Mitigation of Flooding Risks in Residential Neighbourhoods

Riverside Park Stormwater Feasibility Study

City of Ottawa | AECOM Canada ULC | ICWMM 2026

Presenter

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Presentation Outline

Riverside Park-2D PCSWMM

PRIMARY FOCUS

Using 2D PCSWMM modelling to assess and mitigate flooding in Riverside Park — an established residential neighbourhood with no dedicated overland flow (Major System) outlet — to improve level of service from the 2-year to 100-year storm event.

01 **Study Area & Background**

Riverside Park site location, drainage infrastructure overview

02 **2D PCSWMM Model Development**

Mesh, catchbasins, rating curves, 1D-2D connections, boundary conditions

03 **Model Validation**

August 2023 storm validation results

04 **Existing Conditions Level of Service**

Minor system, basement flooding, major system LOS

05 **Mitigation Solutions & Results**

Part 1 & 2 measures, LOS improvements for all systems

06 **Challenges & Lessons Learned**

PCSWMM 2D modelling experience and recommendations

Riverside Park Neighbourhood Study Area

Riverside Park Background

Riverside Park

Location

1960s, 2yr LOS

Built (No Dual Drainage, today 5yr LOS)

Fully Separated

System Type

6 Total

Minor System Outfalls

Key Challenge

No Overland (Major System) Outlet

⚠ August 10, 2023 — Extreme Storm Event

Riverside Park -2D PCSWMM

60 mm

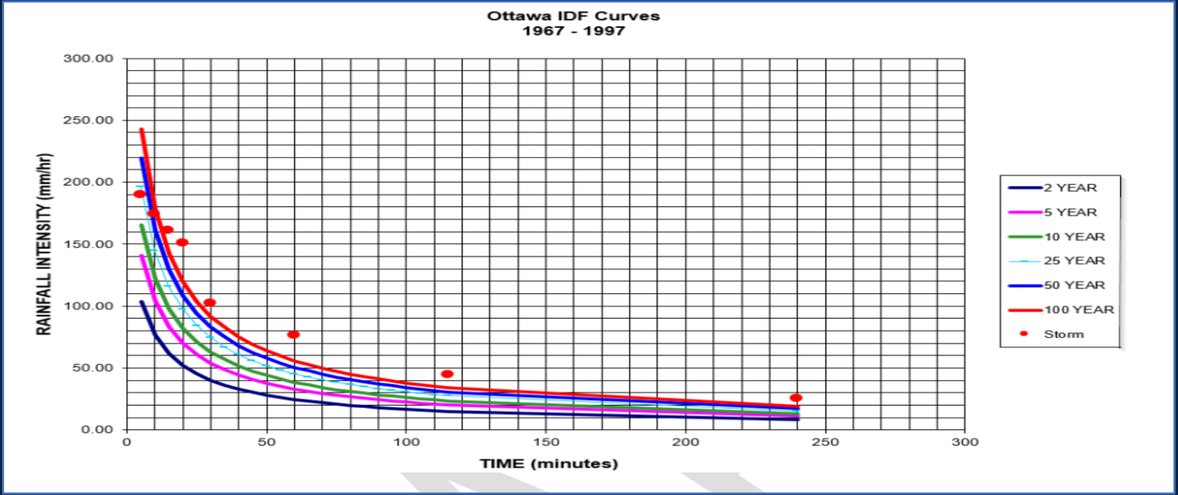
total rainfall over 5 hours

190 mm/hr

peak 5-minute intensity

Equivalent to or Exceed 100-Year Design Storm

City of Ottawa IDF Curve — Peak Intensity Comparison



RETURN PERIOD COMPARISON — 5-MINUTE PEAK INTENSITY

2-Year	~80 mm/hr
10-Year	~130 mm/hr
100-Year	~190 mm/hr
Aug 2023	**190 mm/hr**

⚠ August 10, 2023 — Potential Causes of Flooding

Riverside Park – 2D PCSWMM

Reported Flooding

Walkley Road, Ottawa — August 10, 2023
Source: CBC News

↑ Storm Sewer Surcharge

Minor system pipes (designed for 2-yr storms in the 1960s) overwhelmed — HGL rose above pipe obvert across much of the network.

~ Excess Overland Runoff

Rainfall far exceeded pipe capacity. Surface runoff accumulated faster than catchbasins could drain it to the minor system.

▼ Depressed Driveways

232 reversed-slope driveways act as low points. Overland flow and sewer backflow combined to flood 100 driveways above damage threshold.

✕ No Major System Outlet

Riverside Park has no defined overland flow (Major System) Outlet. Parks provided some storage but were overwhelmed — water spilled into rear yards and private property.

Key Takeaway: The absence of a defined major system outlet is the root constraint — the minor system must absorb all excess flow with no overland escape route.

Existing Conditions Flooding Analysis

Develop 2D Model

Build and integrate 2D mesh with 1D storm sewer network from City's PCSWMM model

Simulate Systems

Model surface runoff, overland flow (major), and pipe flow (minor) under design storms and Aug 2023 event

Identify Flood Areas

Pinpoint areas prone to flooding during extreme events using model simulation results

Establish Current LOS

Determine approximate storm level of service for the minor system, basement flooding, and major system

Target Mitigation

Assess feasibility of mitigation measures to reduce flooding and improve LOS

2D PCSWMM Modeling Approach

Data Collection

- City GIS data
- LiDAR (2020)
- Aerial photos
- Storm sewer information
- Catchbasins
- Depressed driveways
- Historical flooding records

PCSWMM 1D Model

- Review City's 1D PCSWMM model
- Data gaps
- Identify issues in storage, conduits, pipe profiles and catchbasins

