



Beyond the Storm: Risk-Based Process and Tool to Enable Better Understanding and Management of Climate Change Risks

Great Lakes and St Lawrence Cities Initiative Webinar

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Flooding of Roads

Loss of Tree Canopy

Increase in Insurance Claims

Rail Tracks Undermined

Power Outage

Loss of Traffic Signal Control

Heat Wave

Washout of Roads

Increase in WSIB Claims

Rutting of Roads

Infrastructure Degradation

Louisiana or Toronto?

Collapse of Catchbasins

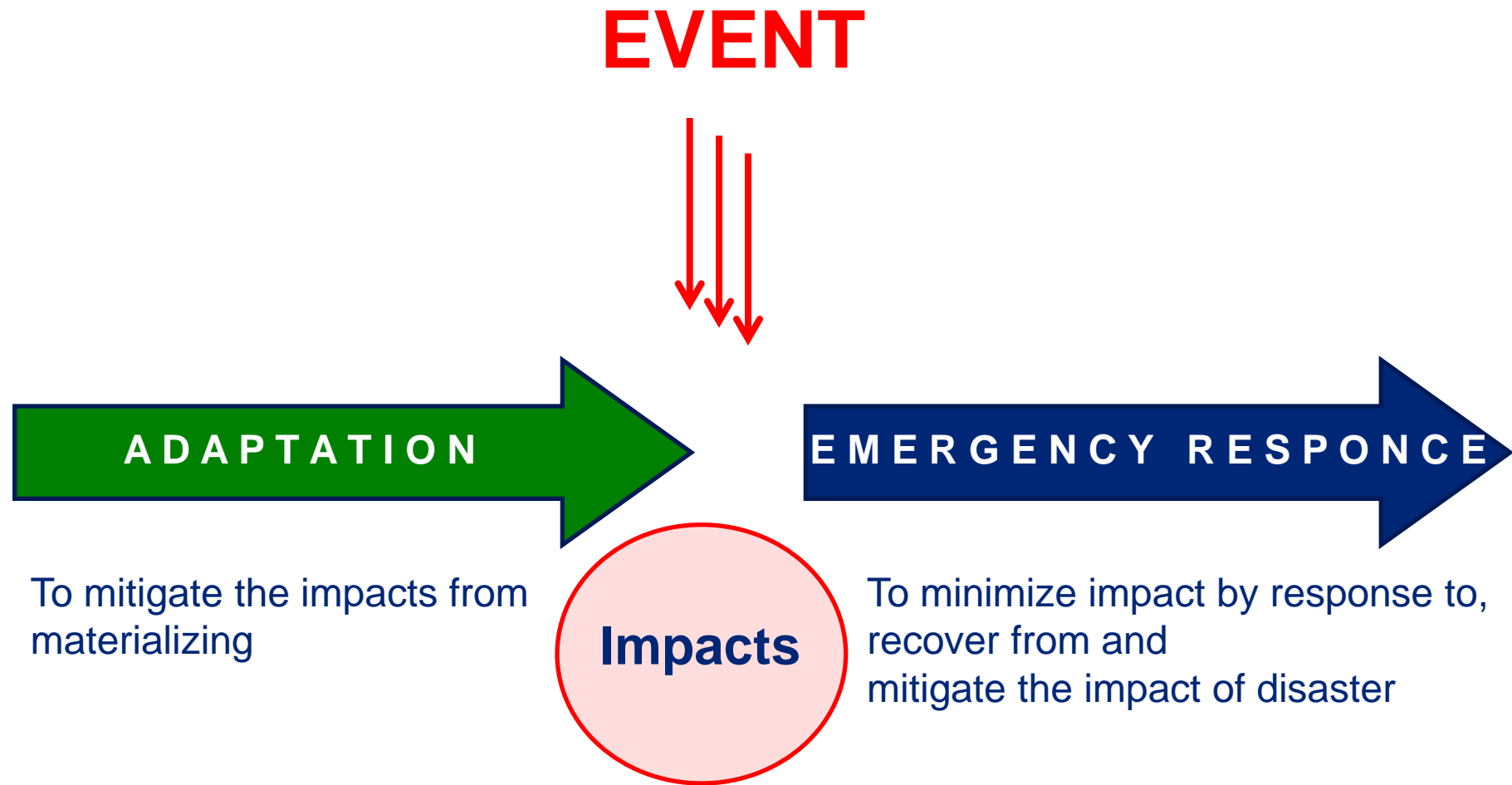
Loss of Communication

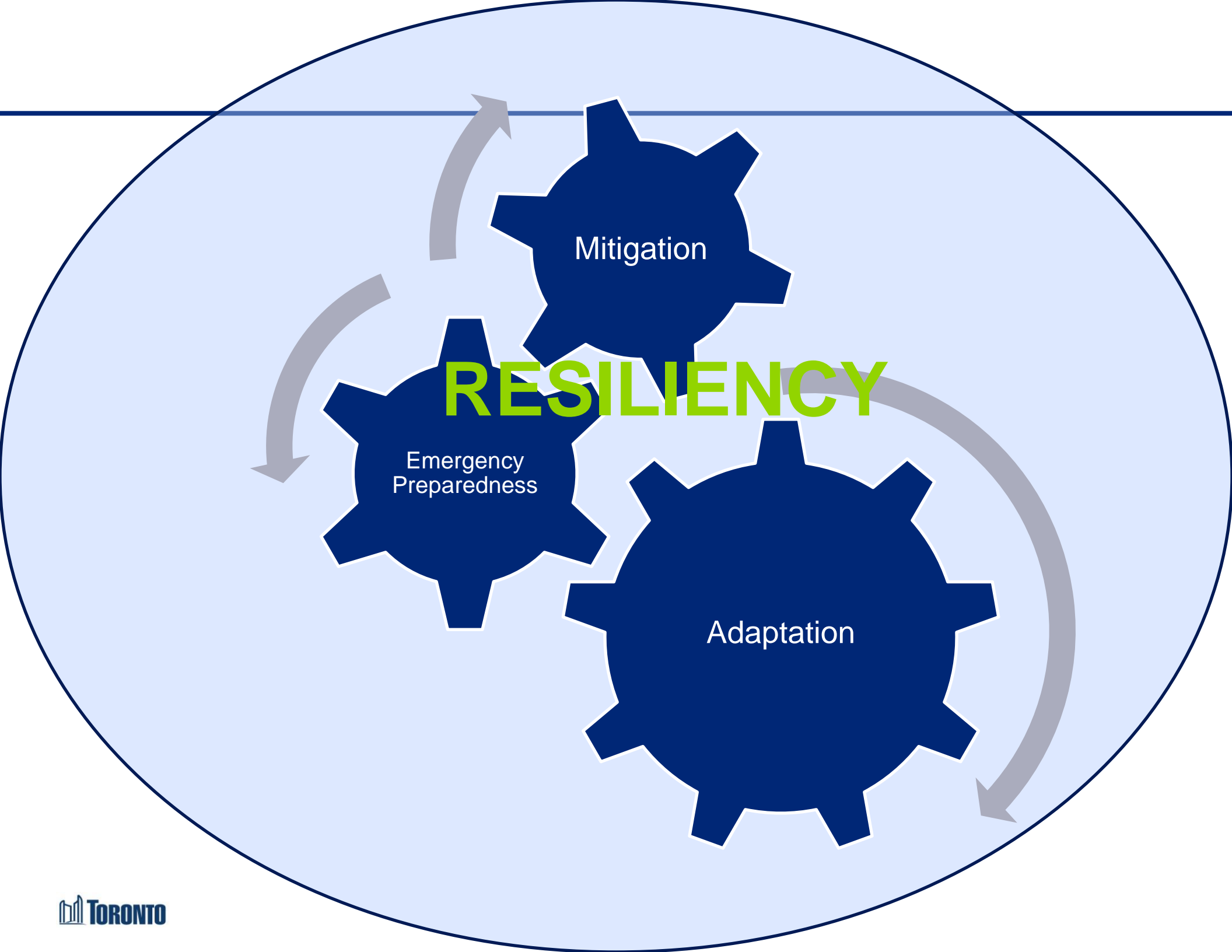


Why Manage Climate Change Risk

Drivers	Challenges
Economic Development	Outdated climate info , codes & standards and procurement policies
Safety: avoid harm to residents, staff and customers	<ul style="list-style-type: none"> • Aging infrastructure • Cost and time required for infrastructure upgrades • Increasing concentration of built assets
Customer service	Structural damage, system degradation and loss of function
Cost avoidance: <ul style="list-style-type: none"> • damage from extreme weather • credit & insurance risk rating of City & taxpayers 	Identify sectoral interdependencies and synergistic risk
Legal liability of organizations & individuals	Disruption of operations and emergency response capability
Evidence of due diligence	Need for enhanced coordination among departments, agencies, sectors and governments

