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Credit Valley Conservation inspired by nature

SOURCE TO STREAM CONFERENCE

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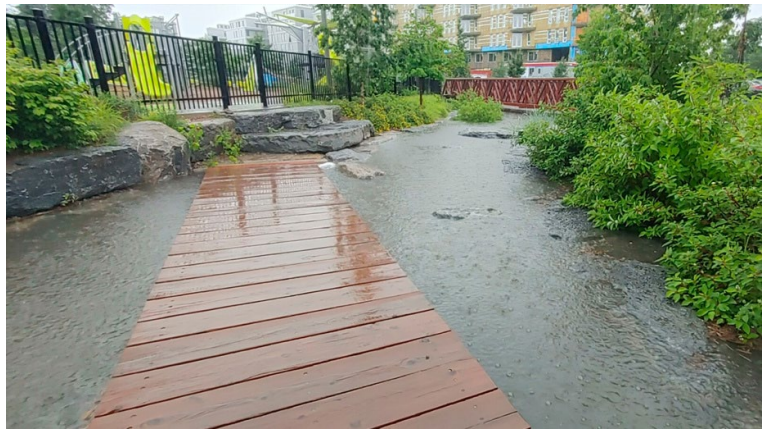
Building Up Resilience for Existing Drainage Networks: Approaches with Water Squares and Sponge Parks in Montreal (QC)

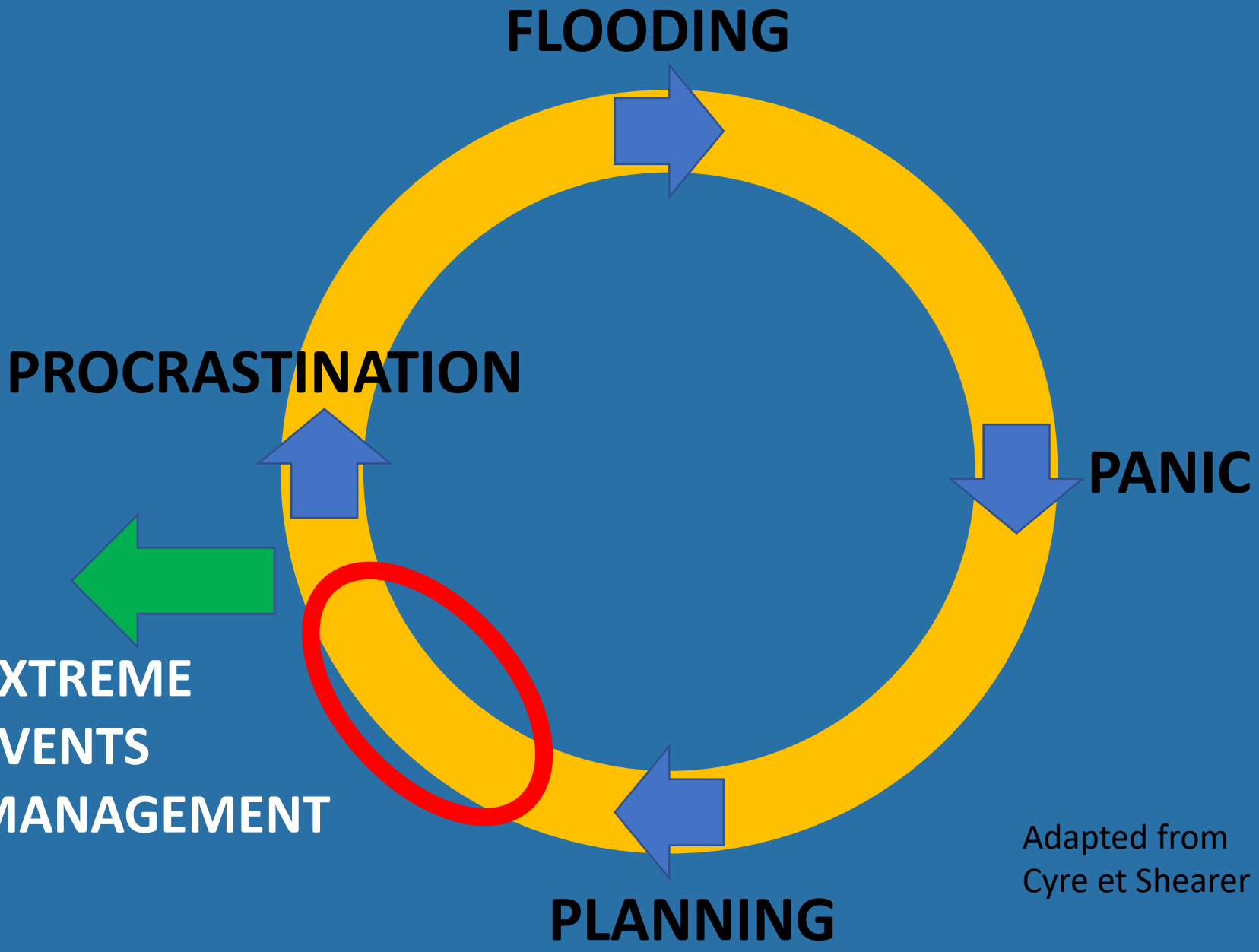


Gilles Rivard, Ing., M. Sc.

Communauté métropolitaine de Montréal

lasalle nhc

HYDRO*ILLOGICAL* CYCLE



Adapted from
Cyre et Shearer (1987)

Why talk about resilience ?

The future is not
what it used to be…

Montreal area (Spring 2017)

Toronto

Why talk about resilience ?

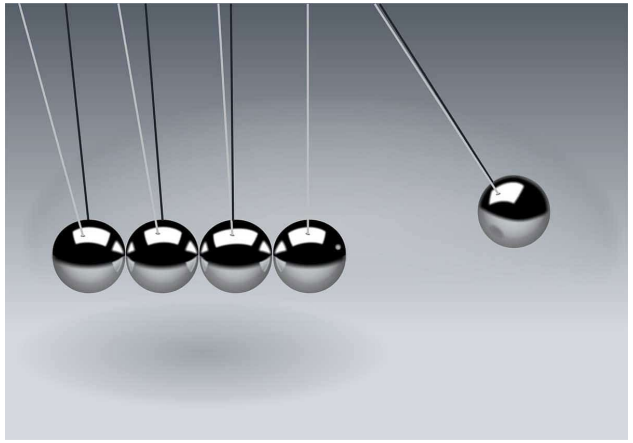
A wise man proportions his belief to the evidence.

All knowledge degenerates into probability.

The only immediate utility of all sciences is to teach us how to control and regulate future events and their causes.

We see many successions, never causalities.

Causes and effects



David Hume (1711—1776)

An Enquiry Concerning Human Understanding

Climate change and observed flooding events

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Why talk about resilience ?

The problem with existing systems and urban flooding

Rebuild all the sewer networks ?

Debby (Aug. 9th 2024)

The case of Montreal

- Large part of the sewer networks is combined
- Basin divide near the center of the island
- Old system of collectors draining to the interceptors
- Different **causes of flooding** (rivers – local sewer network – combination)

Action Plan

Network of resilient Cities (https://resilientcitiesnetwork.org/)

Developed after events of 2017

Action Plan - Montréal

Specific action plan for flood resilience (announced at the Montreal Climate Summit in 2024)

- Support owners in the process of adapting their buildings;
- Focus on prevention by adapting regulations;
- Seize every opportunity to continue building **resilient infrastructures**.

Over 400 sponge sidewalks (curb extensions) and 30 sponge parks planned

Outline

- Resilience to flooding - A (very) short history
- CSA Standards and the problem(s) with existing drainage systems
- Using new tools to look at old problems with a more robust and efficient approach
- Case studies – Sponge parks as a partial answer

Resilience – A short history

Resilience and Stability of Ecological Systems
Holling - 1973

Resilience determines the persistence of relationships within a system and is a measure of the ability of these systems to absorb changes of state variables, driving variables, and parameters, and still persist.

Resilience – A short history

Reliability

Before 1980

Systems designed to operate without problems for a given design event

Approach: Conduits designed for a return period of years

Risk

1980 to end of 1990

Systems designed with consideration of risks and consequences for events beyond the design event

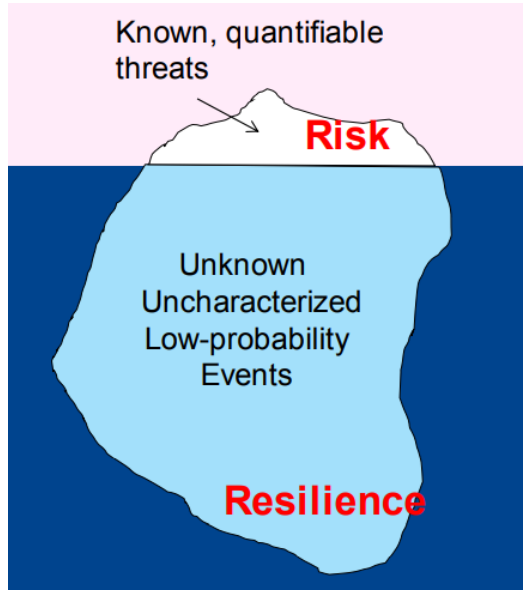
Approach: Considering different types of events and return periods, quantifying risks and managing consequences

Resilience

Since 2000

Systems designed with principles of resilience

Approach: Climate change and uncertainties taken into account



Risk = (Probability of a climatic event) × (Probability of undercapacity for the event) × (Consequence (f(Exposition, Vulnerability)) or Costs)

Resilience – A short history

Review

Review of Urban Flood Resilience: Insights from Scientometric and Systematic Analysis

Meiyan Gao [1,2], Zongmin Wang [1,2] and Haibo Yang

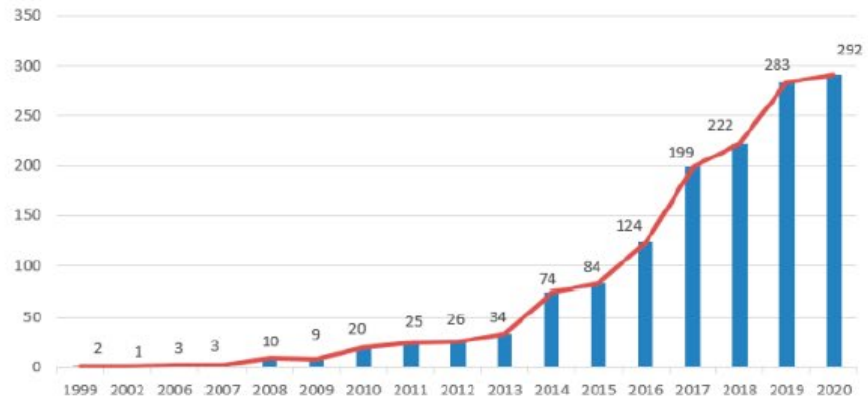
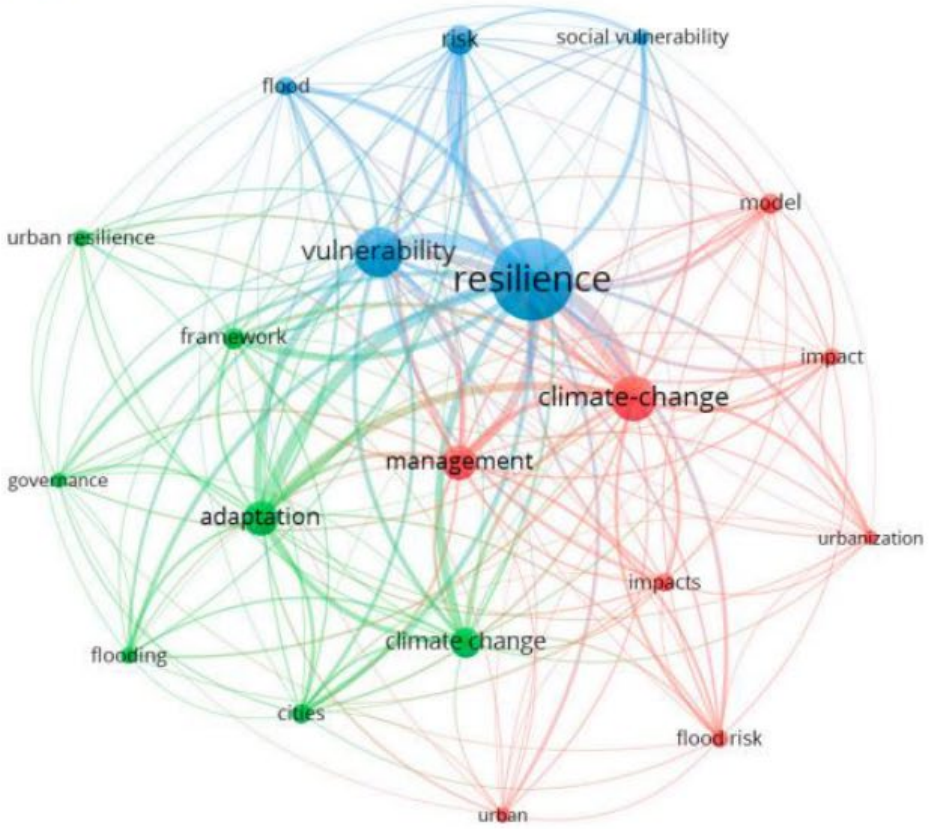


Figure 7. Increasing trend of literature about urban flood resilience.