2D Model Build

- Integrate 1D minor system with 2D overland mesh
- Apply rating curves for CBs
- Assign boundary conditions at outfalls
- Incorporate hydrographs for external area

Model Validation with August 2023 Event

Reproduce reported flooding conditions using the August 2023 flood record

PCSWMM 2D MODEL FRAMEWORK

Integrated 1D-2D Dual Drainage Model

1D COMPONENTS

- Storm sewer network (21.9Km)
- Culverts (2)+Underpass
- Outfalls (6)
- Catchbasins (680)

→

COUPLING

- 1D-2D integration
- Outlet links
- Dual drainage (Major 2.2Km)

→

2D COMPONENTS

- Overland flow mesh
- Surface routing
- Flood mapping

797
Catchments

165
ha

1D+2D
Integration

3hr Chicago
Design Storms

August 10, 2023
Storm Event

2D PCSWMM MODEL DEVELOPMENT-BOUNDING LAYER

Overland Area

- Style: Hexagonal
- Resolution 12 m
- Roughness: 0.05

Roadway

- Style: Hexagonal
- Resolution 6 m
- Roughness: 0.011

Sufficient Detail for High-Level Study

2D PCSWMM Model Development-2D Mesh

- DEM
- Roadway-Centerline
- Building Layer-Obstruction
- Landuse-Manning’s n
- Model Stability and Computational Efficiency

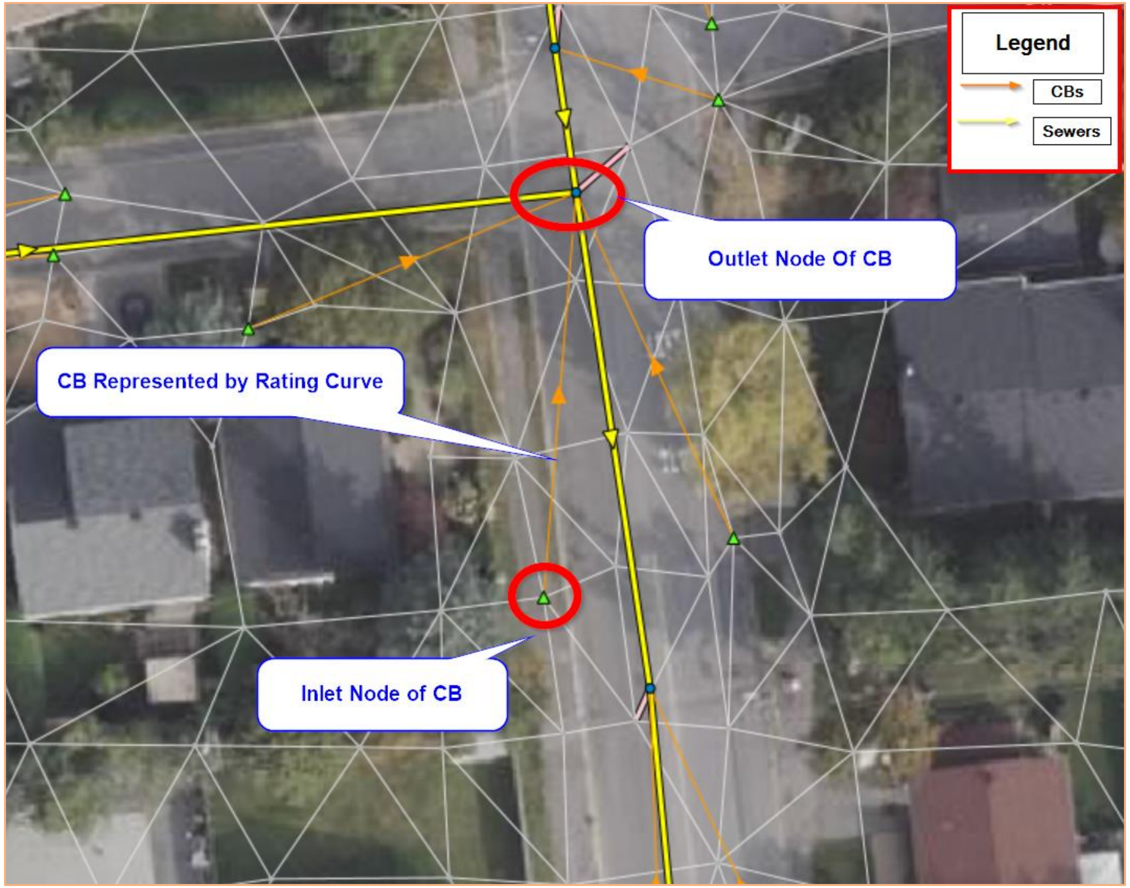
2D PCSWMM Model Development - Catchbasin Simuation

ROW CBs in Sag

ROW CBs in Slope

Rear Yard CBs

Depressed Driveway CBs

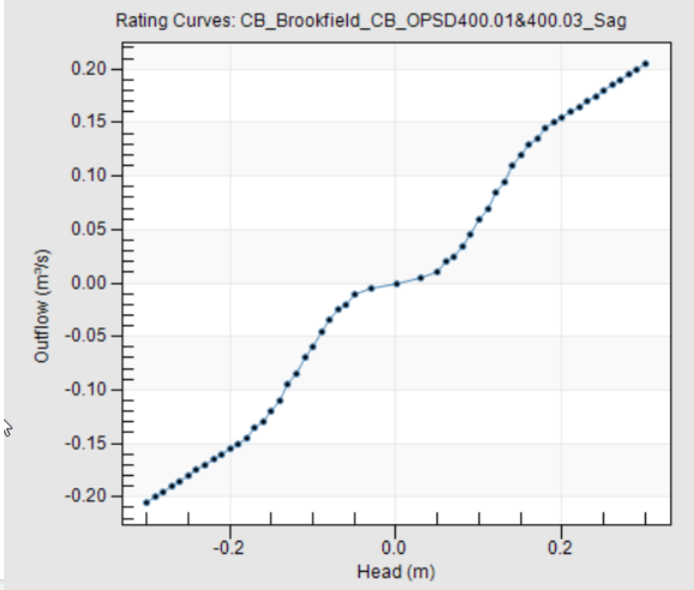


Catchbasins & Rating Curves

Catch Basin Rating Curves

Bidirectional

Extended rating curves in the reverse flow direction to represent asymmetric, bidirectional flow behavior at catch basins

