none"> No injuries/ medical treatment No impairment of well-being / quality of life 	<ul style="list-style-type: none"> Minor injuries / first aid or minor illness Minor discomfort or displacement 	<ul style="list-style-type: none"> Serious injuries to clients or staff resulting in non-permanent injury / Lost time incident Workplace/living conditions are temporarily rendered unusable/unavailable, with moderate disruption to productivity and living arrangements/ quality of life (e.g. need temporary shelter) 	<ul style="list-style-type: none"> Serious injuries to clients or staff resulting in some permanent disability Staff/ clients/ residents are unable to use City facilities and services for a sustained period with significant impact on work and living arrangements / quality of life (e.g. displaced from own residences) 	<ul style="list-style-type: none"> Death and/ or significant permanent disability of clients or staff Staff/ clients/ residents are permanently unable to use City facilities and services –with catastrophic impact on work and living arrangements / quality of life (e.g. unable to find suitable alternative living arrangements)
Corporate Processes and Functions, and Service Delivery	<ul style="list-style-type: none"> No or very minor disruption in delivery of essential services, projects or processes No increase in demand for services 	<ul style="list-style-type: none"> Minor disruption in delivery of essential services, projects or processes Minor increase in demand for services, but manageable within existing budget 	<ul style="list-style-type: none"> Moderate disruption in delivery of essential services, projects or processes Moderate increase in demand for services, requiring increasing frequency of delivery and minor budget provision 	<ul style="list-style-type: none"> Significant disruption in delivery of essential services, projects or processes Significant increase in demand for services, requiring large increase in frequency/breadth of delivery and moderate budget provision 	<ul style="list-style-type: none"> Unable to perform essential services , projects or processes for extended period

Risk Analysis Evaluation

- The **greatest intensity** in the threshold of an event is **used in the conclusions** of the study
- Example: The **highest level** of precipitation occurring in one day
- Likelihood of the risks is then determined

		Consequence				
Likelihood		Insignificant	Minor	Moderate	Major	Catastrophic
	Almost Certain	M	M	H	E	E
	Very Likely	L	M	H	H	E
	Likely	L	M	M	H	H
	Unlikely	L	L	M	M	H
	Rare	L	L	L	L	H

UNDERSTANDING THE RISK ASSESSMENT

Risk Level	Description
Extreme	<p>Primary or critical risks requiring immediate attention. They may have a high or low likelihood of occurrence, but their potential consequences are such that they must be treated as a high priority.</p> <p>Deputy City Manager involvement is essential. DCM to follow City protocol for notification of City Manager, Mayor or Council.</p>
High	<p>These risks are classed as significant. They may have high or low likelihood of occurrence, but their potential consequences are sufficiently serious to warrant appropriate consideration.</p> <p>Senior management involvement (e.g. Division/ Organization Head) is essential. The Deputy City Manager should be informed.</p>
Medium	<p>These risks are less significant, but may cause upset and inconvenience in the short-term.</p> <p>Operations Management should ensure that preventive controls and mitigation plans are established and maintained, and risks are re-assessed at appropriate intervals. The Division / Organization Head should be informed.</p>
Low	<p>These risks are both unlikely to occur and not significant in their impact.</p> <p>Risks should be managed by routine procedures. Employees and contractors should be made aware of risks.</p>

Risk Analysis Results – Top 10

Asset/Service	Risk Scenario	Time Horz	Assets	Cost / time	Environment	Logistics	People	Processes	Max. I
Stormwater Pipes	Weather, Total Precip. >100mm in 5 Consecutive Days, Official: Increased Volume of Runoff, Surge, Overflow , Flooding	2050s	High	Extreme	High	High	High	High	Extrem
Stormwater Pipes	Weather, Heavy 5 Day Total Rainfall, Adhoc: Increased Volume of Runoff, Surge, Overflow , Flooding	2050s	High	Extreme	High	High	High	High	Extrem
Stormwater Pipes	Weather, Extreme Heavy 1-day Total Rainfall, Adhoc: Increased Volume of Runoff, Surge, Overflow , Flooding	2050s	High	High	High	Medium	High	High	High
Stormwater Ponds Wet	Weather, Total Precip. >100mm in 5 Consecutive Days, Official: Overflowing/Overtopping, Local Flooding, Public safety, Level of	2050s	Medium	High	High	Medium	High	Medium	High
Stormwater Ponds Wet	Weather, Heavy 5 Day Total Rainfall, Adhoc: Overflowing/Overtopping, Local Flooding, Public safety, Level of Performance/Water Quality	2050s	Medium	High	High	Medium	High	Medium	High
Other Drainage: Culverts, Ditches and Manholes	Weather, Max 5-Day Precip., Official: increased Flow, Clogging , Surge, Flooding	2050s	Medium	High	Medium	Medium	Medium	High	High