CSA Standards

Flood resilient design of new residential communities

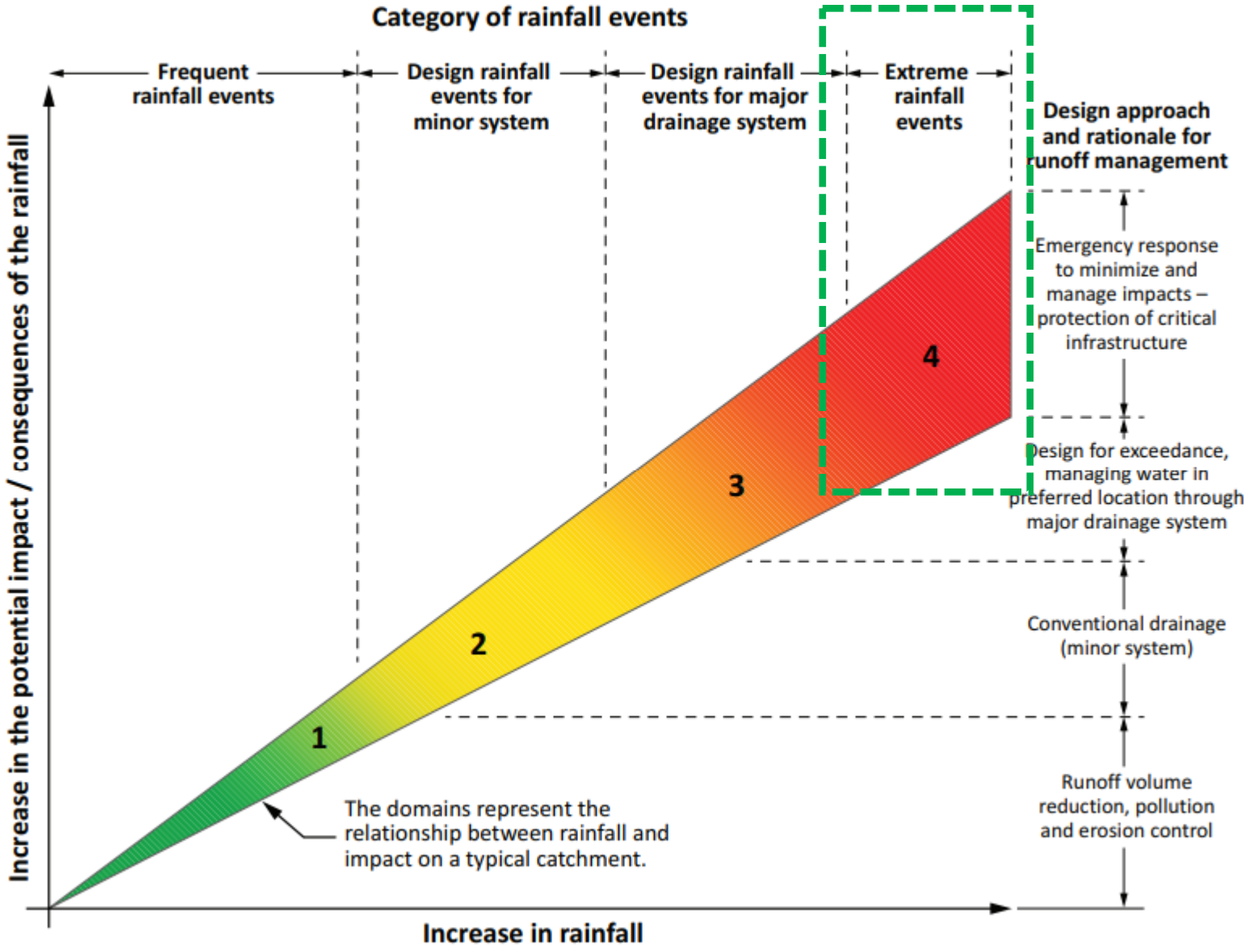
CSA W204:19
National Standard of Canada

Prioritization of flood risk in existing communities

CSA W210:21
National Standard of Canada

The Problem(s) with Existing Systems

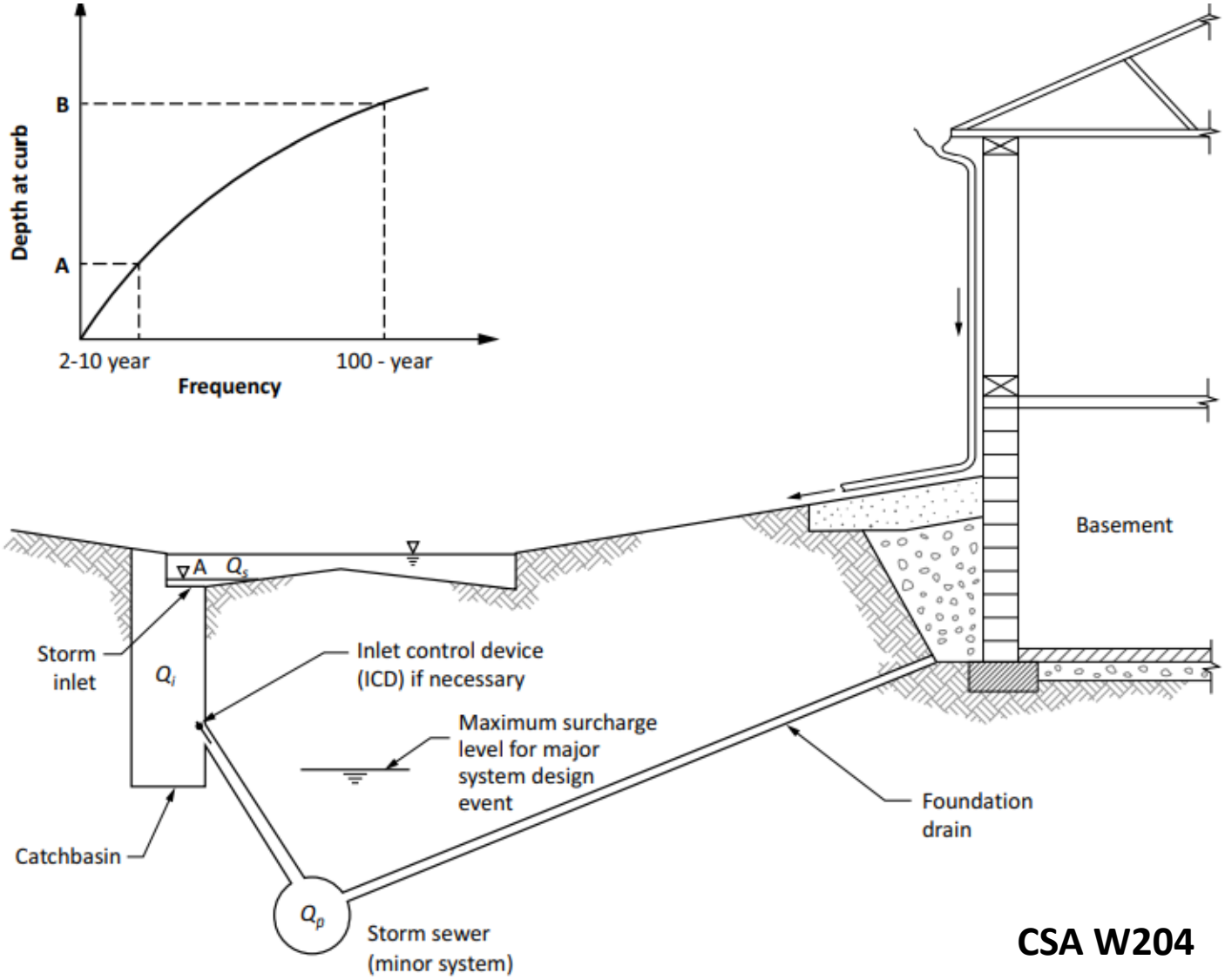
Extended range for rainfall events



CSA W204

CSA Standards

Importance of dual drainage analysis



CSA W204

The Problem(s) with Existing Systems

Toward More Resilient Urban Stormwater Management Systems—Bridging the Gap From Theory to Implementation

Bert van Duin[1,2], David Z. Zhu[1], Wenming Zhang[1], Robert J. Muir[3], Chris Johnston[4], Craig Kipkie[5] and Gilles Rivard[6]*

[1] Department of Civil and Environmental Engineering, University of Alberta, Edmonton, AB, Canada, [2] Water Resources, City of Calgary, Calgary, AB, Canada, [3] Dillon Consulting Limited, Toronto, ON, Canada, [4] Kerr Wood Leidal Associates Ltd., Burnaby, BC, Canada, [5] Kerr Wood Leidal Associates Ltd., Calgary, AB, Canada, [6] Lasalle | NHC, Laval, QC, Canada

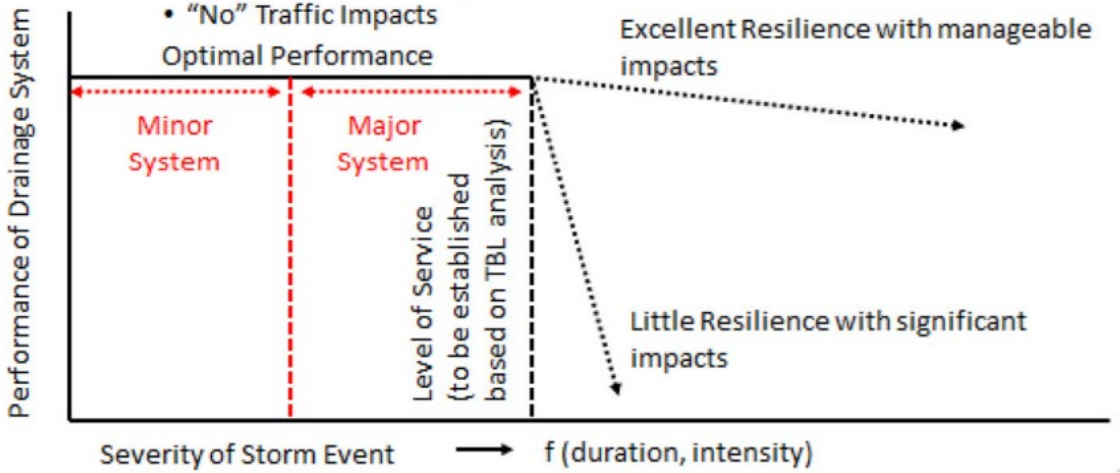
Three main components to create a resilient system :

1. Continuous flow route;
2. Appropriate freeboard to building entrance elevations; and
3. Appropriate setbacks.

Related to low points caracteristics

The Problem(s) with Existing Systems

- "No" Damage
- "No" Loss of Life
- "No" Business Interruptions
- "No" Traffic Impacts



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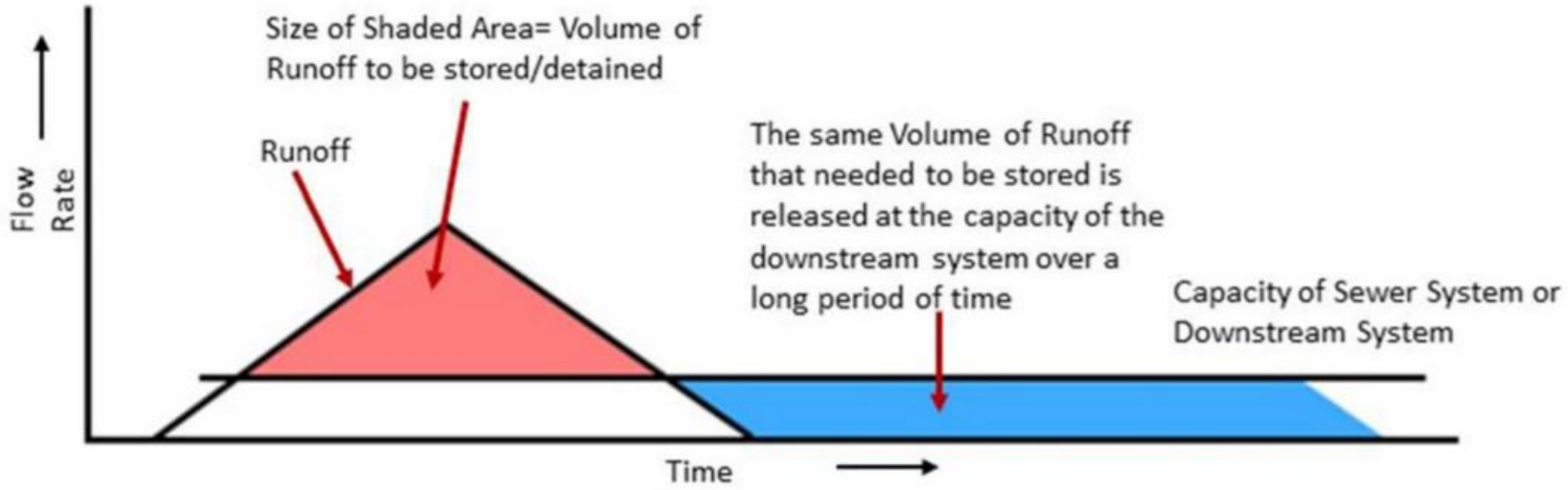
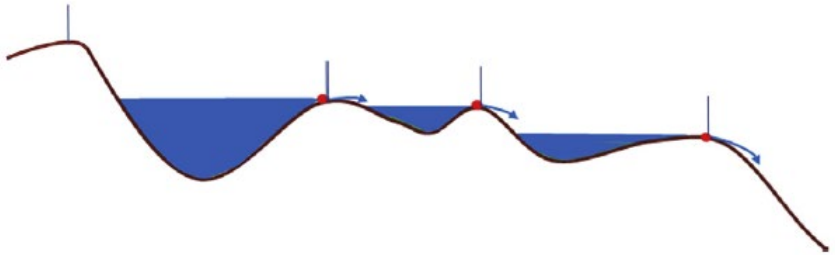
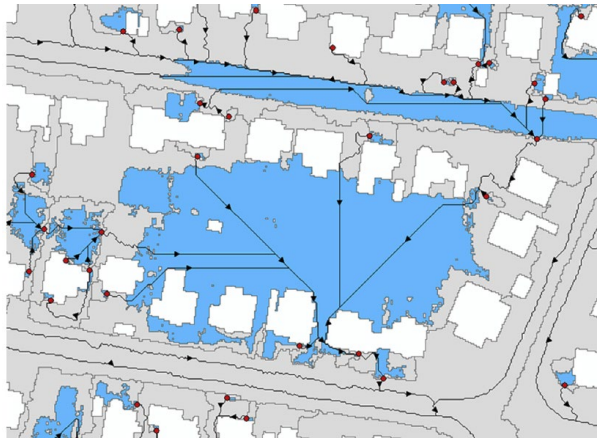