Path to Resiliency





MS-ACCESS Enabled Risk Tool

Welcome to the Environmental Risk Assessment Tool

Welcome to the Environmental Risk Assessment Tool
The Environmental Risk Assessment Tool (ERAT) is a multi-purpose tool that supports assessments of environmental risk associated with City of Toronto programs and operations. The companion ERAT User Guide provides direction to complete one or multiple assessments within the database.
The ERAT is a standalone application that is both a data collection tool and a data management tool. Risk assessors can use the tool to assist in the systematic collection, storage and reporting of environmental risk assessment data. It has the ability to attach supporting information in a variety of formats including historical cost and incidence data, digital photos, emergency plans as part of the record of assessment application to store, search and analyze data collected then print a variety of reports.


1. Establish the Context

2. Risk Identification

3. Risk Analysis

4. Risk

City of Toronto:
Climate Change Risk Assessment
User and Technical Manual



Version Number: 1.0

Weather Risk Study for Transportation Services : Transportation Services ,2011 , Period 1

2. Risk Identification

2.1 Identify Risk Sources

2.2 Identify Vulnerabilities and Controls

2.3 Identify Risks

3. Risk Analysis

3.1 Estimate Consequence and Likelihood

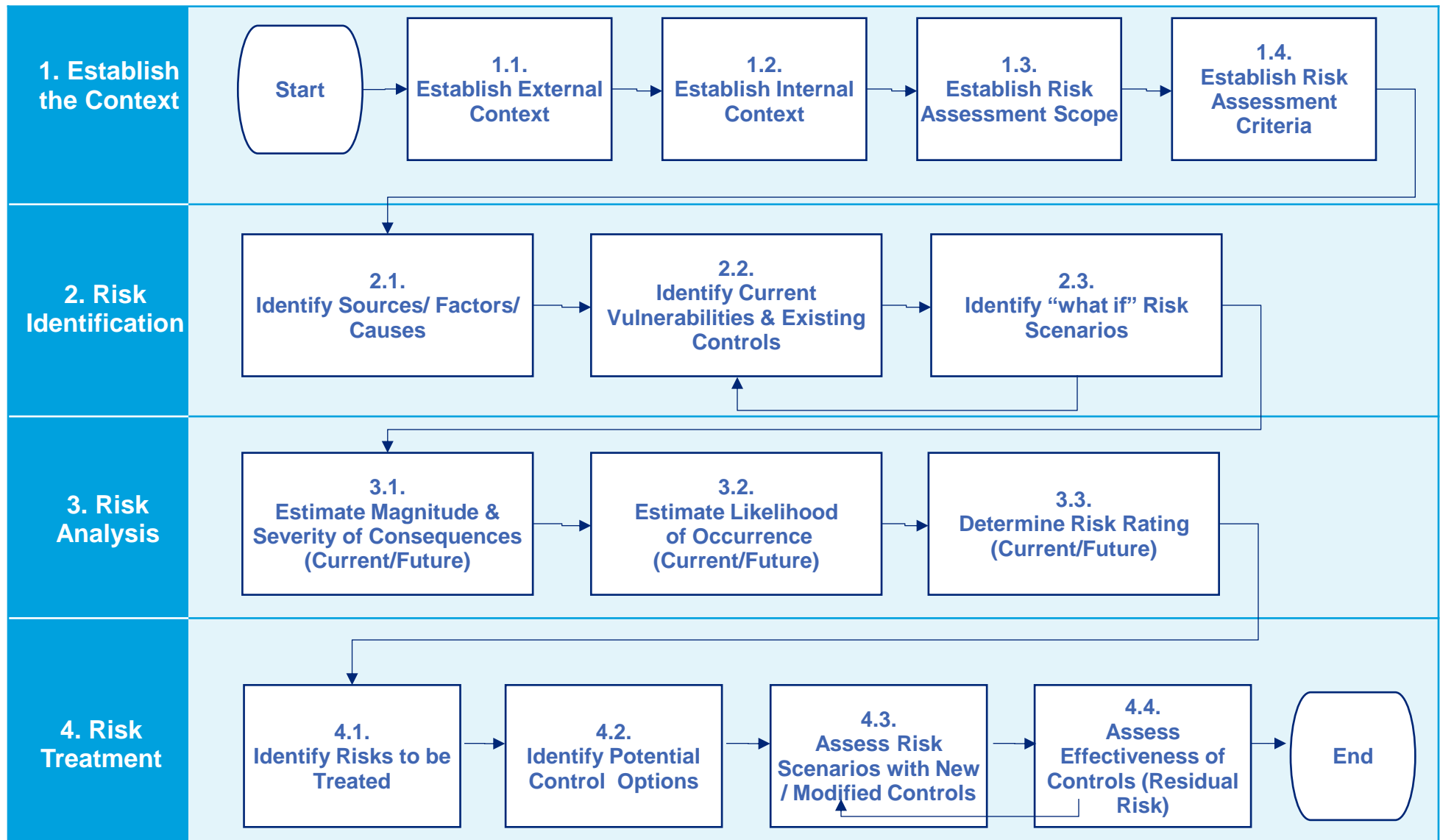
