AECOM

A Quantitative Approach to Carbon Life-Cycle Assessment and Decarbonization of Infrastructure Projects

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Presenter

Fabianna Palacios
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Background

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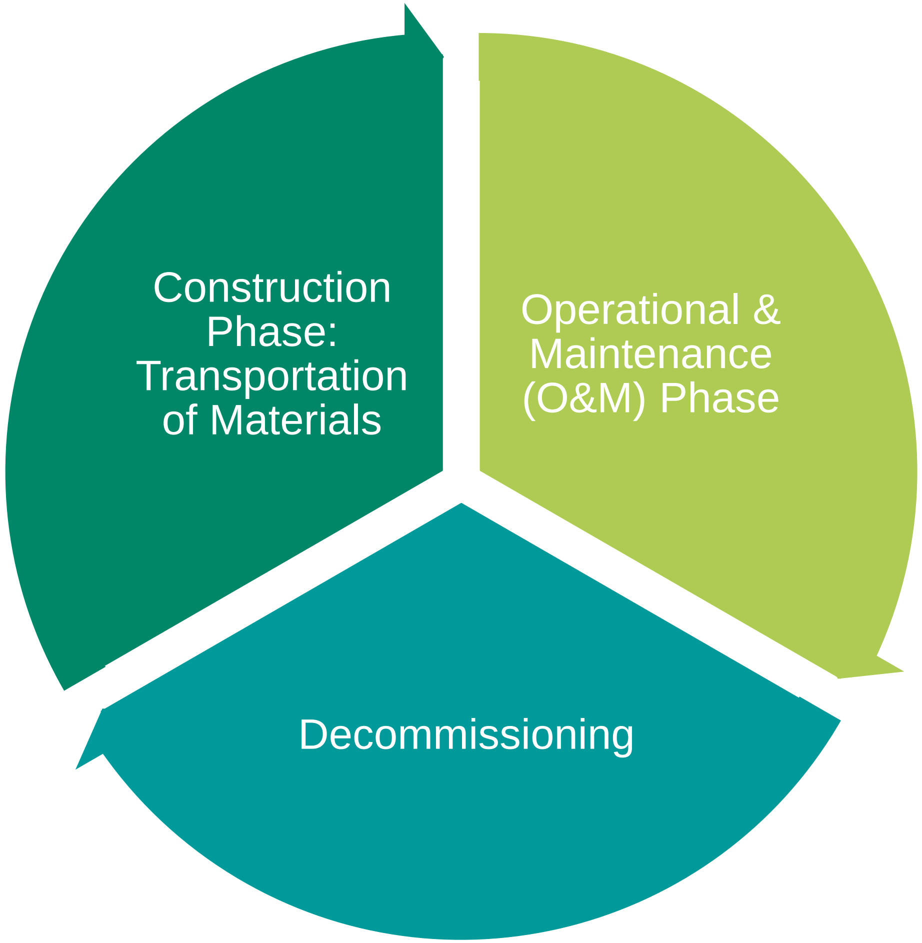
Background

Infrastructure is responsible for most of the greenhouse gas emissions (GHG) worldwide. Estimated at 79% of total emissions associated with **energy**, **buildings** and **transport.**

These increased emissions have resulted in a **rapid acceleration** of global anthropogenic climate change and unequivocal warming of the climate system in recent decades.

"It is critical that we invest in sustainable infrastructure that adapts to future uncertain climate conditions and contributes to the decarbonization of the economy" – Inger Andersen, Executive Director of UNEP.

Infrastructure Lifecycle



Infrastructure for Climate Action | UNOPS (PDF)

MECP Guide: Considering Climate Change in the Environmental Assessment Process

Qualitative Considerations

- ✓ Identify any measures that could contribute to climate change mitigation
- ✓ Document measures that could reduce or avoid GHG emissions and enhance storage when the project is implemented.

Quantitative Considerations

- ✓ Quantify the project's GHG emissions as if it were to be implemented with no climate change measures vs with measures incorporated.
- ✓ Quantify the potential avoided GHG emissions and improvements to carbon storage by implementing the project with mitigation measures.