The Problem(s) with Existing Systems

Basic task – Gain a better knowledge of the actual flow paths during extreme events and low points in the major system





Arc-Malstrøm: A 1D hydrologic screening method for stormwater assessments based on geometric networks

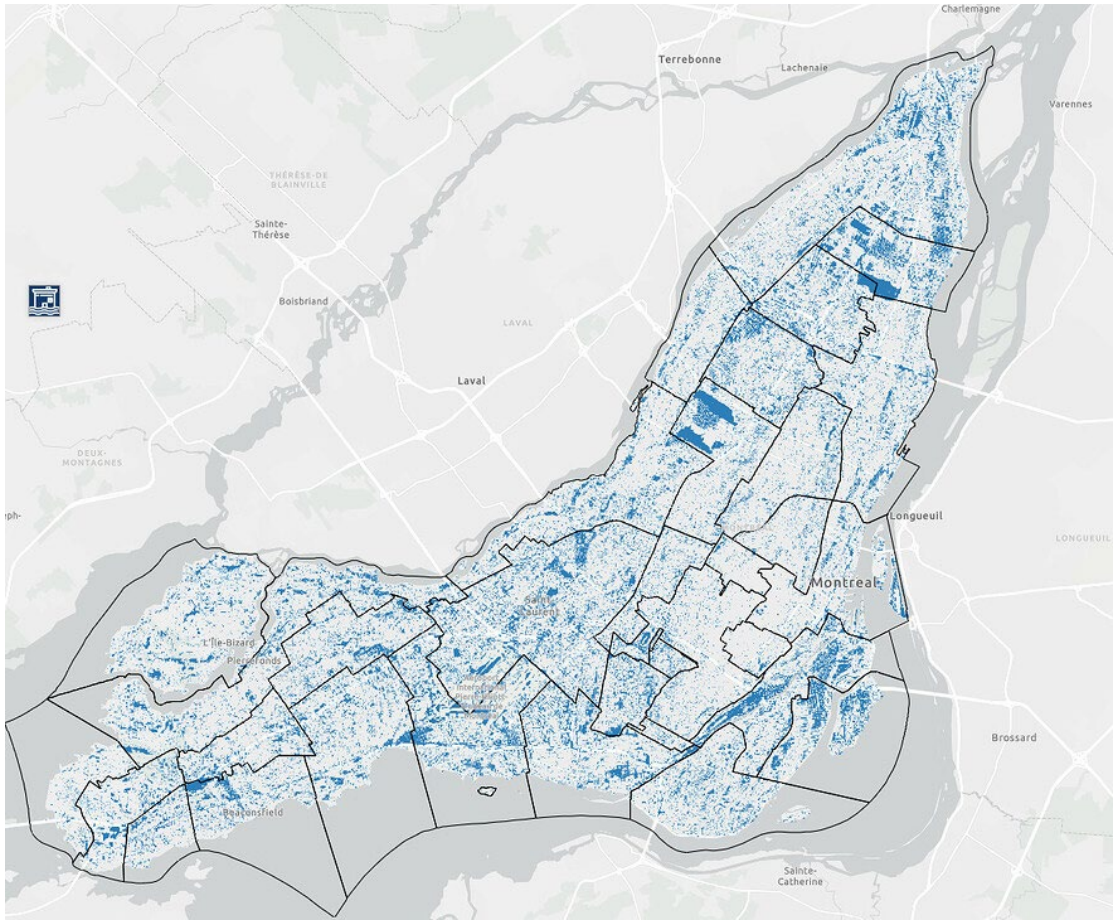
Thomas Balstrøm [a,*], David Crawford [b]

[a] Department of Geosciences and Natural Resources, University of Copenhagen, Øster Voldgade 10, DK-1350, Copenhagen K, Denmark
[b] Geodatabase Product Engineer, Esri, 380 New York St., 92373, Redlands, CA, USA

2018

The Problem(s) with Existing Systems

Basic task – Gain a better knowledge of the actual flow paths during extreme events and low points in the major system



Low point accumulations determined for the entire territory

The Problem(s) with Existing Systems

Relevant parameters to quantify resilience

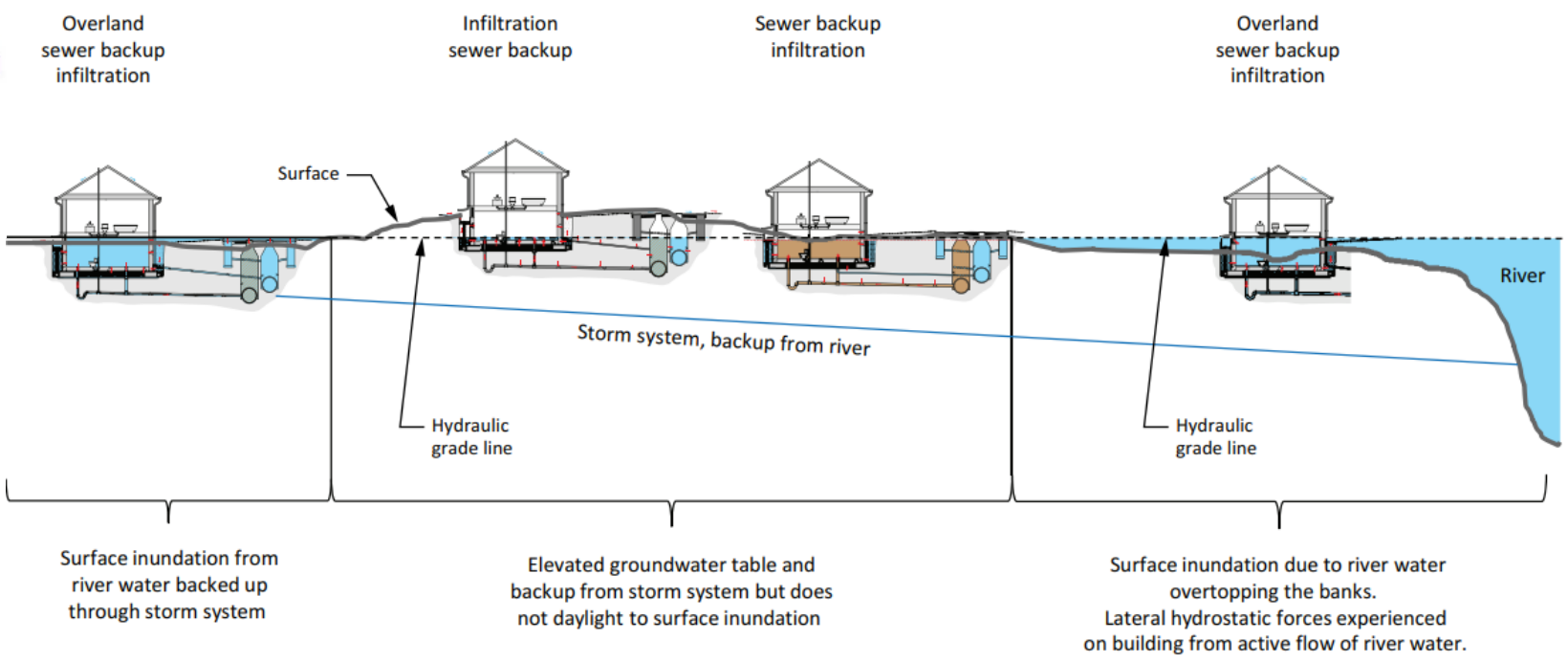
- Surface areas flooded
- Duration of flooding
- Maximum water levels at low points
- Horizontal and vertical distances to buildings or infrastructures

The Problem(s) with Existing Systems

1. Quantify the root cause
Consider the appropriate scale

(CSA Z800)

The relationship between river flooding and flood causes discussed in the Guideline
(See Clause 4.5.)

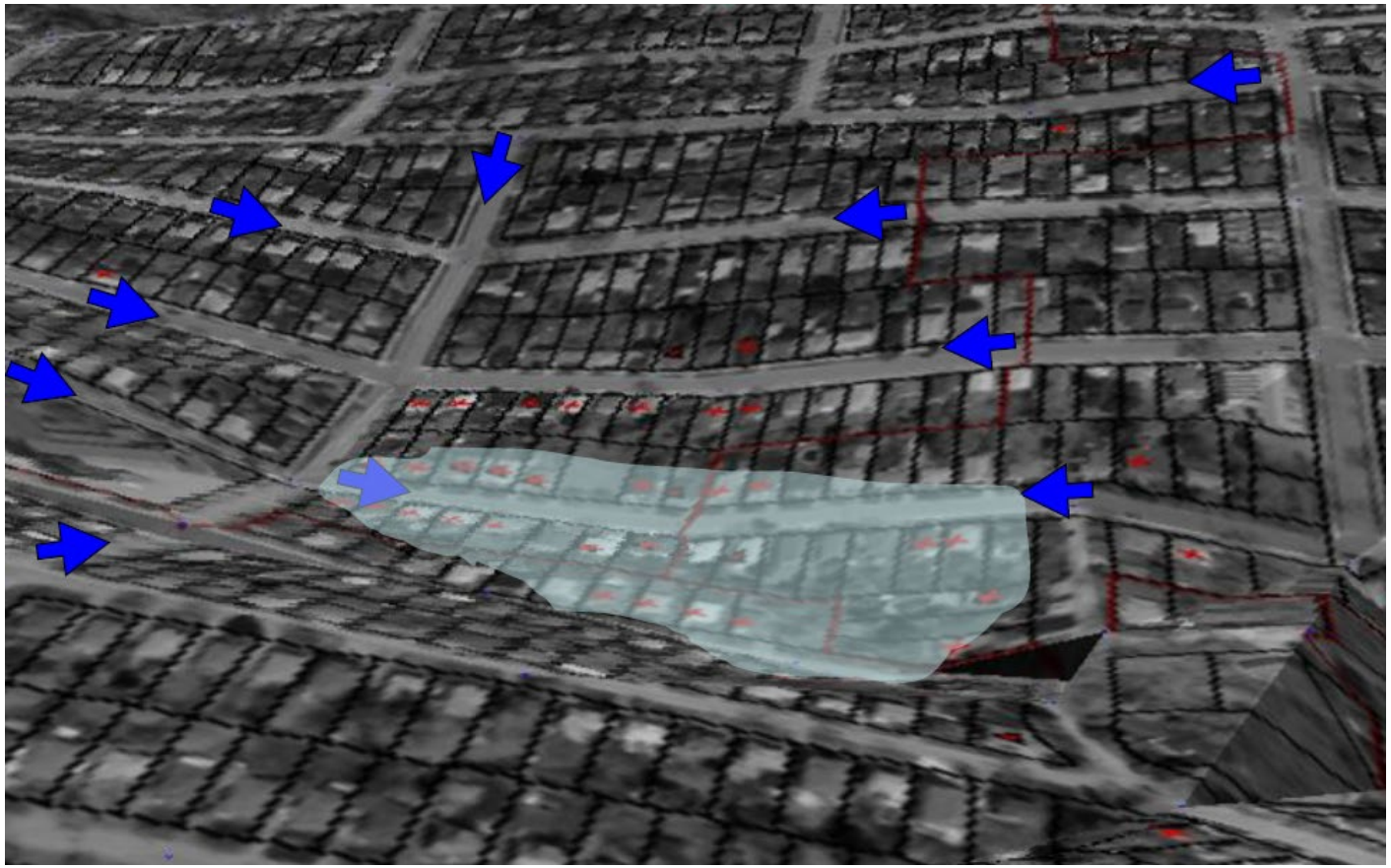


The Problem(s) with Existing Systems

2. Quantify the risk and consequence of flooding

And what could (should) we do about it ?