3.2 Calculate Risk Rating

Asset	Consequence	Time Period	Assets	Threats	Logistics	Processes	Services
Under Major Roads	Weather, Extreme Rain, Official Flooding, Infrastructure Damage...	1 Year	High	Medium	High	Medium	High
Under Major Roads	Weather, Extreme Rain, Official Flooding, Infrastructure Damage...	2000	Medium	Low	Low	Low	Low
Under Major Roads	Weather, Extreme Rain, Official Flooding, Infrastructure Damage...	2060	Low	Medium	Medium	High	High
Under Major Roads	Weather, Extreme Rain, Official Flooding, Infrastructure Damage...	1 Year	Medium	Low	Medium	Medium	Medium
Under Major Roads	Environmental, Oil Spill, Adverse Road Closure...	2000	Medium	Medium	Medium	High	Medium
Under Major Roads	Environmental, Oil Spill, Adverse Road Closure...	2060	Low	Low	Low	Low	Low
Under Major Roads	Weather, Extreme Cold, Official Health Problems...	1 Year	High	Medium	High	High	High
Under Major Roads	Weather, Extreme Cold, Official Health Problems...	2000	Low	Low	Medium	Medium	Medium
Under Major Roads	Weather, Extreme Cold, Official Health Problems...	2060	High	High	Medium	High	High
Under Major Roads	Weather, Extreme Rain, Official Flooding, Infrastructure Damage...	1 Year	High	Medium	Low	Low	High
Under Major Roads	Weather, Extreme Rain, Official Flooding, Infrastructure Damage...	2000	Medium	Medium	High	High	Medium
Under Major Roads	Weather, Extreme Rain, Official Flooding, Infrastructure Damage...	2060	Medium	Medium	Medium	High	Medium