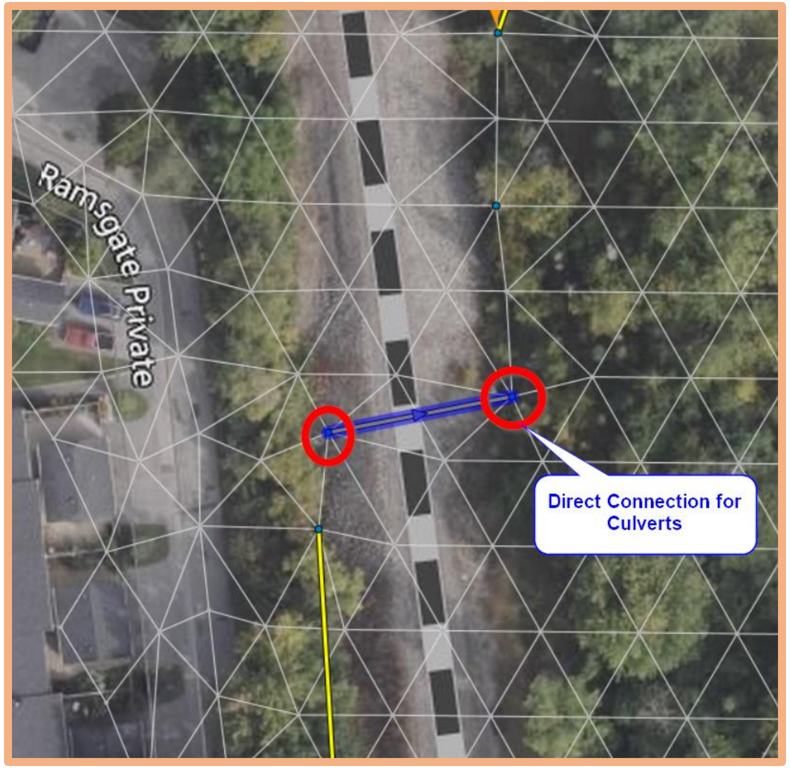


CB Grate Types Identified

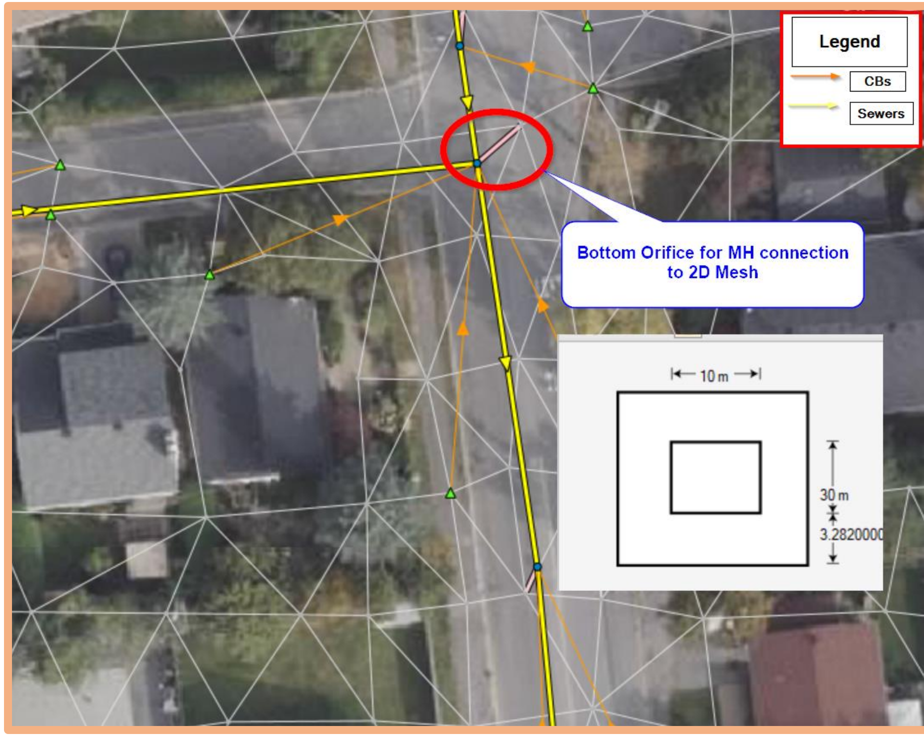
- S19 "Fish" (sag & grade)
- S22 "Curb Inlet" (sag & grade)
- Round Herringbone OPSD 400.07
- Square Herringbone OPSD 400.02
- Herringbone OPSD 400.01/03
- Horizontal Bar MT-310
- Single Grid (sag & grade)
- Honeycomb / Ditch Inlet
- Double Herringbone (sag)
- Double Horizontal Bar (sag)

2D PCSWMM Model Development – 1D 2D Connection

Culverts – Direct Connection



MH- Bottom Orifice Connection



Minor System Outfalls & Boundary Conditions

Sawmill Creek

Free Outfall (2- to 10-Year storms)