IMPORTANCE OF MAJOR SYSTEM AND LOW AREAS

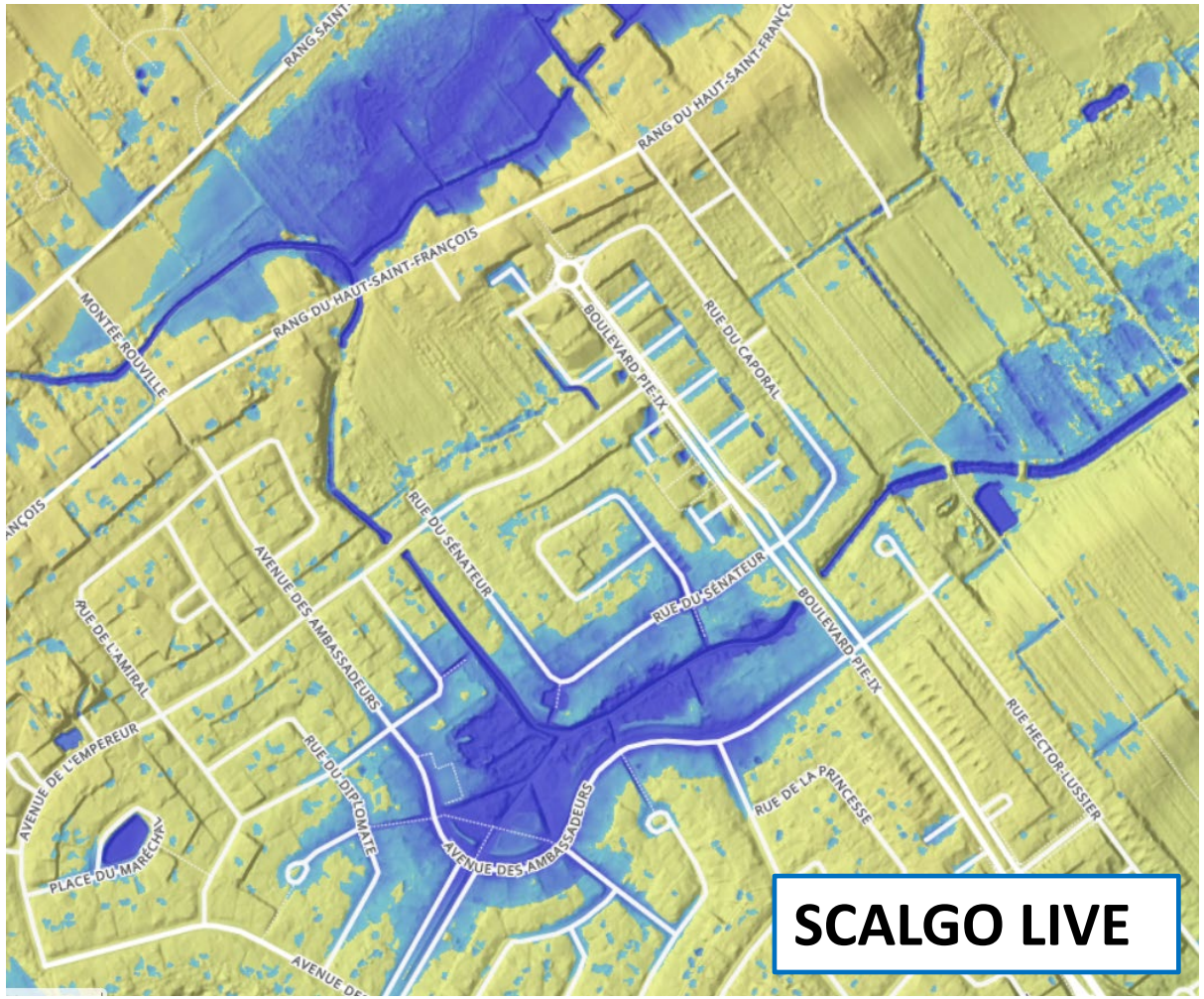


New Tools and Adapted Approaches

- Necessity to use 2D modeling and detailed analysis
- Important component of GIS data (DEM, elevations and caracteristics of buildings, locations of catch basins, location of depressed driveways and potential entrances of water through buildings, etc.)

New Tools and Adapted Approaches

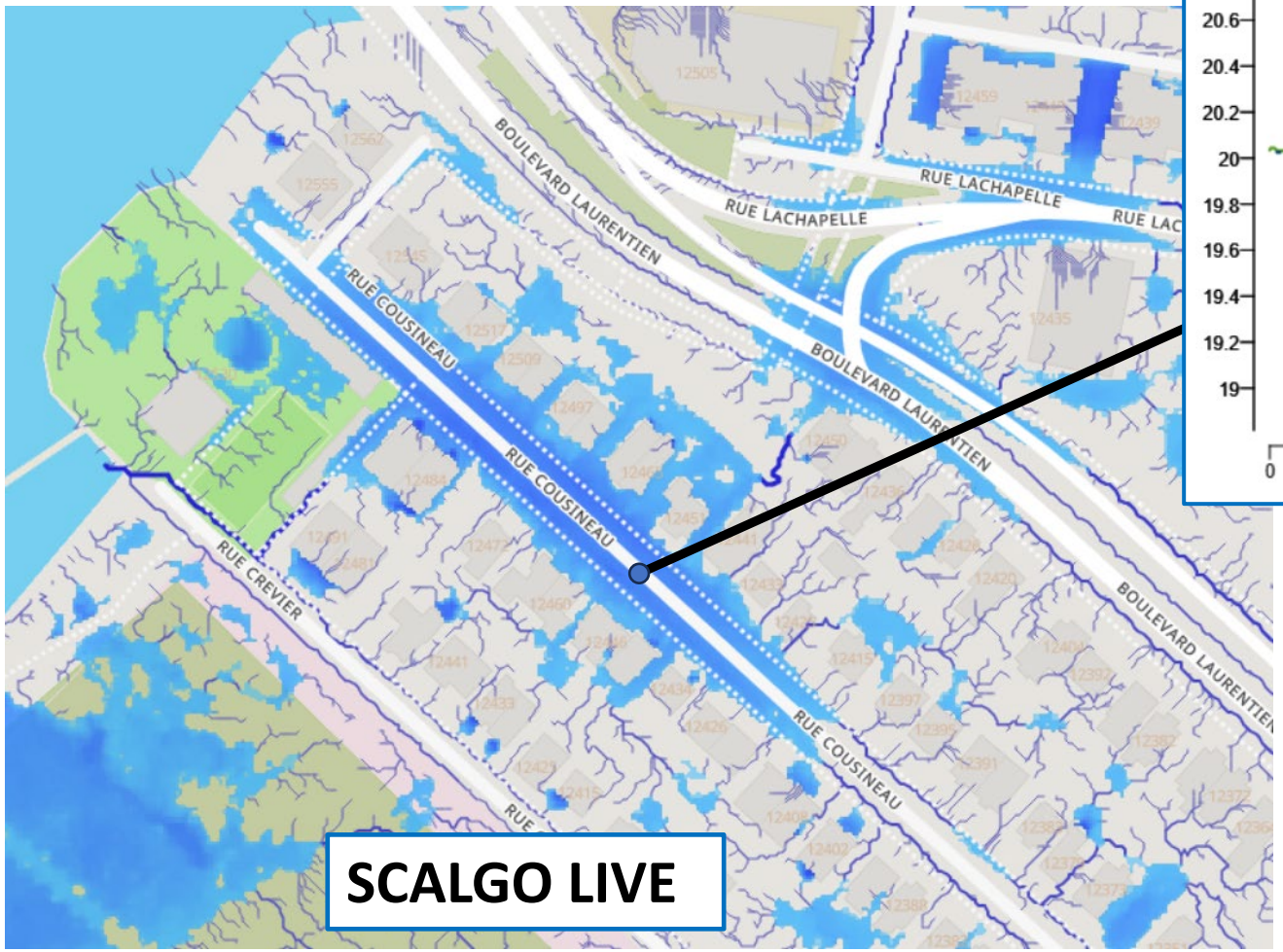
- **Tools for planning**
  - Simplified hydrology
  - Simplified consideration of underground pipe systems

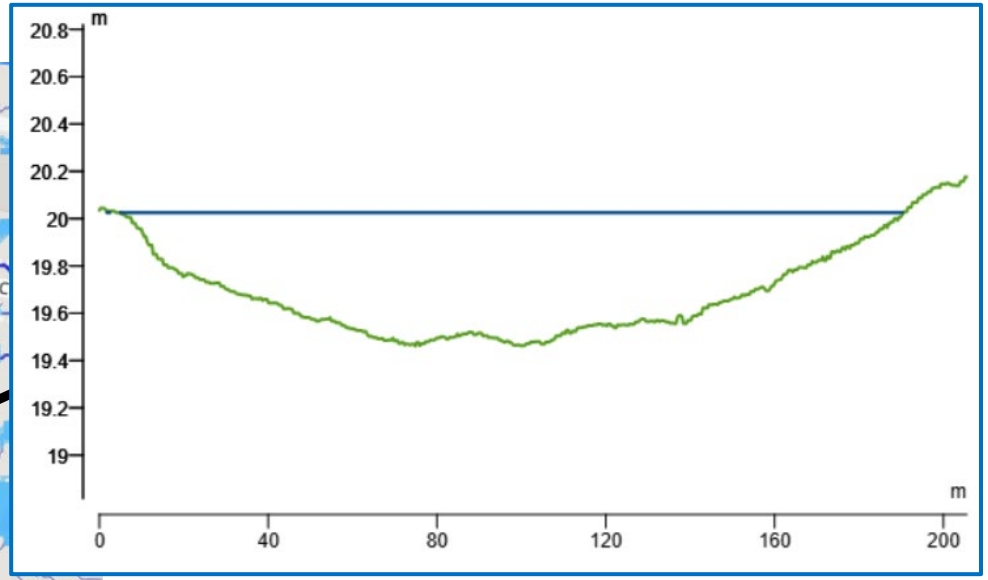


Scalgo Live
HEC-RAS 2D (Rain-on-Grid)
PCSWMM 2D(Rain-on-Grid)

New Tools and Adapted Approaches

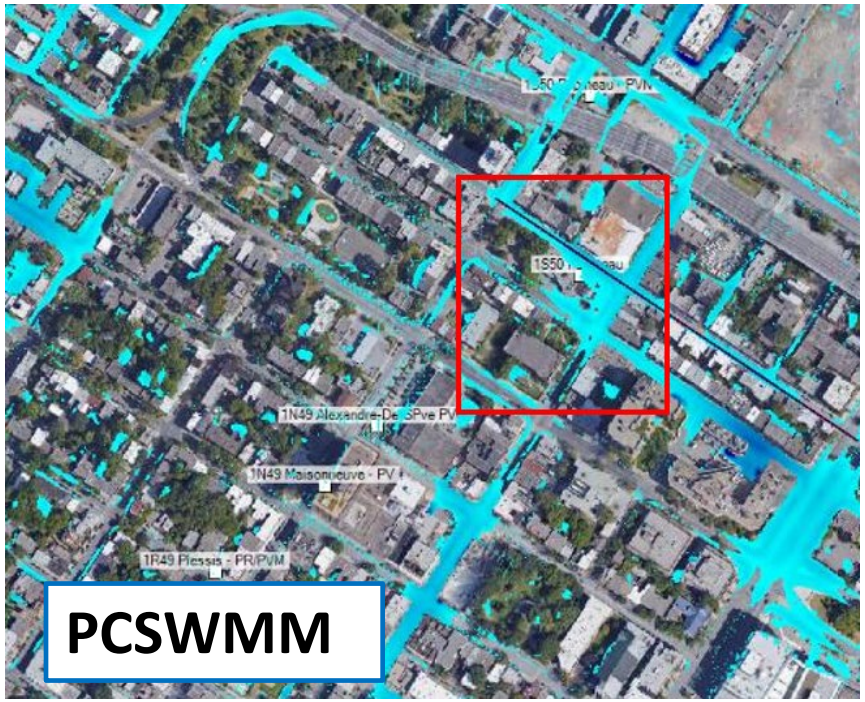
- **Tools for planning**





New Tools and Adapted Approaches

- **Tools for detailed design**
  - Detailed hydrology and hydraulics
  - Detailed integration of major systems, catch basins and pipe systems



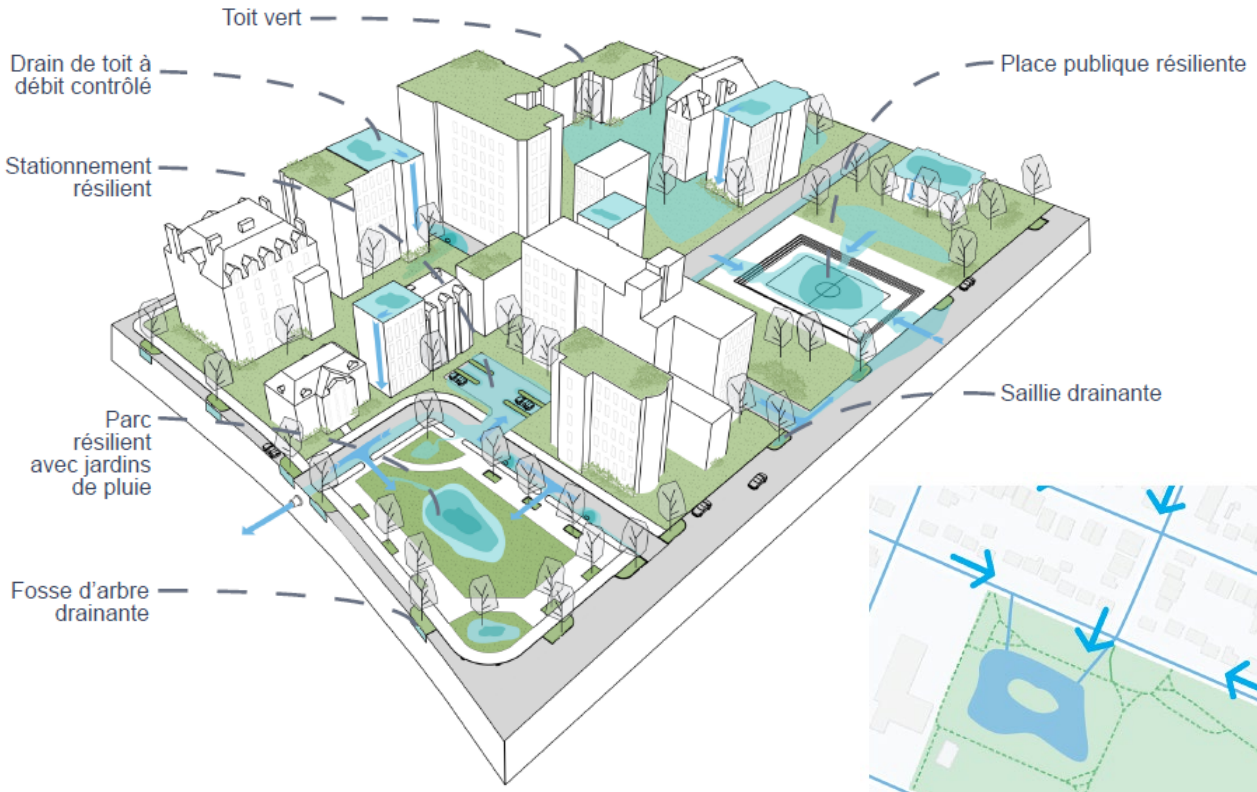
Water depth around 300 mm to 600 mm during heavy rainfall