Considering climate change in the environmental assessment process | ontario.ca

MECP Guide: Considering Climate Change in the Environmental Assessment Process

Potential Impacts of Climate Change on a Project

- How vulnerable is the project to climate change?
- Does the project contribute to the vulnerability or resilience of surrounding ecosystems?
- Are there potential impacts that climate change may exert on the proposed project?
- Are there alternative methods that could reduce the negative impacts of climate change?
- Could the project result in the disruption of Indigenous cultural resources?

New York snowstorm (Independent, 2014)

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MECP Guide: Considering Climate Change in the Environmental Assessment Process

Car exhaust (GoDigit, 2023)

Potential Impacts on Climate Change of a Project

- How might the project affect the removal of carbon dioxide from the atmosphere?
- Has the project considered impacts on climate change in planning?
- Are there alternative methods that would reduce adverse contributions to climate change?
- How might the project impact Indigenous people/communities?
- What can be done to reduce impacts from the project over time?

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Climate Change Mitigation & Adaptation Process

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Climate Change Mitigation

Bradford Bypass (BBP)

Project: New proposed highway to fight congestion across the Greater Golden Horseshoe.

Assessment: To assess the impact of the project on GHG emissions, a traffic analysis was performed, comparing existing conditions assessed during 2019 without the construction of the BBP, assessed in 2041 w/o the BBP, and including the BBP.

Link ID	Link Description	2019		2041 (w/o BBP)		2041 with BBP	
		AADT	Truck %	AADT	Truck %	AADT	Truck %
G1	HWY A	4500	5.1%	3100	9.7%	1600	15.6%
G2	HWY B	9300	6.2%	9000	12.2%	8100	7.9%
G3	HWY C	3600	2.2%	2700	11.5%	1700	5.3%

Potential mitigation options were proposed for each stage of the project (i.e., construction, operation, and maintenance) such as:

- ✓ Re-naturalization
- ✓ Sourcing sustainably manufactured materials and using recycled materials
- ✓ Implementation of High Occupancy Lanes on the BBP

Climate Change Adaptation

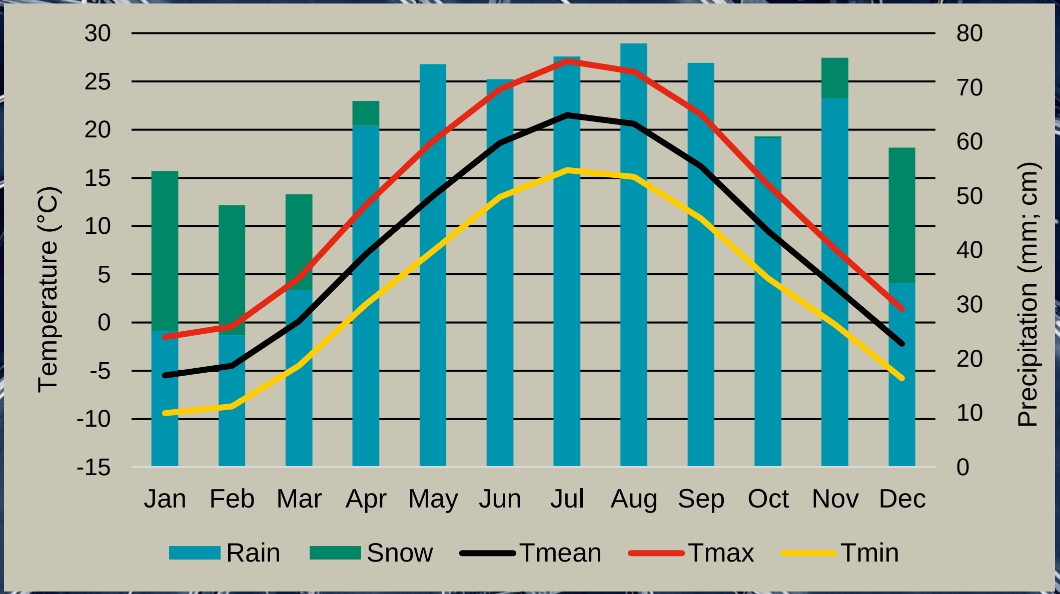
Bradford Bypass (BBP)

Assessment: A Climate Change Resilience Assessment (CCRA) was performed as a preliminary screening to provide input and direction for the design, construction, operation, and maintenance of the project. This involved a risk management approach to:

- ✓ **Anticipate** climate change-related risks that may have impact
- ✓ **Identify** potential actions to help prevent, withstand, respond to, recover from, and adapt to these risks

Five key steps from the ISO 31000 Risk Management Standard were followed:

a. Establish context
b. Risk Identification
c. Risk Analysis
d. Risk Treatment
e. Adaptation Measures



Historical Climate Data Analysis

Climate Change Adaptation

Bradford Bypass (BBP)

Climate Change Projections

As future global emissions of GHGs and other pollutants are uncertain, four scenarios with different GHG concentration trajectories were conducted.