Sawmill Creek

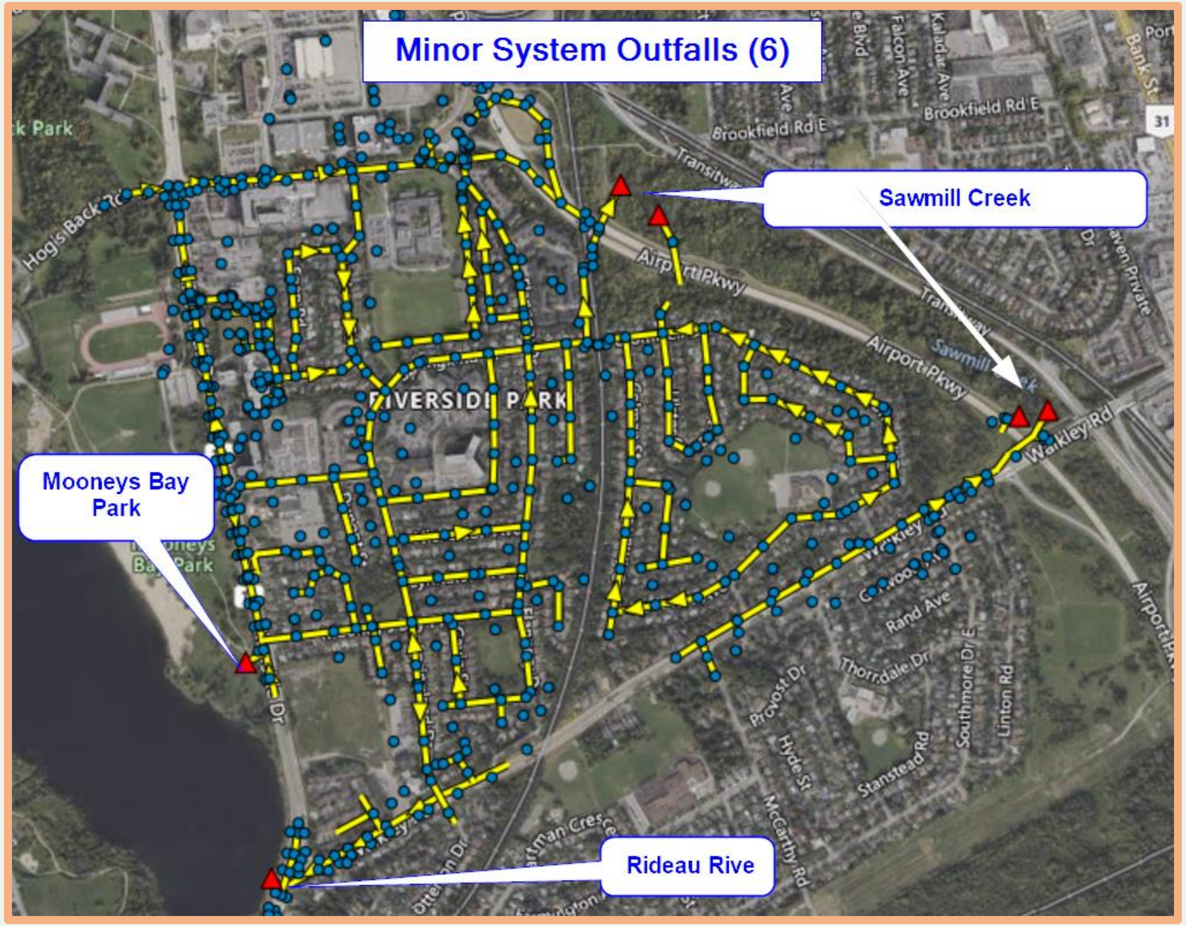
Normal (Major Storm Events)

Rideau River

Free Outfall (all storms)

Direct to Rideau River

Fixed to 2-Year Water Level (74.04m)



Model Validation – August 2023 Storm Event

Good alignment with reported flooding (Basement and Surface)

Reported flooding locations from the August 2023 event matched well with model simulation results. Basement flooding defined as MH hydraulic grade lines were over 1.8 m of road centerline.

Surface ponding validated against DEM

Model predictions of surface water accumulation closely matched an independent DEM-based ponding check, confirming the 2D mesh accurately represents overland flow patterns and ponding locations.