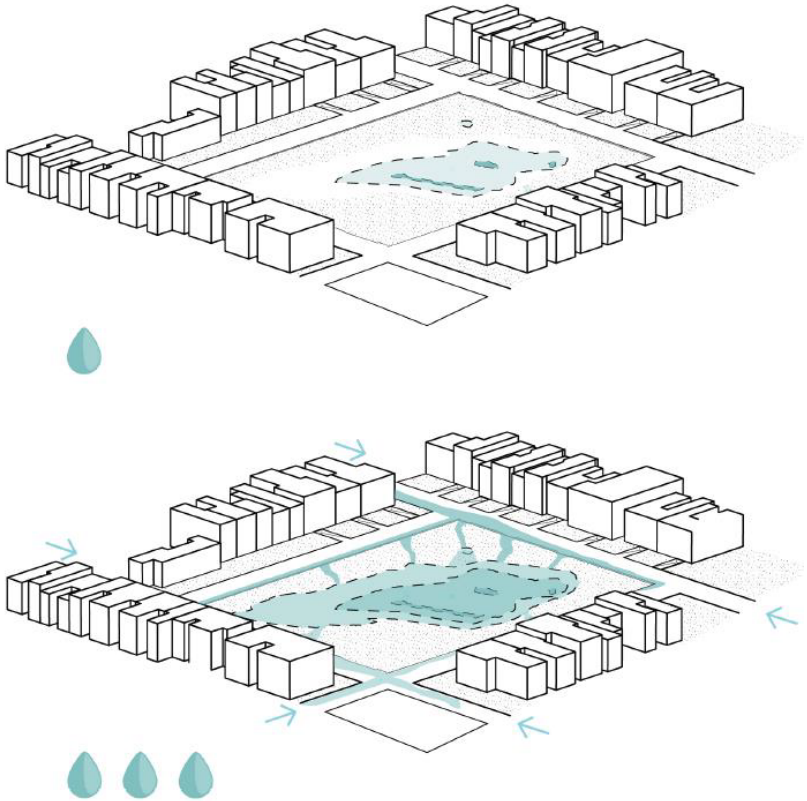
Model gives around 600 mm depth at the same spot

Sponge Parks – General Concepts

Some inspiration from international examples (Water square – Rotterdam)

Sponge Parks – General Concepts





Montréal – Espaces résilients publics : la boîte à outils (Toolbox)

Sponge Parks – General Concepts

Types of layout and design elements

Dépression végétalisée

Parc Pierre-Dansereau — Montréal

Enghaveparken - Copenhague

Parc — Gelsenkirchen

Espace imperméable

Enghaveparken — Copenhague

Skatepark Van Horne — Montréal

Bellamyplein — Rotterdam

Espace de biorétention

Parc Dickie-Moore — Montréal

Parc Pierre-Dansereau — Montréal

Place des Fleurs-de-Macadam — Montréal

Montréal – Espaces résilients publics : la boîte à outils (Toolbox)

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Sponge Parks – General Concepts

Opportunities for multi-functional design

Variation de l'état sec et submergé

Parc Pierre-Dansereau — Montréal

Parc Pierre-Dansereau — Montréal

Place des Fleurs-de-Macadam — Montréal

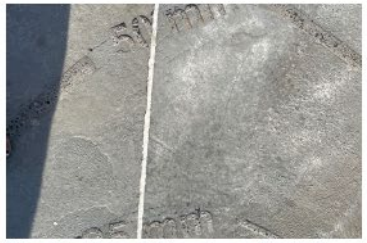
Dénivelés

Ruelle verte — Montréal

Kokkedal project — Danemark

Parc Pierre-Dansereau — Montréal

Évocation de l'eau en surface



Place des Fleurs-de-Macadam — Montréal

Place des Fleurs-de-Macadam — Montréal

Place des Fleurs-de-Macadam — Montréal

Montréal – Espaces résilients publics : la boîte à outils (Toolbox)

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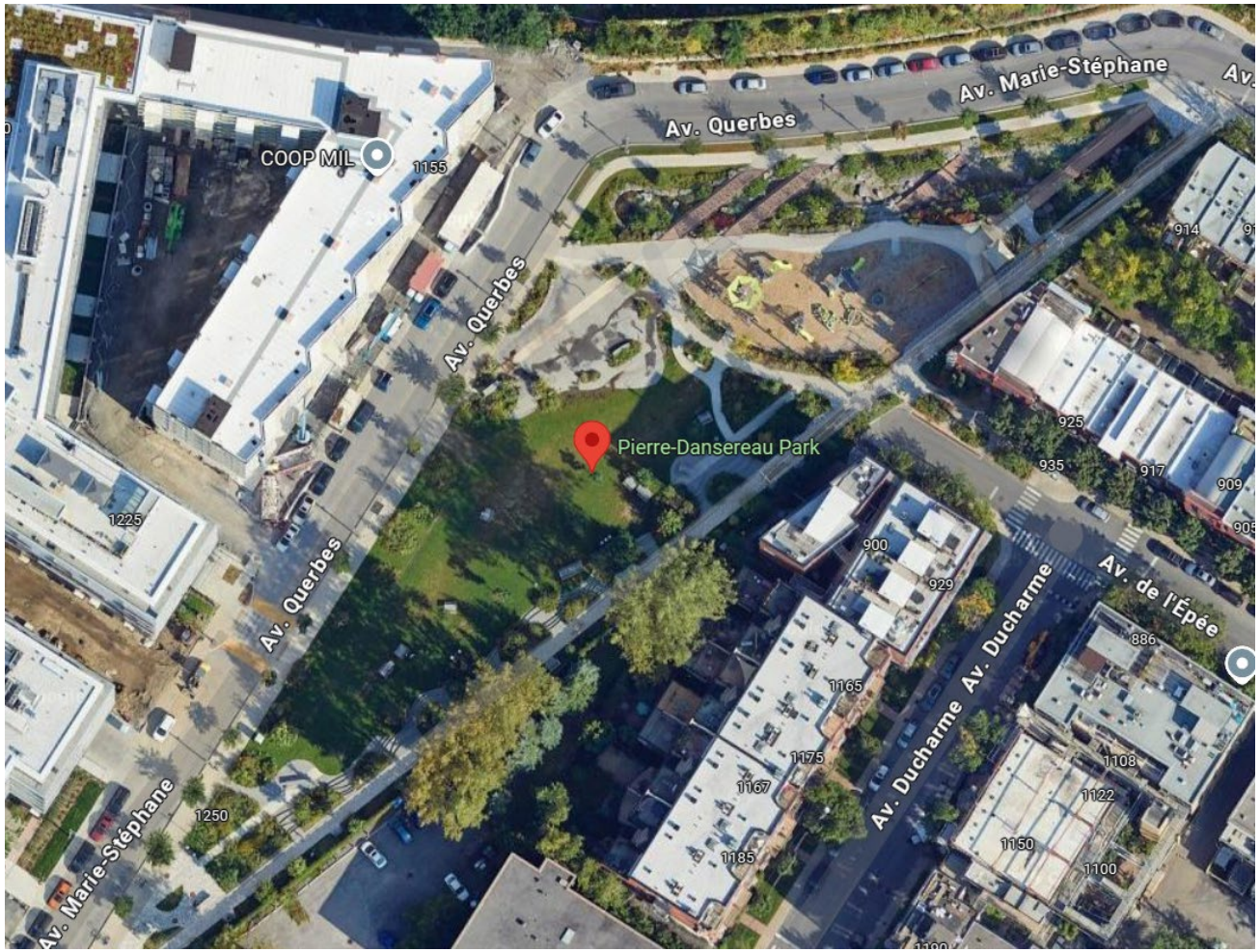
Case Studies – Sponge Parks

1. Parc Pierre-Dansereau

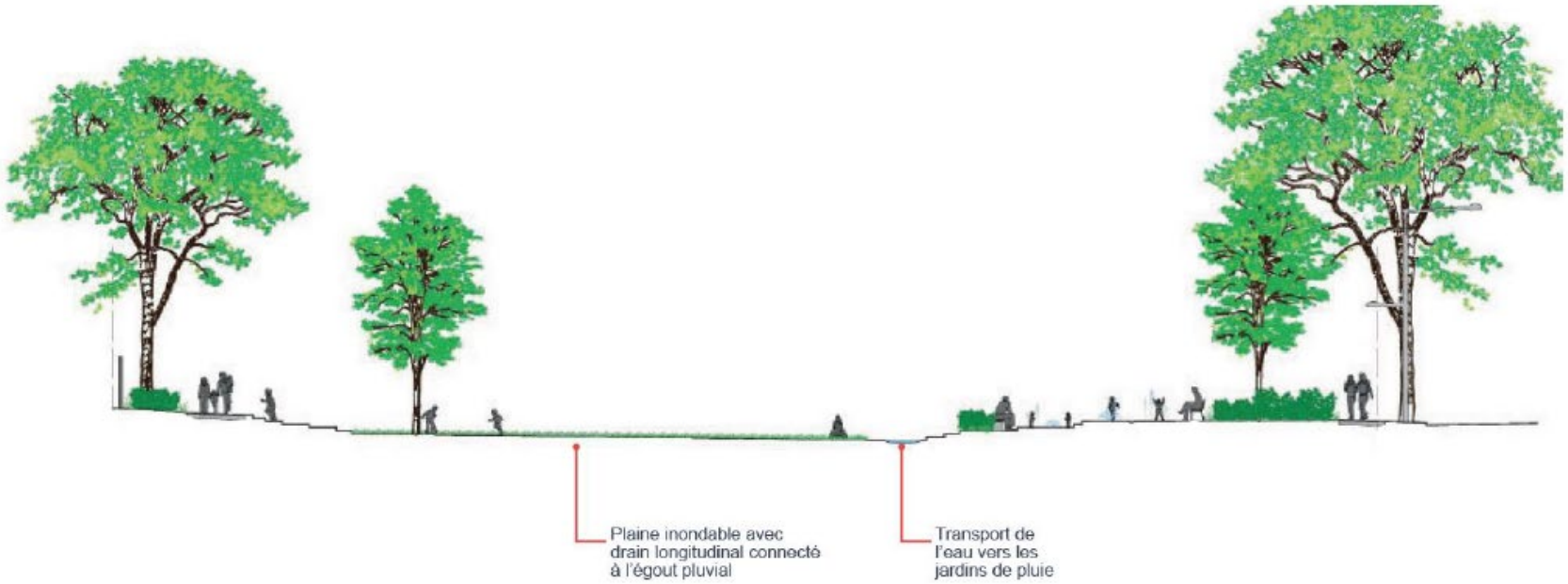


	Hauteur d'eau	
Récurrence de pluie	Espace central	Jardin de pluie
20 ans	0 - 260 mm	460 mm
50 ans	100 - 350 mm	550 mm