City of Toronto's Climate Change Risk Assessment

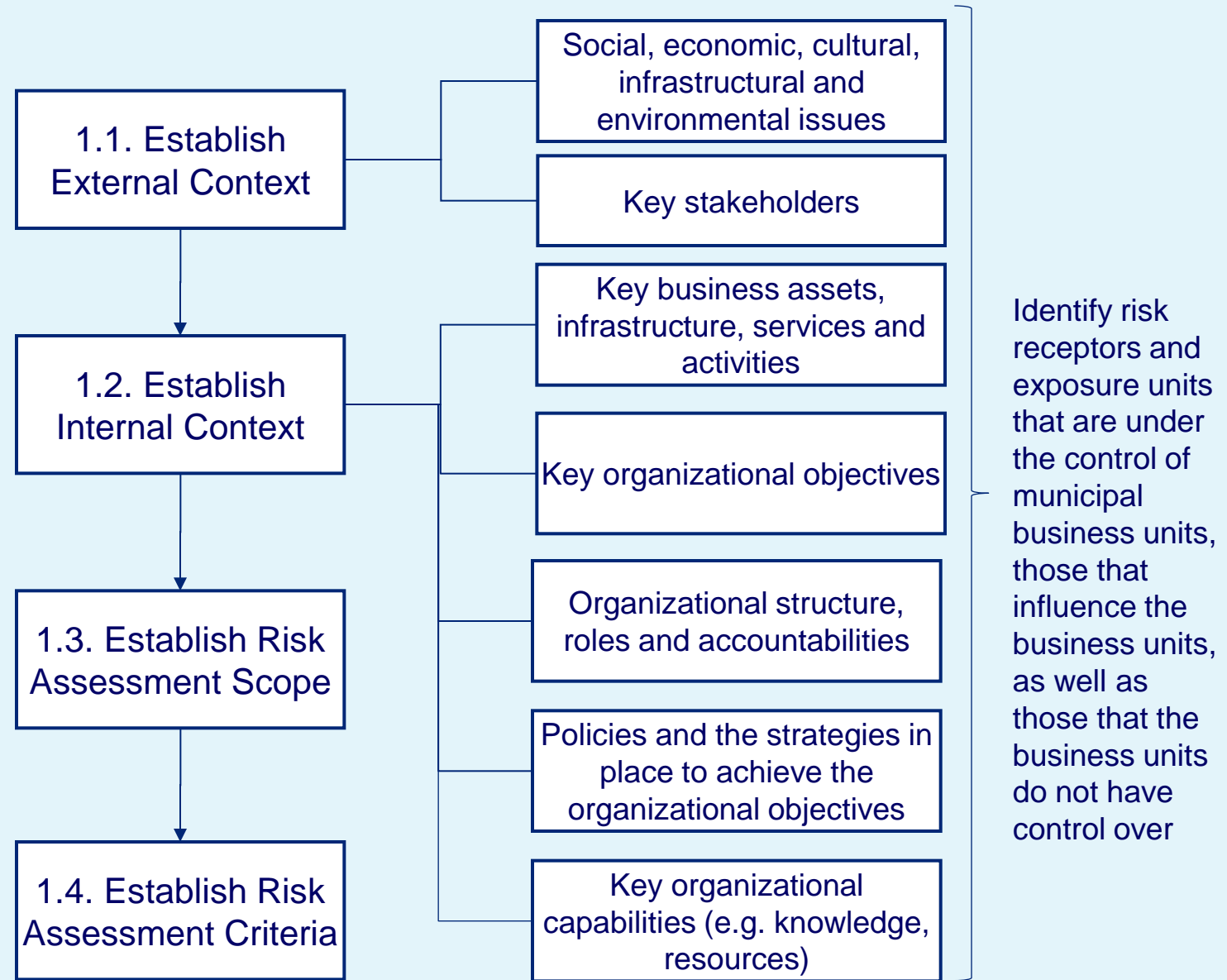
The process comprises four (4) steps, each consisting of component sub-steps