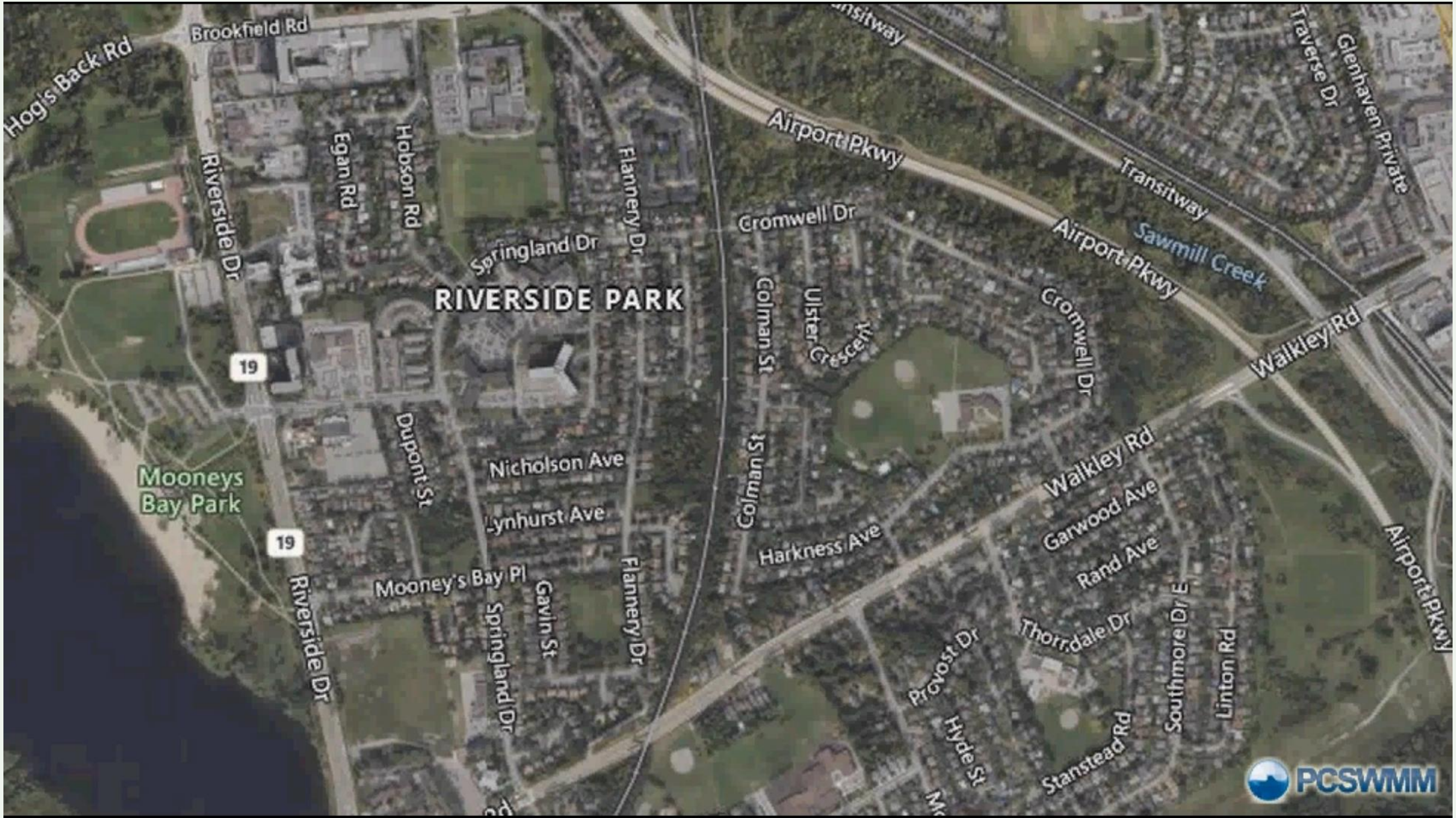
100 of 232 depressed driveways flooded above damage threshold

Ponding exceeded 0.06 m at these locations during the event, caused by both surface spill from the ROW and sewer backflow through catchbasin leads.

No dedicated major system outlet identified

The study area lacks a defined overland flow route. Parks provided temporary storage but were overwhelmed during the event, with surface water spilling into rear yards and private properties.

Existing Condition August 10, 2023, Model Results (Video)



Level of Service — Criteria Definition

Riverside Park-PCSWMM 2D

01 Minor System

Storm Sewer Surcharge Limit

CRITERIA

Pipe system must remain free-flow (no surcharge). HGL must stay below the pipe obvert.

D/Df < 1 or Q/Qf < 1

Non-surcharged condition

RESULT

Thematic map produced for design storms.

02 Basement Flooding

HGL Depth Below Road Centreline

CRITERIA

HGL must remain ≥ 1.8 m below road centre line.

HGL ≥ 1.8 m

Below road centreline

RESULT

Thematic map and profile produced for design storms.

03 Major System

First Building Contact with Ponding Water

CRITERIA

No ponding water ≥ 10 mm contacts a residential building footprint.

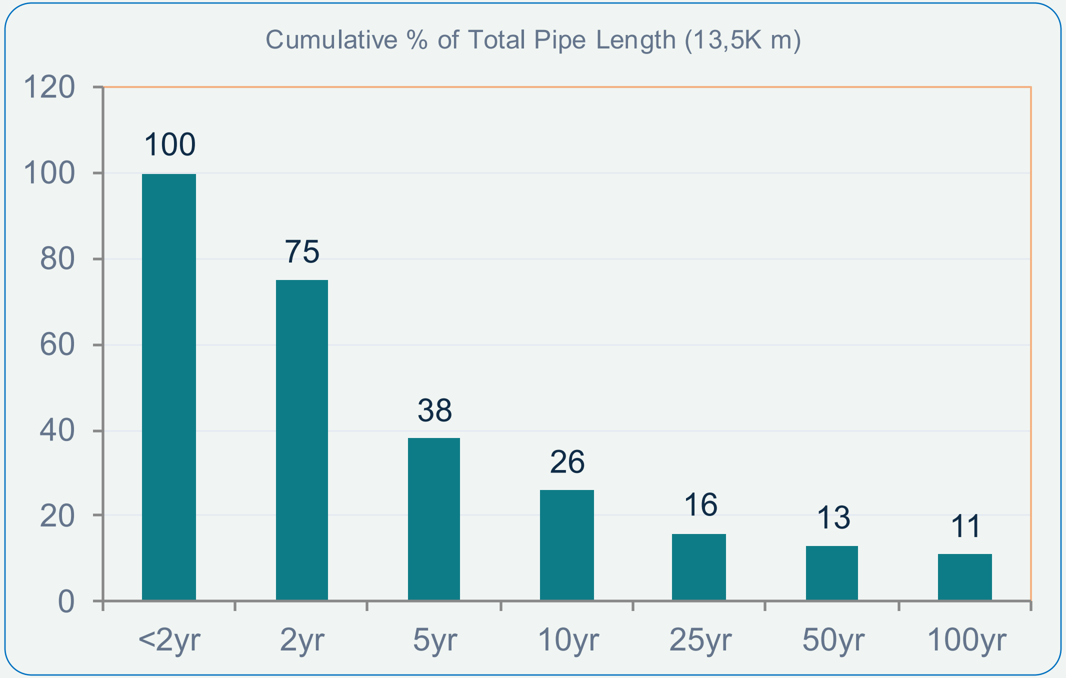
No ponding depth ≥ 10 mm

Touching building footprint

RESULT

1386 buildings assessed from 2-yr to 100-yr storms. Number of impacted buildings mapped using GIS building footprints.