Construction: 2021
Area: 6320 m^2
Volume of water: 630 m^3
Budget: 3,1 M$

Case Studies – Sponge Parks

1. Parc Pierre-Dansereau




Noue de biorétention avec trop-plein

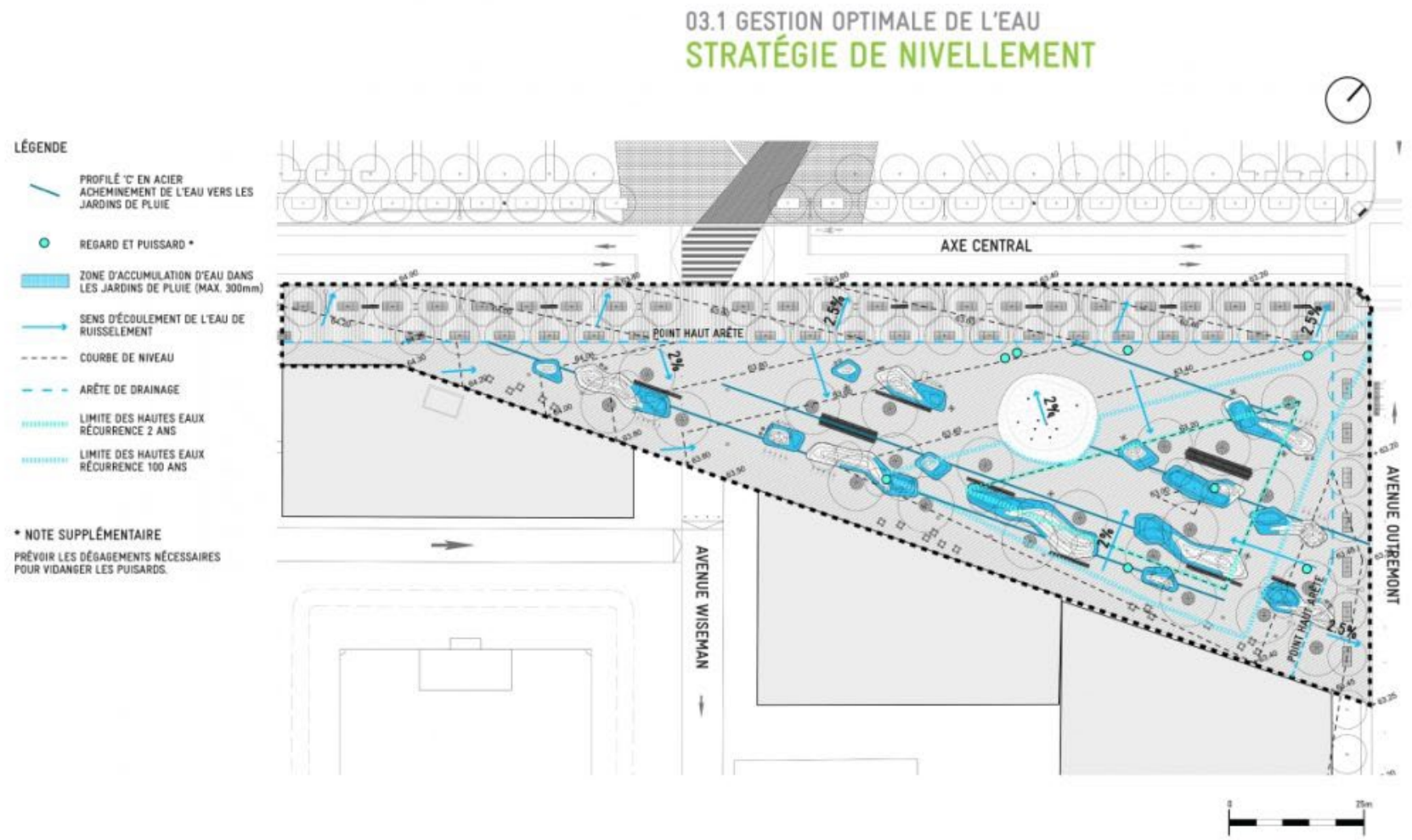

Puisard connectant les jeux d'eau aux jardins de pluie


Pleine gazonnée multiusage inondable avec drain


Passerelles

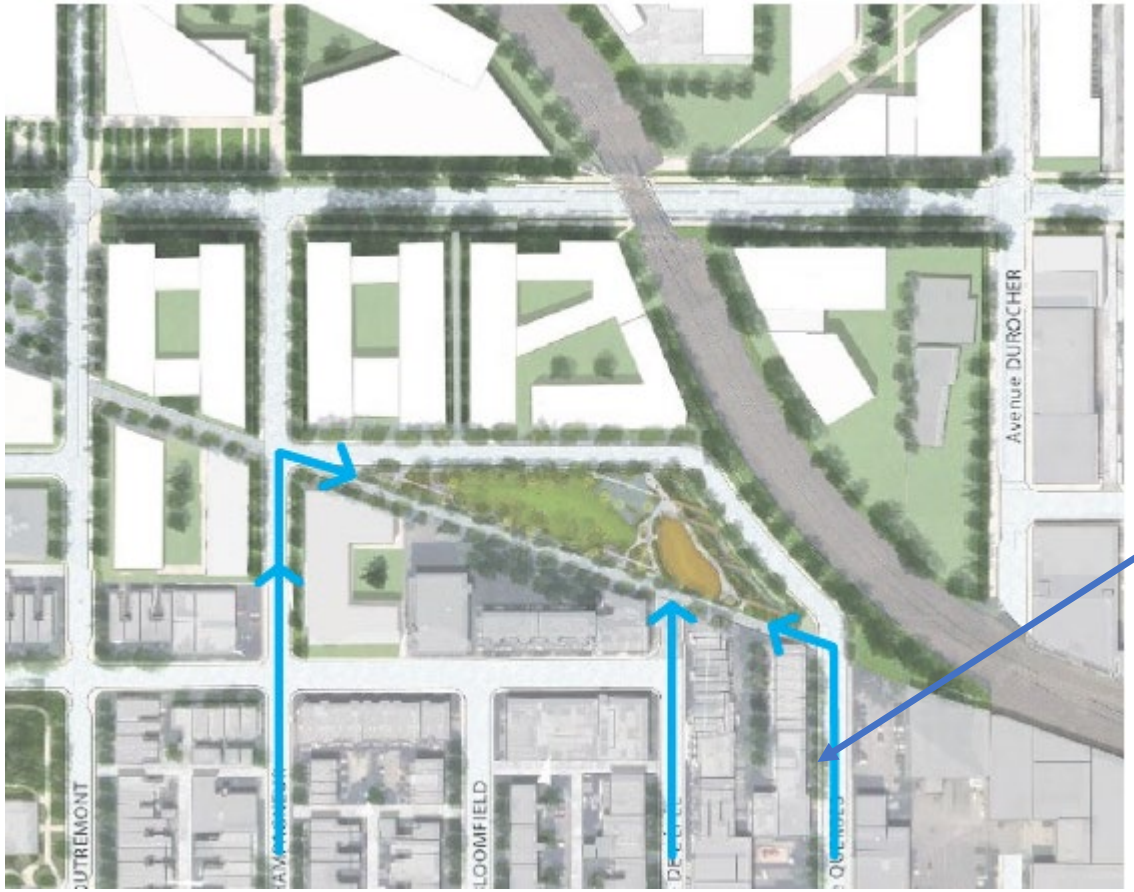
Case Studies – Sponge Parks

1. Parc Pierre-Dansereau



Case Studies – Sponge Parks

1. Parc Pierre-Dansereau

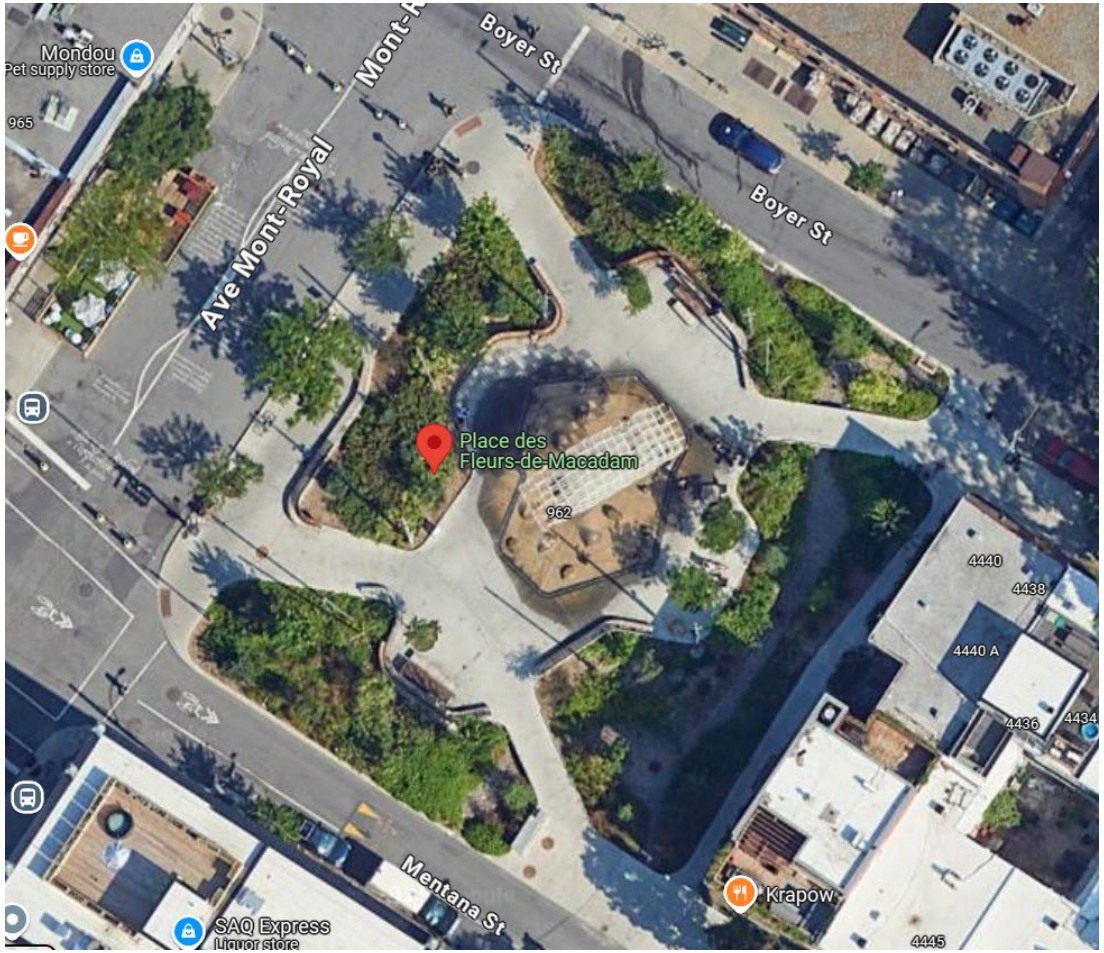


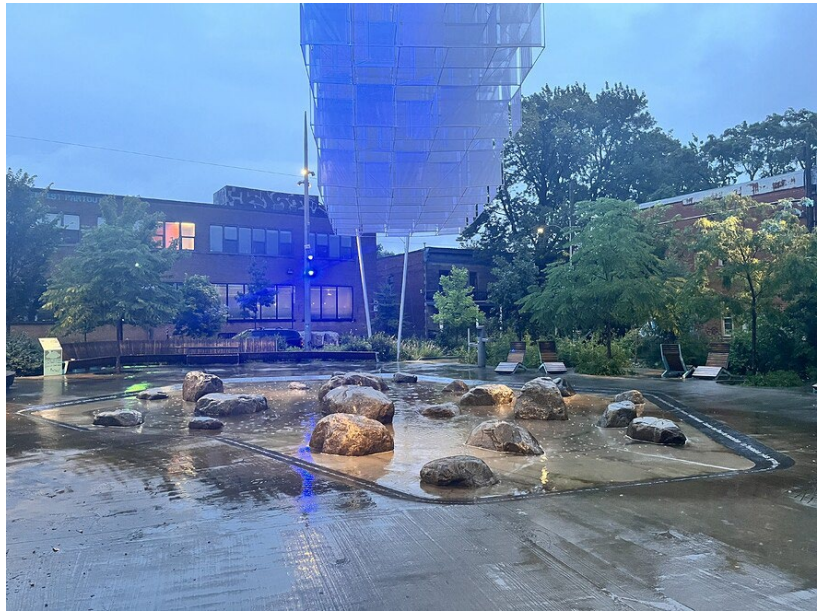
Case Studies – Sponge Parks

1. Parc Pierre-Dansereau

Case Studies – Sponge Parks

2. Parc Fleur-de-Macadam

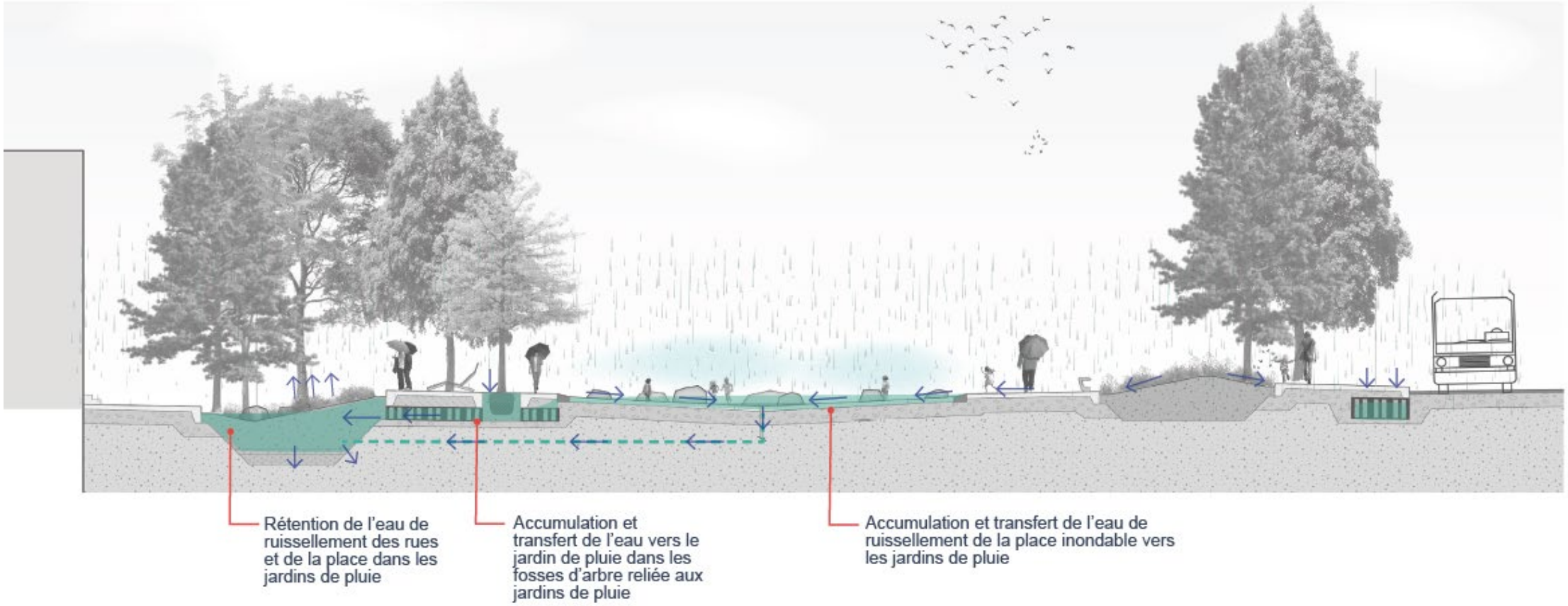




Construction: 2021
Area: 2110 m^2
Volume of water: 170 m^3 (total infiltration)
Budget: 2,2 M$