RCP2.6	Stringent mitigation scenario
RCP4.5	Intermediate mitigation scenario with ambitious emission reduction
RCP6.0	Intermediate to high emissions scenario
RCP8.5	Very high-emission scenario ("Business-as-usual")

Climate Indicator
Climate condition by which an infrastructure would be adversely affected.

Climate Indicators & Probability of Ocurrence

Probability	Frequency of occurrence	Probability of occurrence per year	Score
Very high	Once every year or more	More than 70% (100%)	5
High	Once every 2 years	40%-70% (50%)	4
Moderate	Once every 5 years	20%-40% (30%)	3
Low	Once every 10 years	4%-20% (10%)	2
Very low	Once every 30 years	4% or less (4%)	1

Considering the historical climate and projected changes for both the current and the future timeframe, the probabilities of occurrence for each climate indicator were calculated using historical climate data and future climate projections provided by **ECCC** and **CCCS**, and **AECOM's climate data analysis tool.**

Climate Change Adaptation

Bradford Bypass (BBP)

Risk Analysis

A project's risk of climate change is determined by the severity of the consequence on the assets and the probability of relevant climate variables based on a changing climate.

To estimate the level of consequences, three impact categories were identified based on the most important aspects of the project:

- ✓ Health and safety
- ✓ Infrastructure integrity
- ✓ Operational impacts

Likelihood \ Severity of consequence	Low	Moderate	High
Low	Low risk	Low risk	Moderate risk
Moderate	Low risk	Moderate risk	Moderate risk
High	Moderate risk	Moderate risk	High risk

Adaptation Strategies

Climate Variable		Severity	Likelihood	Risk	Potential Impacts	Proposed Adaptation Measures
Precipitation	Heavy Rainfall	M	H	M	• Accelerates the degradation of the Project structures such as roadways, bridges, culverts • Causes waterlogging and flash floods. • Damages bridges and culverts through bank erosions.	• Enhancing the grade of concrete and the quality of the protective surface • Design the drainage system with increased capacity and use porous pavement. • Frequent maintenance of the conveyance. • To avoid erosion, blankets, geotextiles, and ripraps can be used.
Temperature	Hot Temperature & Heatwave	M	H	M	• Premature deterioration to road pavements asphalt (e.g., potholes, rutting, cracking) • Exacerbates urban heat islands due to increased surface temperatures of the pavement.	• Higher-grade asphalt binders that have higher temperature ranges asphalt binders can be used. • Light-colored asphalts and also asphalt coolants can be used.

These adaptation measures were based on high-level risks originating from the adverse impacts of climate change during the construction and life cycle of the infrastructure.

Municipalities' Climate Action Plan

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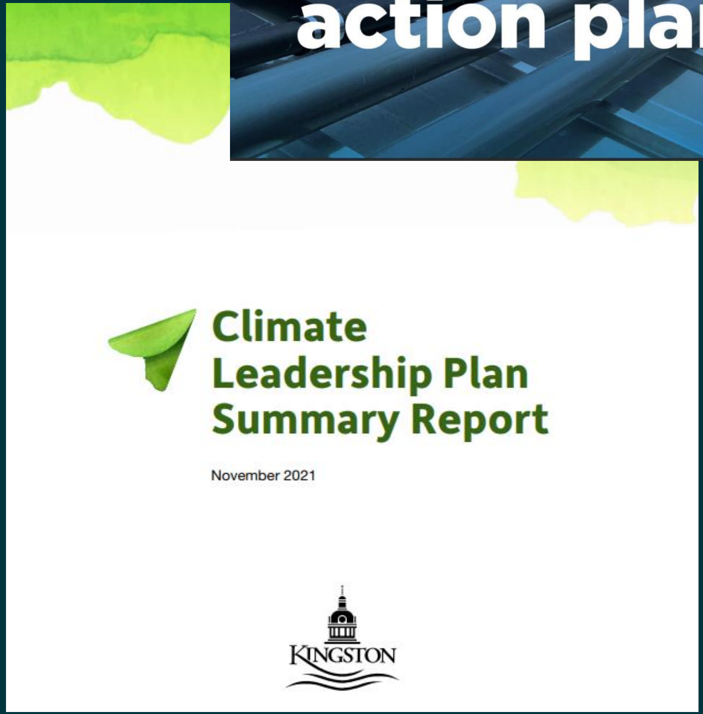
Municipalities' Climate Action Plans