Existing Condition Minor System Level of Service



Key Findings

75%

of pipes at 2-year LOS or greater

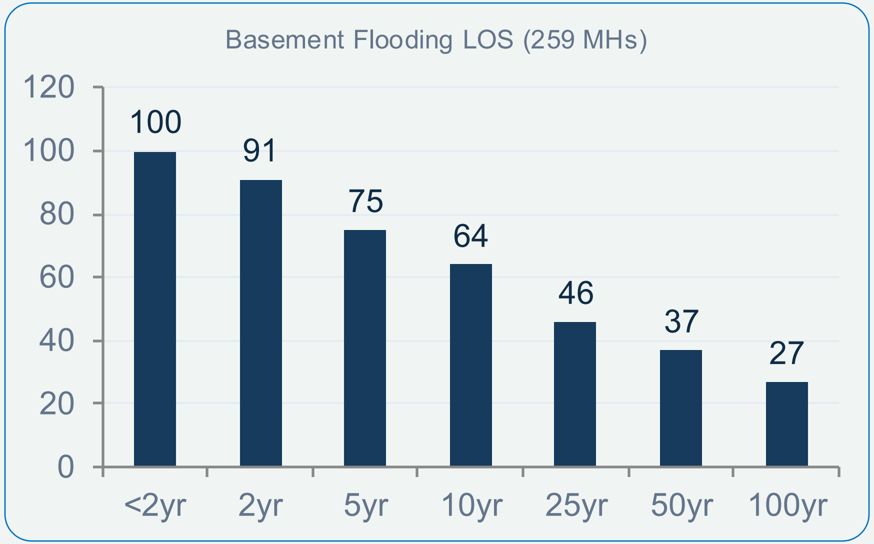
25%

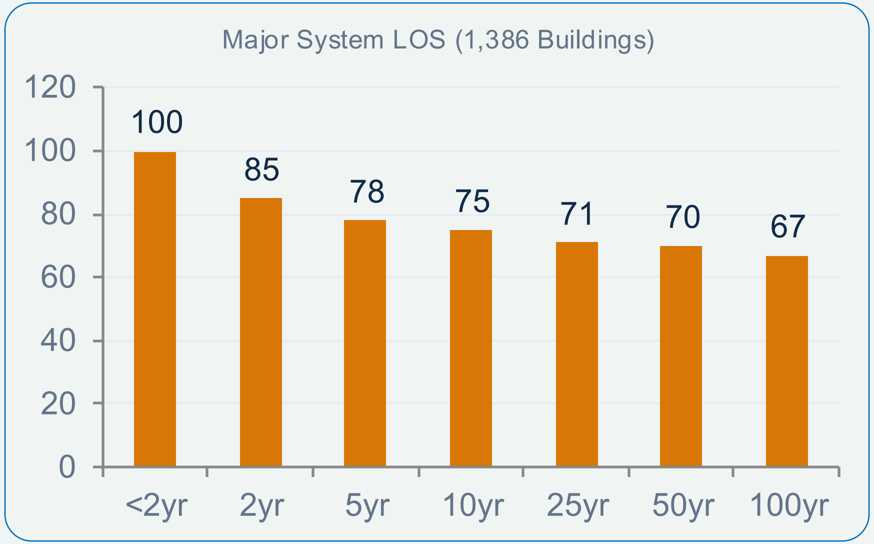
of pipes surcharge under the 2-year event (3,370 m)

Criteria: pipes should remain free flow (HGL below pipe obvert) during design storm.

Most sewers installed 1960s-70s, designed for 2-year storms of that era. Majority of system conveys flows up to the 5-year event.

Existing Condition Basement & Major System Level of Service





Basement: 91% of MHs meet 2-year LOS. Criteria: HGL must remain 1.8 m below road centreline. 9% already at basement flood level under 2-year storm.

Major System: 67% of buildings protected at 100-year LOS. Criteria: 10 mm ponding touching building. 204 buildings impacted under 2-year event.

Existing Level of Service (LOS)