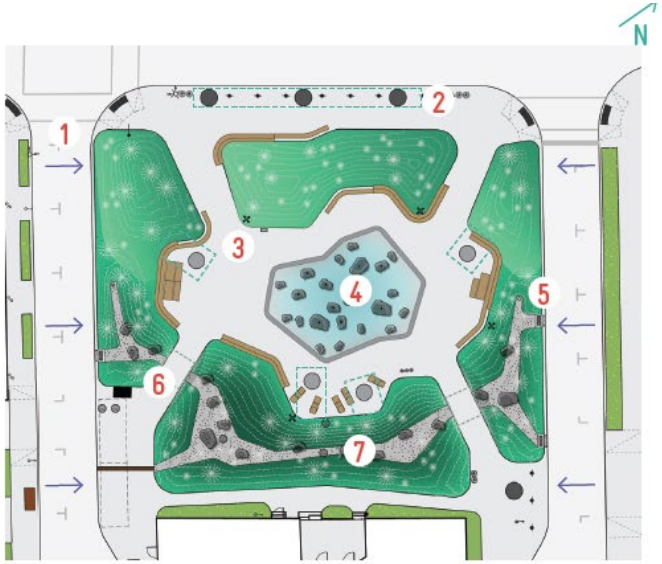
Case Studies – Sponge Parks

2. Parc Fleur-de-Macadam



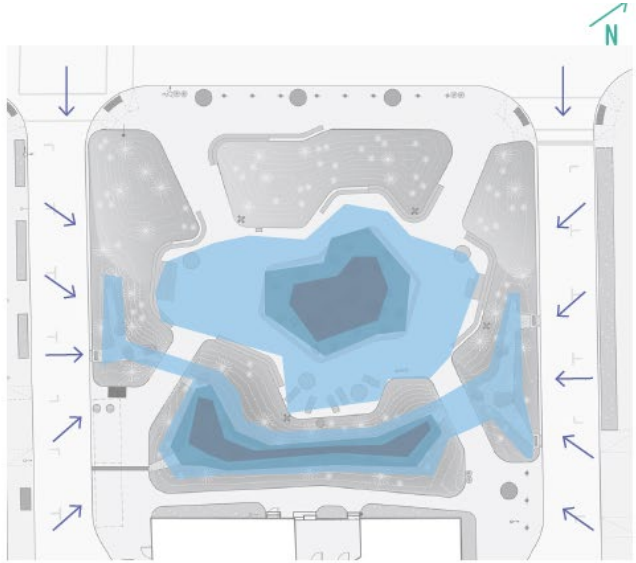
Case Studies – Sponge Parks

2. Parc Fleur-de-Macadam



Types d'ouvrages

1 Rue à dévers unique
2 Fosse d'arbre élargie
3 Fosse d'arbre reliée aux jardins de pluie
4 Espace public inondable
5 Abaissement de bordure et fosse de prétraitement
6 Sentier sur ponceau
7 Jardins de pluie



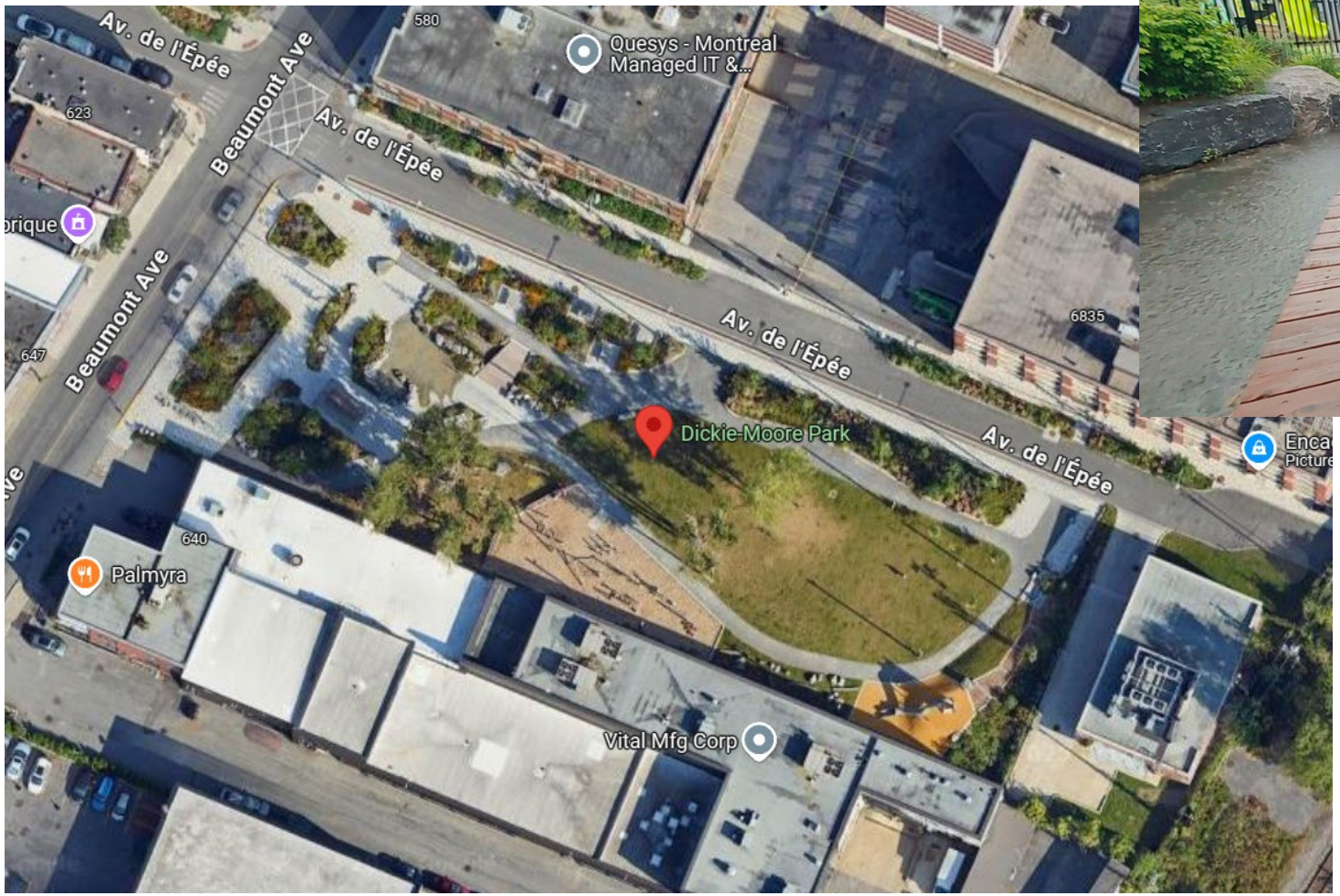
Gestion de l'eau

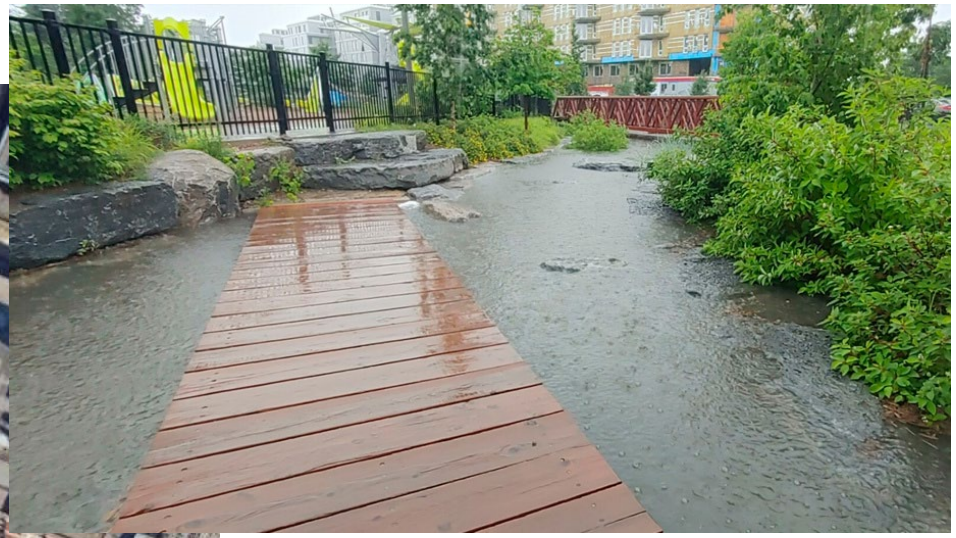
- Rétention et transport des eaux de la place publique vers les jardins de pluie
- Rétention et infiltration des eaux provenant des rues adjacentes

Pluie de récurrence 100 ans
Pluie de récurrence 10 à 25 ans
Pluie de récurrence 5 à 10 ans

Case Studies – Sponge Parks

3. Parc Dickie-Moore



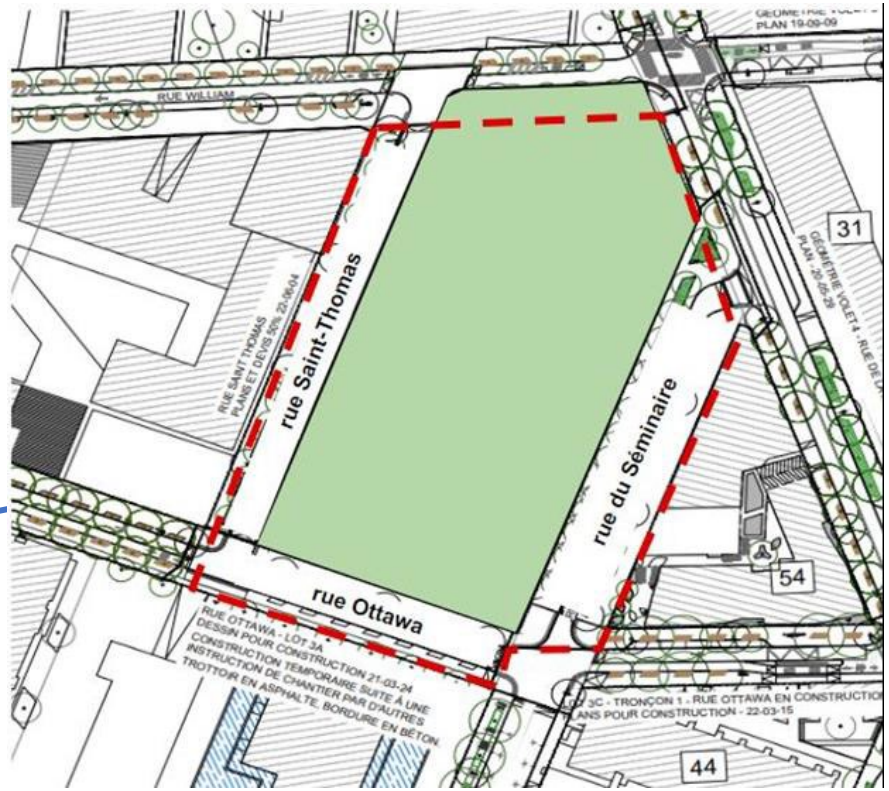


Case Studies – Sponge Parks

3. Parc Dickie-Moore

Case Studies – Sponge Parks

4. Parc des Eaux-Cachées (in development)



ROUSSEAU LEFEBVRE Environnements performants

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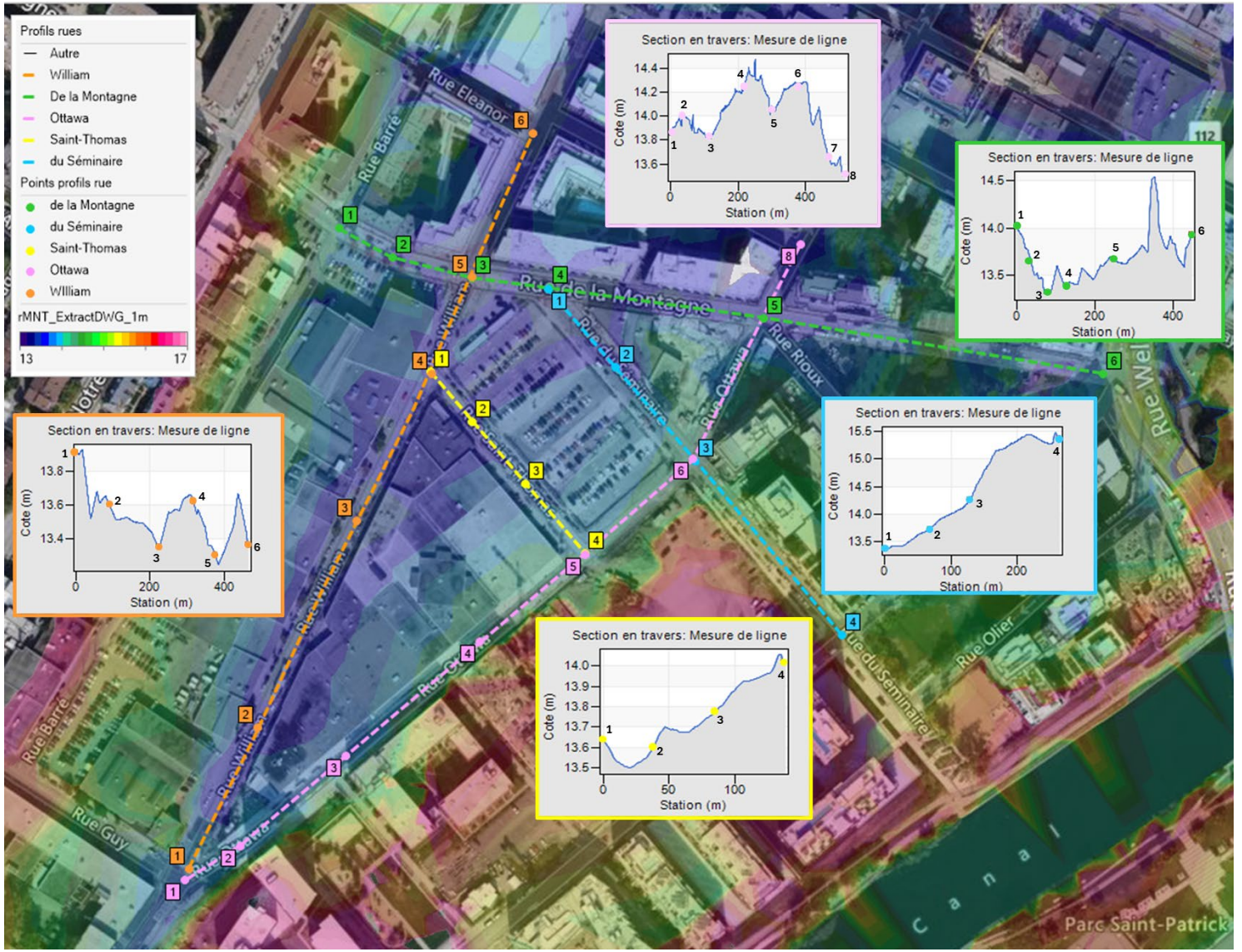
Case Studies – Sponge Parks