[Climate Change Action Plan – City of Mississauga]

Mississauga

- GHG emission reduction from existing and newly developed buildings
- Integrate climate change considerations into municipal park standards
- Invest in low carbon and fuel-efficient modes of transportation to accelerate the adoption of zero emission vehicles



[Climate Leadership Plan - City of Kingston]

Kingston

- Accelerate local production of renewable and low carbon energy by using solar photovoltaics
- Support residents to invest in low carbon home energy retrofits through financing/rental programs
- Educate on new low carbon buildings, enhance design policies and train the City's building inspectors in emerging construction techniques
- Develop infrastructure to locally produce renewable natural gas

Net Zero and Decarbonization

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Net Zero Planning and Decarbonization Throughout the Project Lifecycle

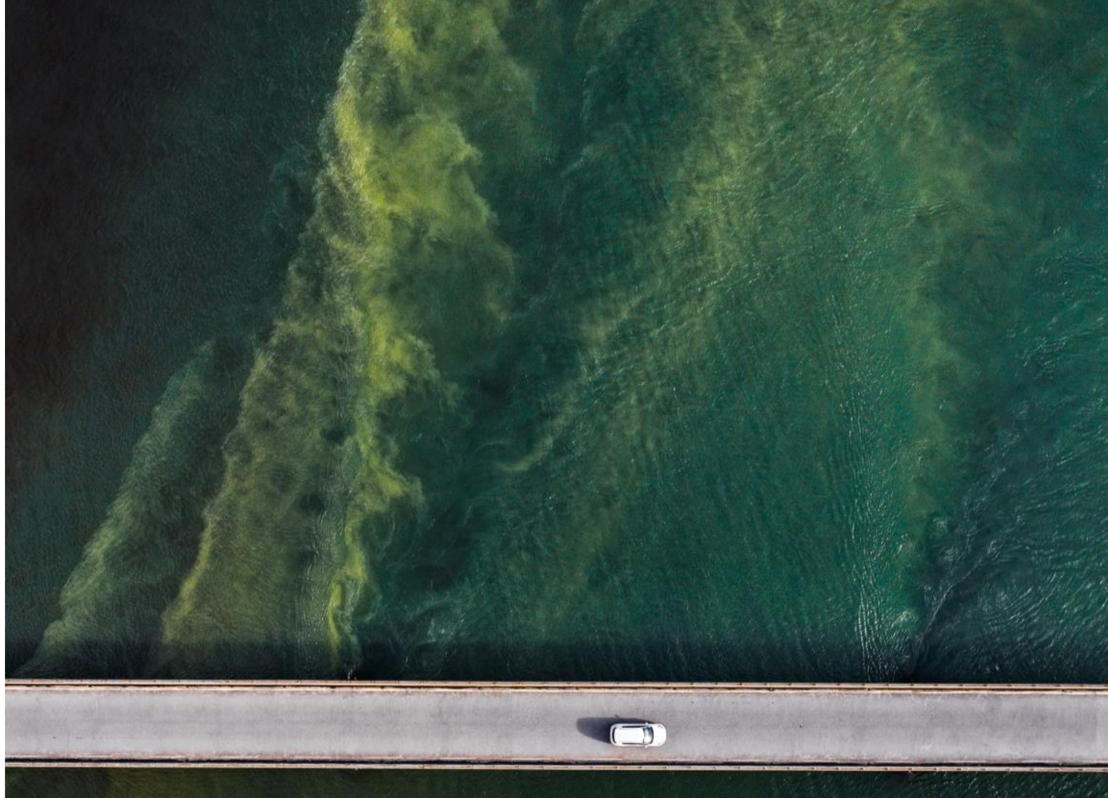
Our Approach

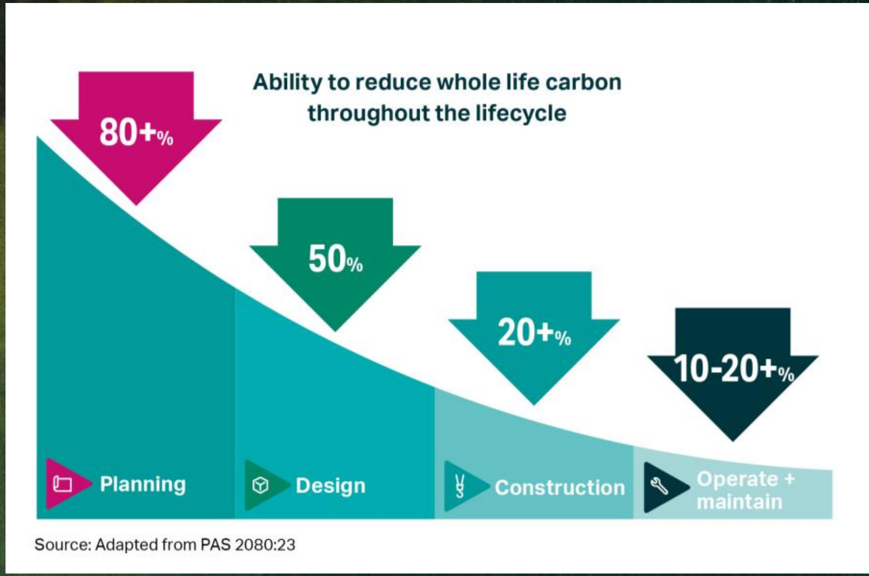
AECOM has been working with entities across the transportation and infrastructure sector to build resiliency and sustainability into their future planning on climate action. Work includes roadmaps to net zero, both direct and indirect greenhouse gas reduction targets, carbon management and accreditation, high performance facility and sustainability infrastructure design and construction, and water and waste management.

Projects

- Sustainable Pavement
- Renewable Energy & STEM Center
- Testing Carbon Reduction Policies in Revised Transport Plan

Considering whole life carbon across asset categories





Source: Adapted from PAS 2080:23

Sustainable Pavements

City of Sydney

Problem: The City of Sydney wanted a sustainable solution to a busy, four-lane throughfare where the road slabs were cracked and faulty, resulting in noise complaints.