The process is linear but also iterative for flexibility



Step 1. Establish the Context

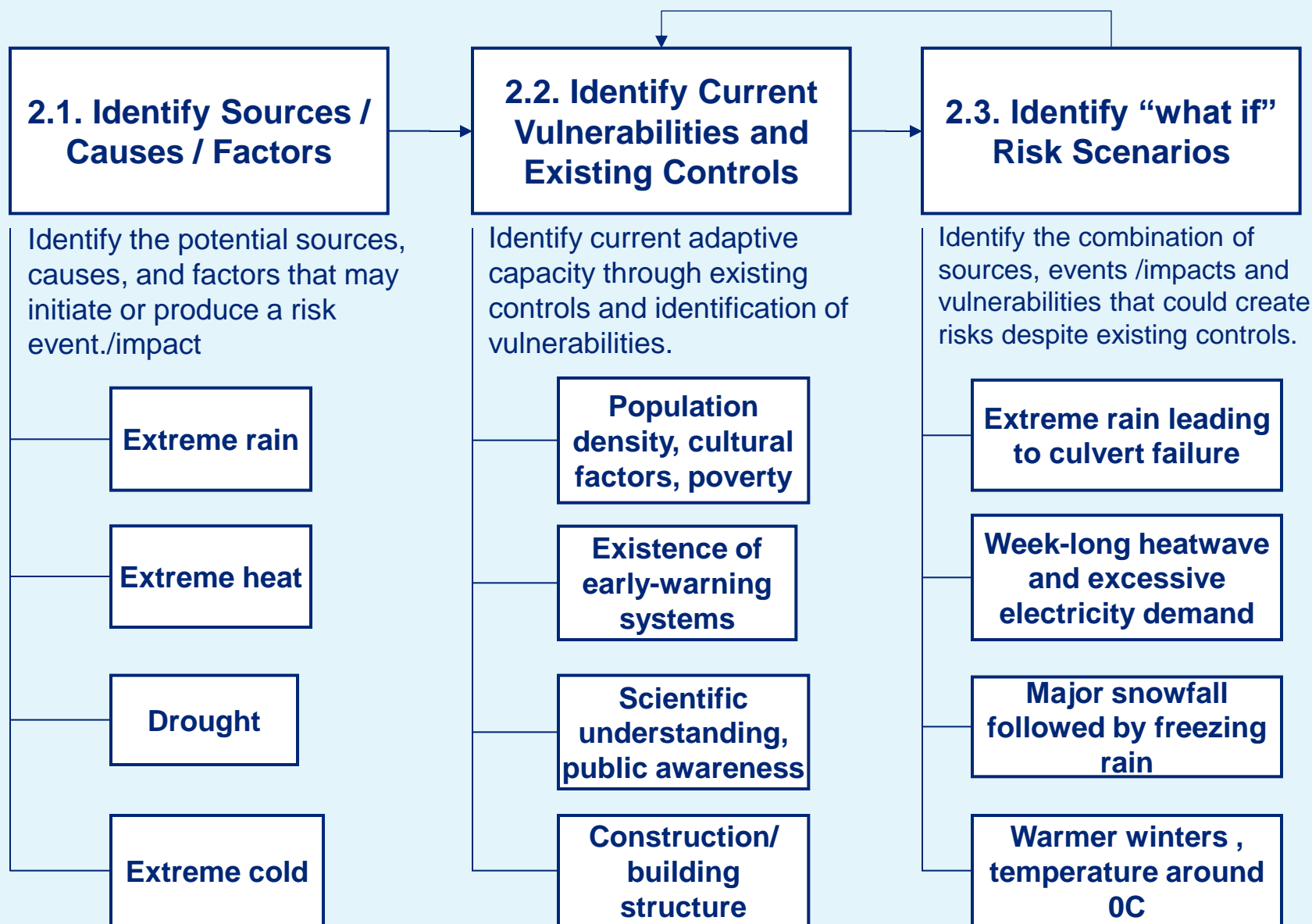
1. Establish the Context



Step 2. Identify Risks

2. Identify risks

Identify the potential sources and factors of risk, where current vulnerabilities exist and the controls that are currently in place, and the potential risk scenarios that may occur.



Step 3. Risk Analysis

3. Risk Analysis

Risk is defined as a combination of the consequences of a risk scenario (including changes in circumstances) and the associated likelihood of occurrence.

**3.1.
Estimate Magnitude &
Severity of
Consequences
(Current/Future)**



**3.2.
Estimate Likelihood
of Occurrence
(Current/Future)**



**3.3.
Determine Risk Rating
(Current/Future)**

Step 3.1 Estimate Magnitude & Severity of Consequences

Rating	Insignificant (1)	Minor (2)	Moderate (3)	Major (4)	Catastrophic (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
Logistics (Supply Chain, Utilities and Transport Infrastructure)	<ul style="list-style-type: none"> No disruption of City supplies Utilities and transport system continue to function as usual, with no impact on City operations or clients 	<ul style="list-style-type: none"> Limited disruption of supply chain due to isolated events, with City inventory able to cope Isolated incidences of power / water outages / transport system delays, with limited impact on City operations or clients 	<ul style="list-style-type: none"> Suppliers experience moderate delays, with City inventories experiencing shortages Numerous/localized incidences of power / water outages / transport system delays, with moderate impact on City operations or clients 	<ul style="list-style-type: none"> Suppliers are unable to provide materials for a prolonged period of time, with City inventory shortages leading to temporary disruption of services Widespread power / water outages / transport system delays, with significant impact on City operations or clients 	<ul style="list-style-type: none"> Suppliers are unable to provide materials for an extensive period of time, with City inventory shortages leading to lengthy disruption of services Total failure of power / water / transport system, leading to shut-down of City operations and massive disruption of clients
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/unliveable, 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 & Functions, & 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