75%

Minor System Pipes

convey flows at 2-year LOS or greater

91%

Basement Flooding

of manholes below threshold at 2-year LOS

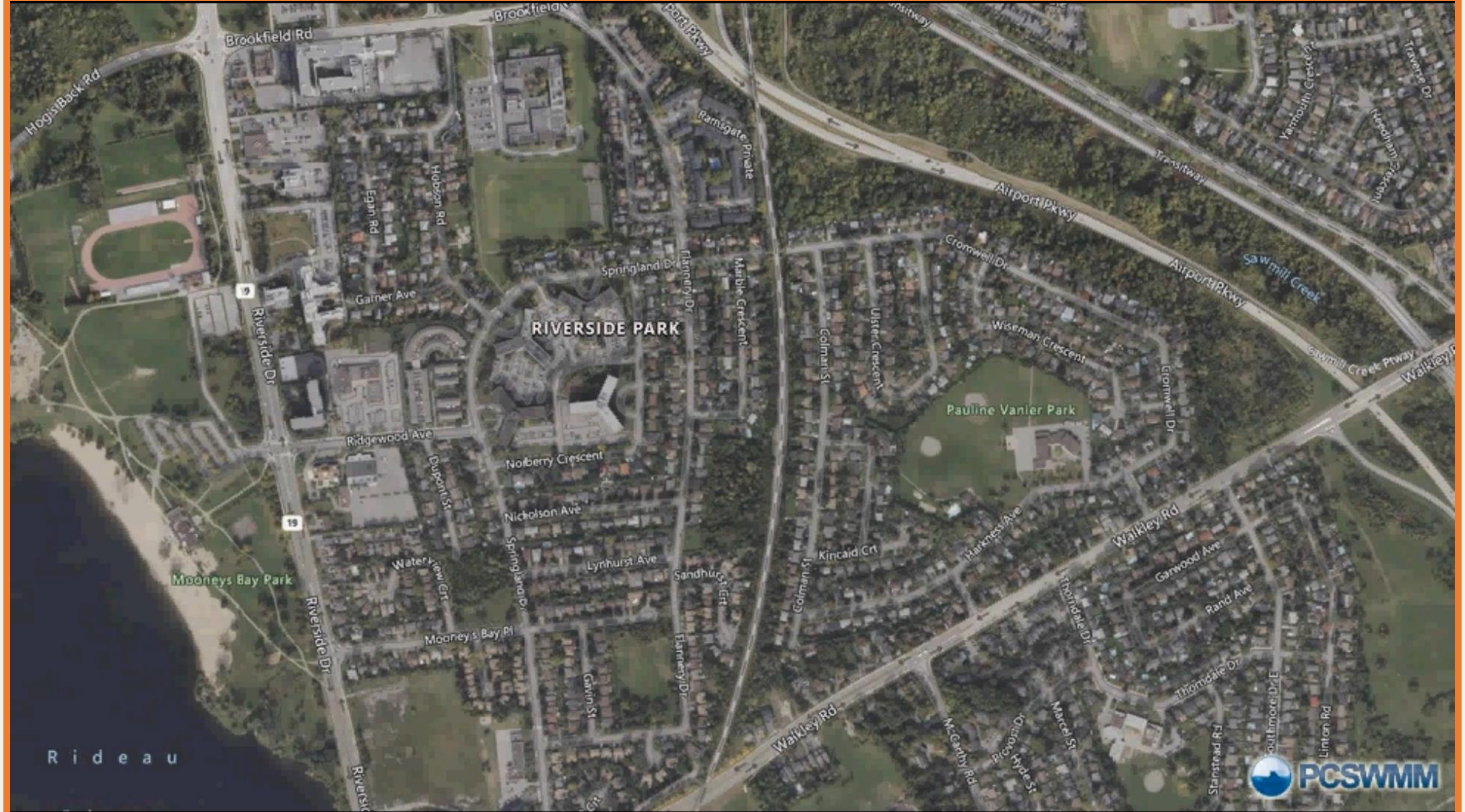
67%

Major System

of properties at 100-year LOS or greater

Key Concern: 25% of storm pipes and 9% of manholes have a level of service below the 2-year storm event. The lack of a defined major drainage system outlet means the minor system must handle all conveyance, making it vulnerable to surcharge during even moderate storms.

Existing Condition 100-Year Model Results (Video)



Recommended Public Solutions - Part 1

Infrastructure improvements within public property (ROW and parks)

1. **Pauline Vanier Park**
   Surface storage to detain overland flow

2. **Paget Park**
   Underground storage facility

3. **ROW boulevard Re-grading**
   Redirect major flow away from rear yard

4. **Pipe Upsizing at Specific Location**

5. **Inlet Control Devices**
   ICDs within ROW to restrict inflow to the minor system and reduce basement flooding

6. **ROW Boulevard Re-grading at Depressed Driveways**
   Limit major flow from spilling into driveways

7. **Superpipe Storage**
   improve minor system LOS

Part 2 Solutions & Combined Results

Part 2: Additional Improvements

1. Enlarge Railway Culvert

At Airport Parkway to relieve outlet restriction

2. Add New Major System Outlet

Major system outlet reconfiguration, requiring property acquisition or EA studies

Combined Impact

Part 1 improves LOS for both basement flooding and major system across the site.

Part 2 adds minor system but provides minimal additional benefit for basement and major system LOS.

Key Limitation

Riverside Park lacks a major drainage system, and road grading does not direct flow toward outlets. The two main outlet restrictions limit the effectiveness of upstream improvements. Due to existing roadway grading and low points, direct drainage toward these outlets remains limited.