4. Parc des Eaux-Cachées

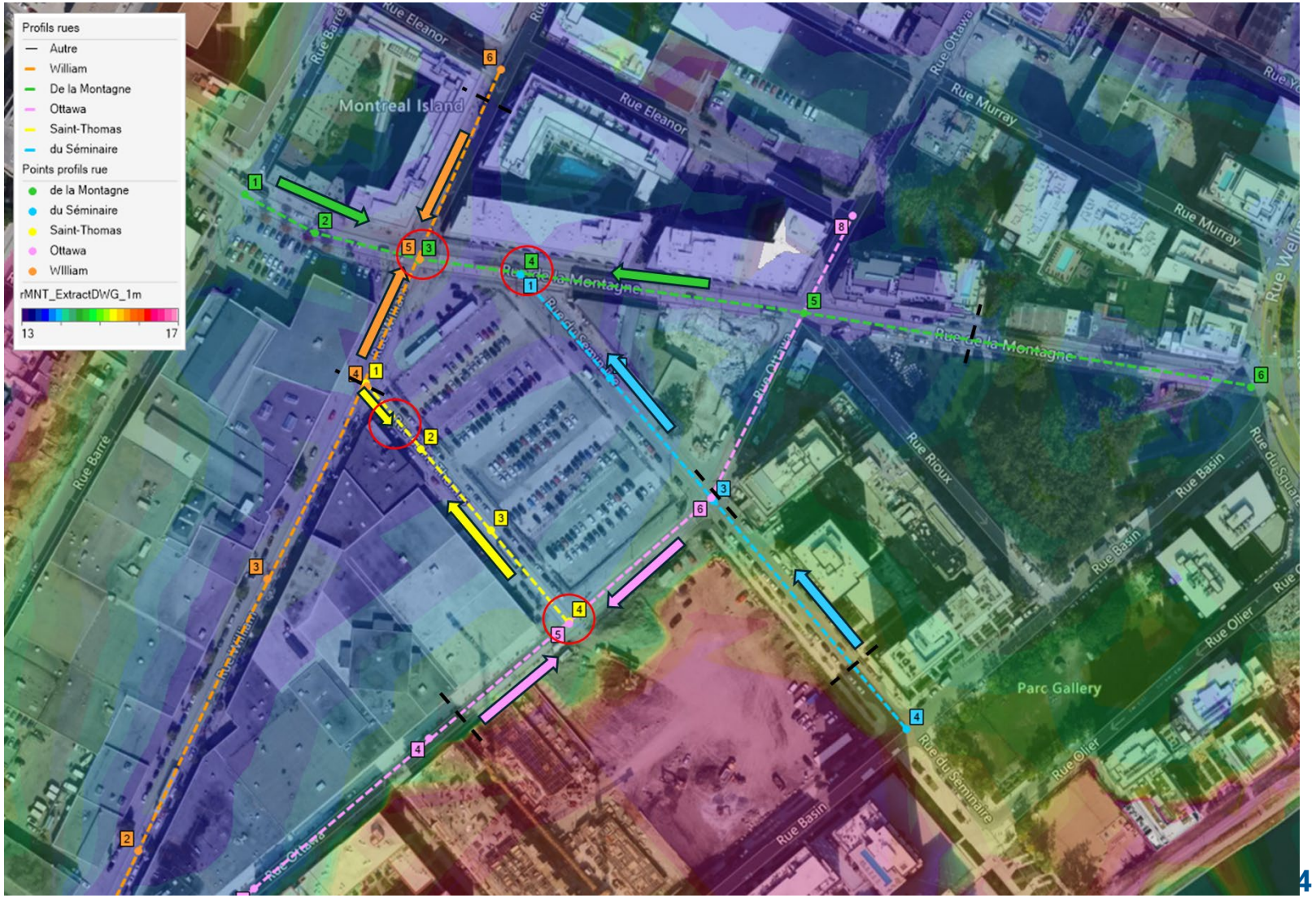
Detailed analyses (2D) of surrounding areas



Case Studies – Sponge Parks

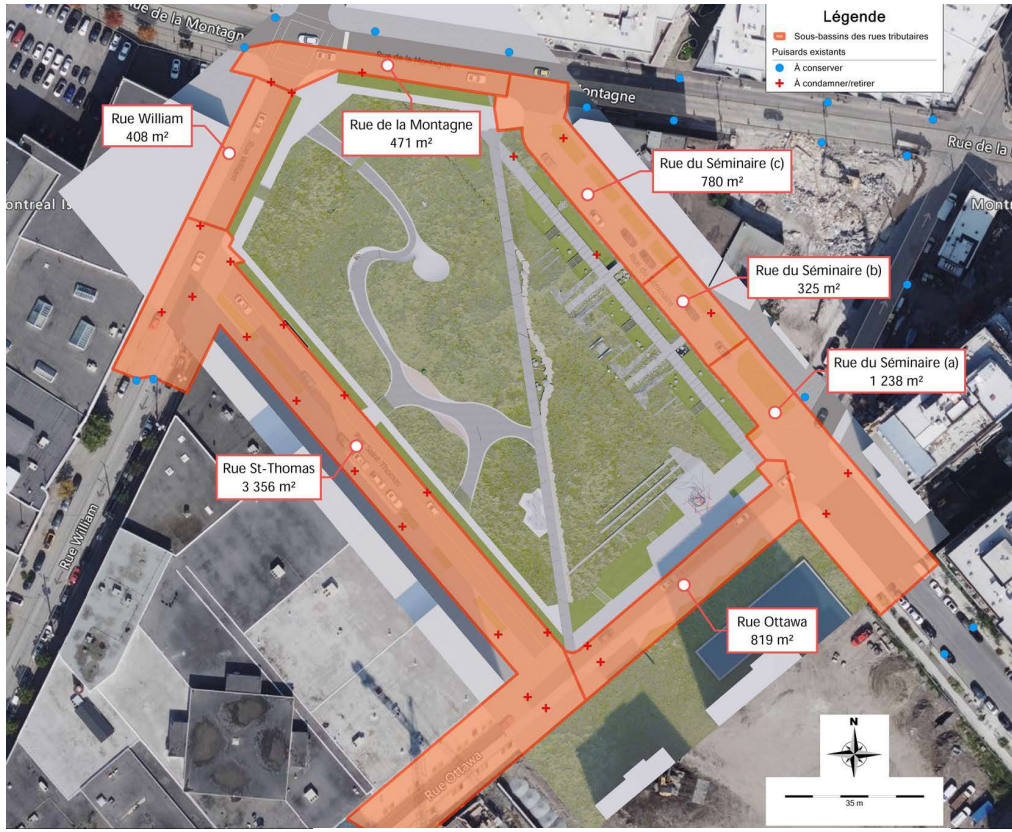
4. Parc des Eaux-Cachées

Looking for ways to maximize water directed to the park



Case Studies – Sponge Parks

4. Parc des Eaux-Cachées



ROUSSEAU LEFEBVRE Environnements performants

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Case Studies – Sponge Parks

4. Parc des Eaux-Cachées

ROUSSEAU LEFEBVRE Environnements performants

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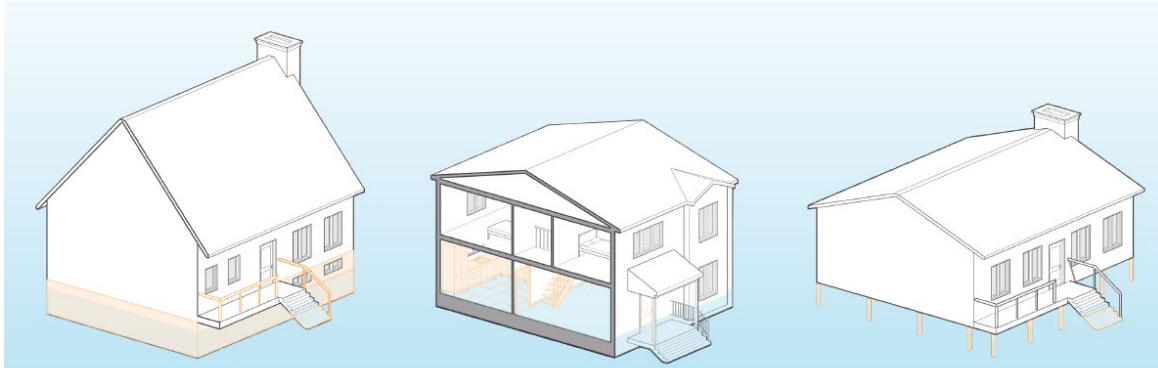
Another element of the strategy: Protection and Prevention



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RESIDENTIAL ADAPTATION

Fact sheets, 2024.03

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ARIACTION

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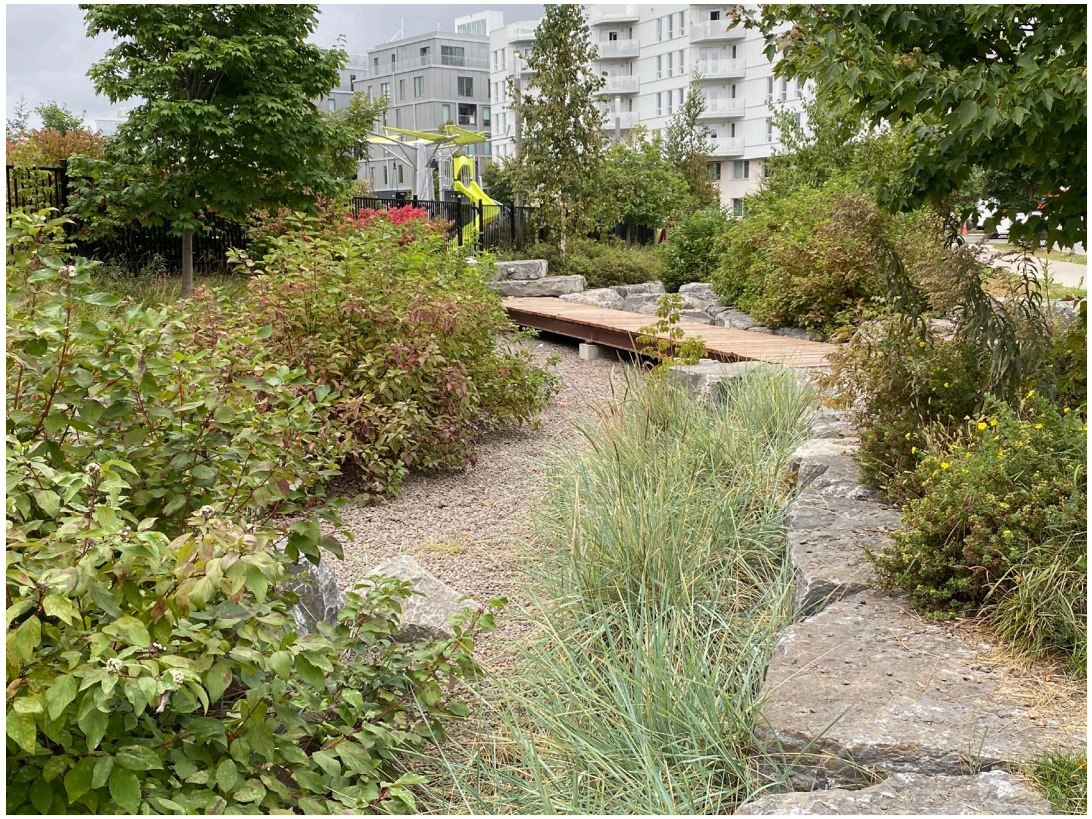
Conclusion and Outlook

- Risk and resilience are 2 different concepts – Increase of resilience of existing networks is necessary
- Evaluating resilience for older areas provides a more robust and optimal plan of interventions



- Better understanding of major system is an important input for evaluating and increasing resilience – Sponge Parks are an essential element for a global strategy

If you find yourself in a hole, the first thing to do is stop digging

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