Sample Definitions

Rating	Insignificant (1)	Minor (2)	Moderate (3)	Major (4)	Catastrophic (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
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 1-4% capital / operating budget variance Localized community / interest group disinterest / concern and some media attention 	<ul style="list-style-type: none"> Representing 5-10% capital / operating budget variance Localized community / interest group disinterest / 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 Irreparable, significant damage to environment Criminal charges and/or civil liability
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 clean-up required, no permanent damage Permit violation Charges leading to fines 	<ul style="list-style-type: none"> Major environmental damage / release, clean-up required some permanent damage Charges leading to fines and/or criminal liability 	
Logistics (Supply Chain, Utilities and Transport Infrastructure)	<ul style="list-style-type: none"> No disruption of City supplies Utilities and transport system continue to function as usual with no impact on City operations or clients 	<ul style="list-style-type: none"> Limited disruption of supply chain due to isolated events, with City inventory able to cope Isolated increases of power / water outages / transport system delays, with limited impact on City operations or clients 	<ul style="list-style-type: none"> Suppliers experience moderate delays, with City inventories experiencing shortages Humane/localized instances of power / water outages / transport system delays, with moderate impact on City operations or clients 	<ul style="list-style-type: none"> Suppliers are unable to provide resources for a prolonged period or time, with City inventory shortages leading to lengthy disruption of services Widespread power / water outages / transport system delays with significant impact on City operations or clients 	<ul style="list-style-type: none"> Suppliers are unable to provide materials for an extensive period of time, with City inventory shortages leading to lengthy disruption of services Total failure of power / water / transport system, leading to shutdown of City operations and massive disruption of clients
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 conditions are temporarily rendered unsuitable, 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 unable to use City facilities and services with catastrophic impact on work and living arrangements / quality of life (e.g. unable to perform essential services)
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, 25% response 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 of delivery and moderate budget provision 	<ul style="list-style-type: none"> Unable to perform essential services / projects or processes for extended period

Cost / Time (including Reputation)

Moderate (3)

- Moderate costs / damages incurred representing 5-10% capital / operating budget variance
- Localized community/ interest group/ stakeholder concern and moderate media attention

Insignificant (1)

Corporate Processes and Functions, and Service Delivery

- No or very minor disruption in delivery of essential services, projects or processes
- No increase in demand for services

Step 3.2. Estimate Likelihood

	Qualitative Probability Estimate	Quantitative Probability Estimate	Recurrence Interval
5	Almost Certain – the risk will occur	90-100% probability	1/1 year event
4	Very Likely – the risk will probably occur	55-90% probability	1/5 year event
3	Likely – the risk could occur	30-55% probability	1/25 year event
2	Unlikely – the risk may occur	5-30% probability	1/100 year event
1	Rare – the risk will occur only in exceptional circumstances	<5% probability	1/500 year event

Risk
Scenario



Prob. of Risk Scenario, D% = A% x B% x C%

Step 3.3. Calculate Risk Rating

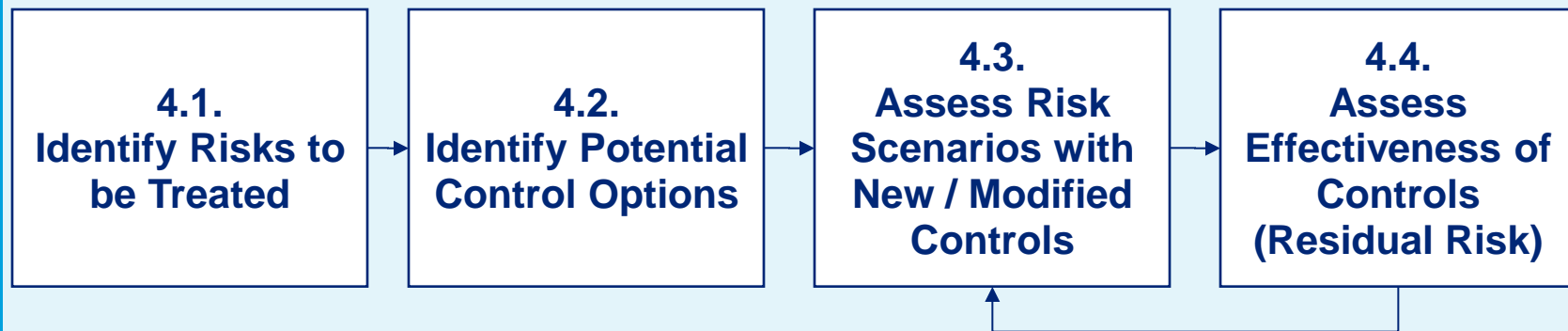
- Consequence and likelihood scores will be combined to yield a risk rating matrix or 'heat map'.
- Assessed risk will be considered current risk with existing controls in place.