Solution: 70% of the slabs were faulty. Removing and replacing them would have required a large amount of concrete mix. We proposed an alternative solution, requiring the replacement of **15%** of the slabs **only**, the installation of new curb and gutter, an asphalt overlay and asphalt reinforcement grid.

Implementation: The carbon savings from this design are equivalent to the average annual energy use for over **10 households**. One year after the completion of the project, the asphalt surfacing is in good condition and the ride quality and noise have improved significantly.

Lifecycle Stages

Design

Construction

Renewable Energy & STEM Center

Suffolk County

Problem: Suffolk County wants to achieve Net Zero and incorporate renewable energy strategies for the Suffolk County Community College STEM Center.

Solution: 24,000-square-foot-state-of-the-art facility focused on visualized energy as the central attraction for students and faculty. The facility can produce enough solar and geothermal energy to make it self-sustaining with **up to 100% carbon reduction.**

Implementation:

- ✓ A sloped roof equipped with photovoltaic (PV) panels tilts toward the south maximizing the energy production of the panels while reducing the solar exposure of south facing windows.
- ✓ A high-performance louvered façade was applied to the building to reduce direct light and solar heat gain.
- ✓ A centre berm to provide insulation and serve as a green roof.

Testing Carbon Reduction Policies in Revised Transport Plan

Leicestershire County Council (LCC)

Problem: LCC wanted a low-cost model to test policies where they have most control over, prior to more detailed modelling.

Solution: Developed the **Carbon Swift Assessment Tool** for transport to demonstrate the impact on emissions for each scenario on different parts of the road network and vehicle types.

Implementation: We compared the carbon impacts of 3 high-level scenarios against a baseline for carbon emissions.

a. Increasing proportion of electric vehicles (EV)
b. Reducing car usage
c. Increasing EV for freight and buses

Thank you!

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