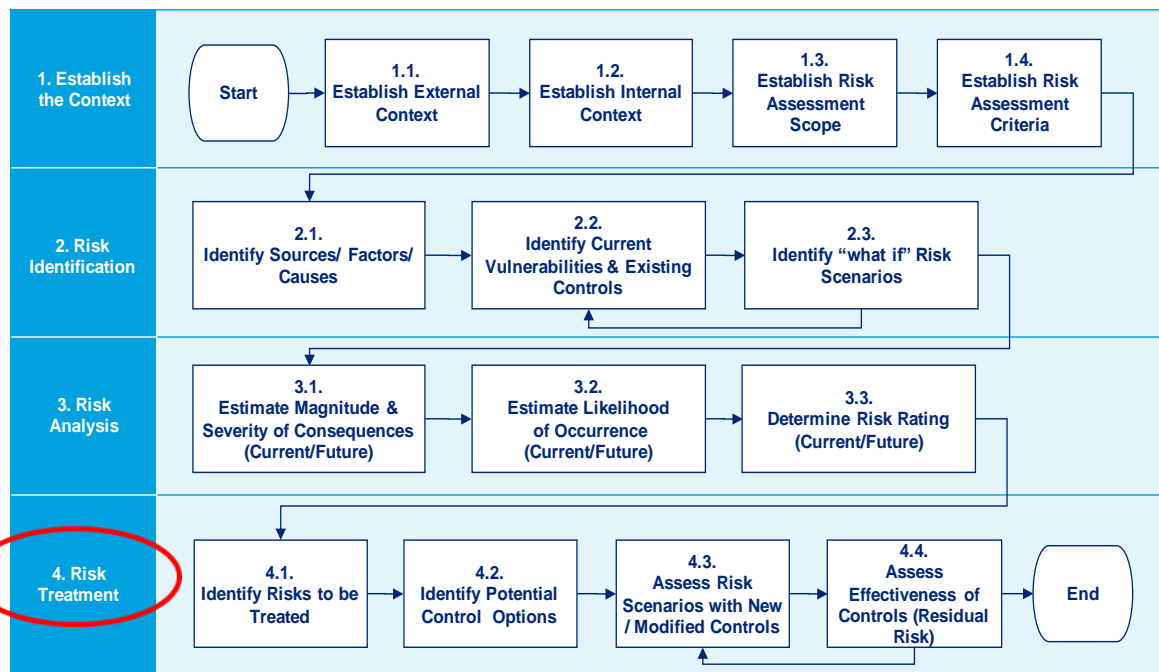
Risk Analysis Results- Top 10

Asset/Service	Risk Scenario	Time Horz	Assets	Cost / time	Environment	Logistics	People	Processes	Max. I
Other Drainage: Culverts, Ditches and Manholes	Weather, Max 5-Day Precip., Official: increased Flow, Washout, Void Formation and Collapse, Flooding	2050s	Medium	High	Medium	Medium	Medium	High	High
Stormwater Ponds Dry	Weather, Total Precip. >100mm in 5 Consecutive Days, Official: Volume Increase, Bank Stability, Loss of Active Storage, Flooding /Public Safety	2050s	High	Medium	Medium	Medium	High	Medium	High
Stormwater Ponds Dry	Weather, Heavy 5 Day Total Rainfall, Adhoc: Increased Volume , Bank Stability, Loss of Active Storage, Flooding /Public Safety	2050s	Medium	High	Medium	Medium	Medium	Medium	High
Stormwater Ponds Dry	Weather, Extreme Heavy 1-day Total Rainfall, Adhoc: Increased Volume , Bank Stability, Loss of Active Storage, Flooding /Public Safety	2050s	High	Medium	Medium	Low	Medium	Medium	High
Other Drainage: Culverts, Ditches and Manholes	Weather, Extreme Heavy 1-day Total Rainfall, Adhoc: increased Flow, Clogging , Surcharge, Flooding	2050s	Medium	Medium	Medium	Medium	Medium	Medium	Medium
Other Drainage: Culverts, Ditches and Manholes	Weather, Total Precip. > 100mm, Official: increased Flow, Clogging , Surcharge, Flooding	2050s	Medium	Medium	Low	Medium	Medium	Medium	Medium

RISK ASSESSMENT PROCESS

Climate Change Risk Assessment for City of Vaughan – Storm water

The City of Toronto Tool Process



Next Steps: Evaluation of Adaptation Measures

- Literature review highlighted a number of measures for consideration including:
 - Flood prevention AND CONTROL
 - Subsurface- network capacity is increased through piping modifications or storage
 - Surface – storage in newly constructed channels and delayed following big rain events
 - Enhance safety and resilience of infrastructure for higher risk areas
 - Consider standards for maintenance of infrastructure in order to increase durability of structures
 - Incorporate measures such as ‘climate change adaptation factors’ to encourage faster updating of climatic design information in codes’ standards



Summary – Key points- SW Climate Change Risk Assessment

Outcomes

- **Increased awareness** to the **risks** of climate change
- **Strengthened ability** to **conduct** risk and vulnerability **assessments**
- More **effective** and **experienced** processes

Outputs

- Inventory and knowledge on the climate scenarios and impacts that threaten SW infrastructure
- Staff engagement through workshops on vulnerability assessment and risk analysis
- Further evaluation of adaptation measures