		Consequence				
		Insignificant	Minor	Moderate	Major	Catastrophic
L i k e l i h o o d	Almost Certain	M	M	H	E	E
	Likely	L	M	H	H	E
	Possible	L	M	M	H	H
	Unlikely	L	L	M	M	M
	Rare	L	L	L	L	M

Step 4 – Risk Treatment

4. Risk Treatment

Risk treatment will identify the high priority risks to be addressed through new / modified controls and a reassessment of risk (residual) with these controls in place.



Transportation Services – Level of Effort

Risk Sources

Extreme Freezing Rain

Extreme Rain

Extreme Heat

Freeze/Thaw

Extreme Snowfall

Extreme Cold

Extreme Wind

High Priority Assets and Critical Services

Roads, Bridges, Culverts: Inspection, Maintenance and Construction

Traffic Controls Signals, RESCU
Operation; Traffic Control Systems;
Business Continuity Plan

Road Operation: Equipment; Staff Health and Safety; Winter Maintenance; Road Repairs; Street Sweeping Service; Inspections and Patrolling; Investigations

Transportation Services

Overall Climate Change Risks Results



Traffic Control Signal Controllers - Extreme Heat

Current Controls	Proposed Controls
<ul style="list-style-type: none"> •Monitoring of controllers •New resilient Controllers, fans and heaters inside controllers •Conflict monitor inspection every 6 months •Maintenance and installation is 100% contracted 	<ul style="list-style-type: none"> •Perform a study to determine the relationship between the temperature inside the controller cabinet versus ambient air temp •Staff to monitor the use of the heater and cooling fan to see if the frequency of use is increasing •Routine inspections, include the inspection of the heating/cooling system •Third party verification of cabinet performance under extreme heat •Improve relationship between Toronto and Bell <hr/> <ul style="list-style-type: none"> •Accelerate the installation of environmental controls in cabinets •Install air conditioners in cabinets for critical intersections – emergency routes •Install UPS – uninterrupted power supply for critical intersections – emergency routes •Engineering vulnerability risk assessment of cabinet performance •Implement an Asset Management System

ADAPTATION

**Develop Strategies,
for Prioritization,
Action Plan,
Communication Plan**

**Assess
Impacts**

**Identify Roles,
Responsibilities,
Interdependencies**

**Select
Events,
Assets,
Services**

Benefits of the CCRA

- Identifies nature and severity of risks to assets and services;
- Identifies most obvious vulnerabilities and short and long term adaptation measures that are practical and achievable;
- Identifies areas where more detailed engineering vulnerability analysis;
- Recommend new designs, retrofitting and rehabilitation;
- Operationalizes climate change;
- Assists in the development of a Adaptation Strategy;
- Ensures consistency and accountability – **due diligence** through a structured, documented approach; and
- Provides a mechanism for communicating climate change risk

Some Lessoned Learned

- Establish a **policy foundation**;
- Use a **Top-Down and Bottom-Up** approach
- Undertake a **prioritization** of the organization's high priority assets and critical services;
- Establish a **work program** for the risk assessment;
- Identify a **lead risk assessor**;
- Identify **interdependencies** and **synergistic risks**;
- Select **risk assessor** and train within each of the functional **groups**; and
- Risk assessment process captures **existing adaptation controls** that provides evidence of due diligence.

Questions

Transportation Association of Canada Risk Analysis and Responding to Climate Change Project

<http://tac-atc.ca/en/projects/seeking-funding/risk-analysis-and-responding-climate-change>

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