Private Property Solutions

Mitigation measures that can be implemented by individual property owners

Redirect Roof Leaders

Route roof leaders to pervious surfaces to reduce direct runoff to storm sewers

Backwater Valves

Prevent sewer backflow into basements during surcharge events

Flood Proofing

Waterproofing walls, sealing cracks, installing window well covers

Sump Pump Installation

Active removal of water from foundation drainage system

Grading & Landscaping

Improve lot grading to direct water away from foundations

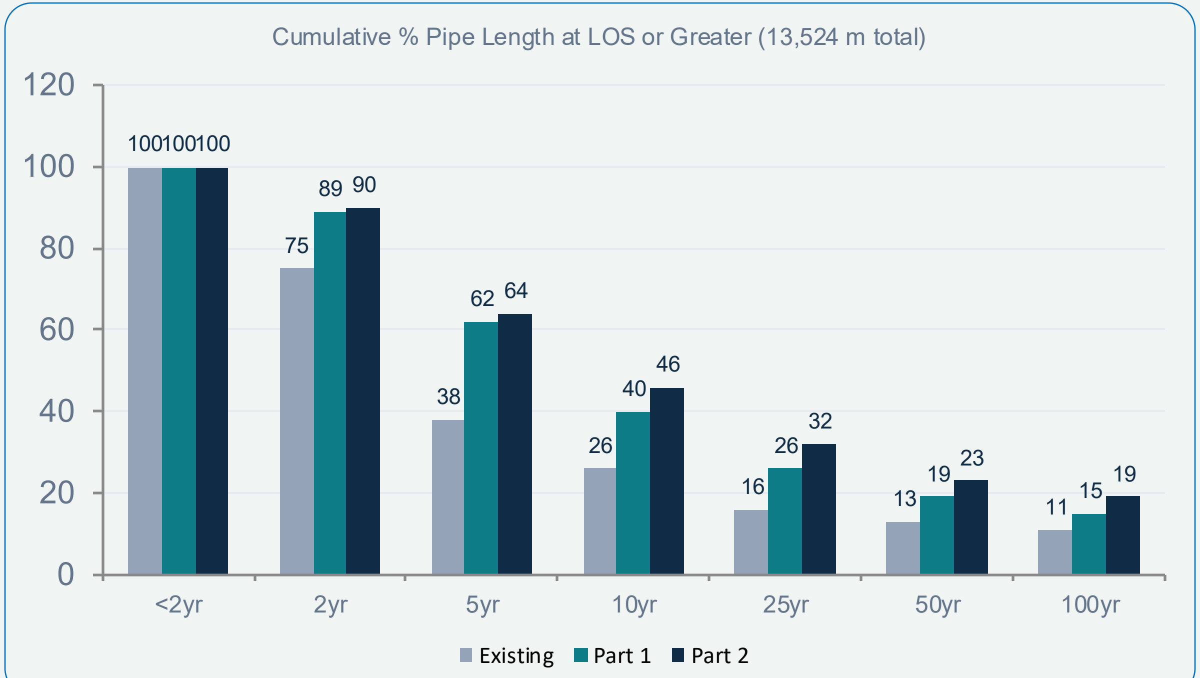
Fill Depressed Driveways

Eliminate low points that trap surface and sewer backflow

Elevate Buildings & Appliances

Raise critical equipment above potential flood levels

Minor System LOS: Existing vs. Proposed



Key Findings

5-Year LOS:

38% → 62% (Part 1)

38% → 64% (Part 2)

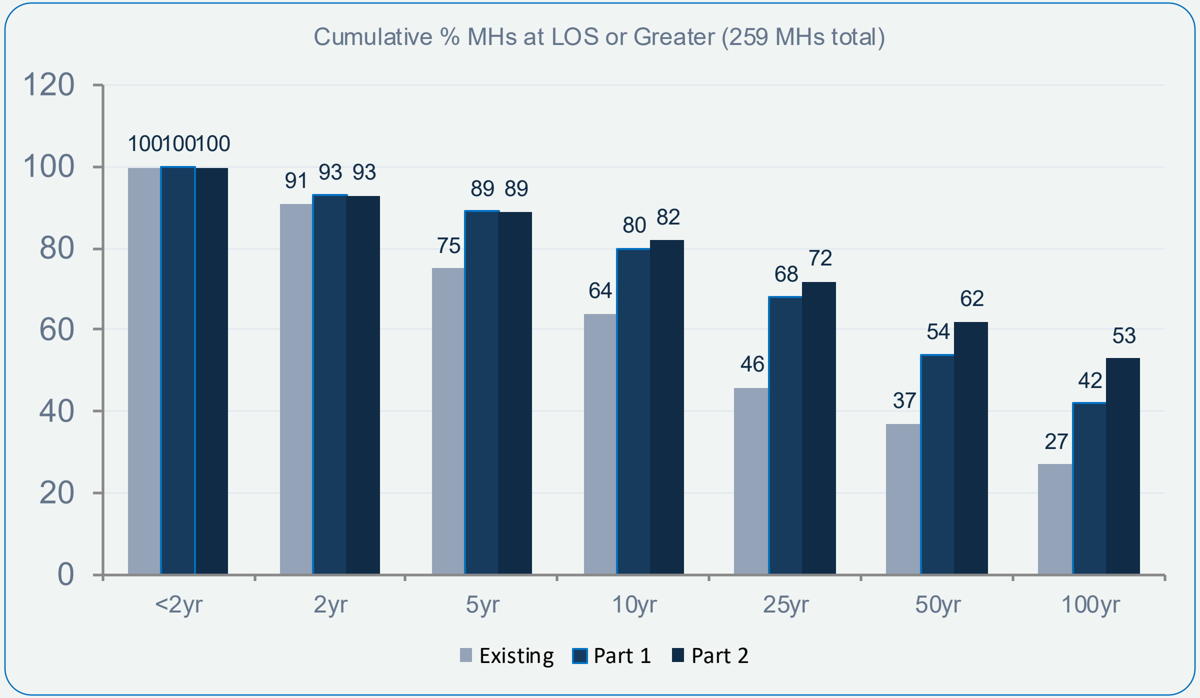
Greatest gain at 5yr event: +24% (Part 1), +26% (Part 2) of total pipe length.

Part 2 adds most benefit at 10yr+ events via railway culvert twinning and Cromwell Dr outlet.

Improvements of 4–26% across all return periods.

Pipe length at 5yr LOS or greater: Existing 5,076 m → Part 1: 8,347 m → Part 2: 8,700 m

Basement Flooding LOS: Existing vs. Proposed



Key Findings

25-Year LOS:

46% → 68% (Part 1)

46% → 72% (Part 2)

100-Year LOS:

27% → 42% (Part 1)

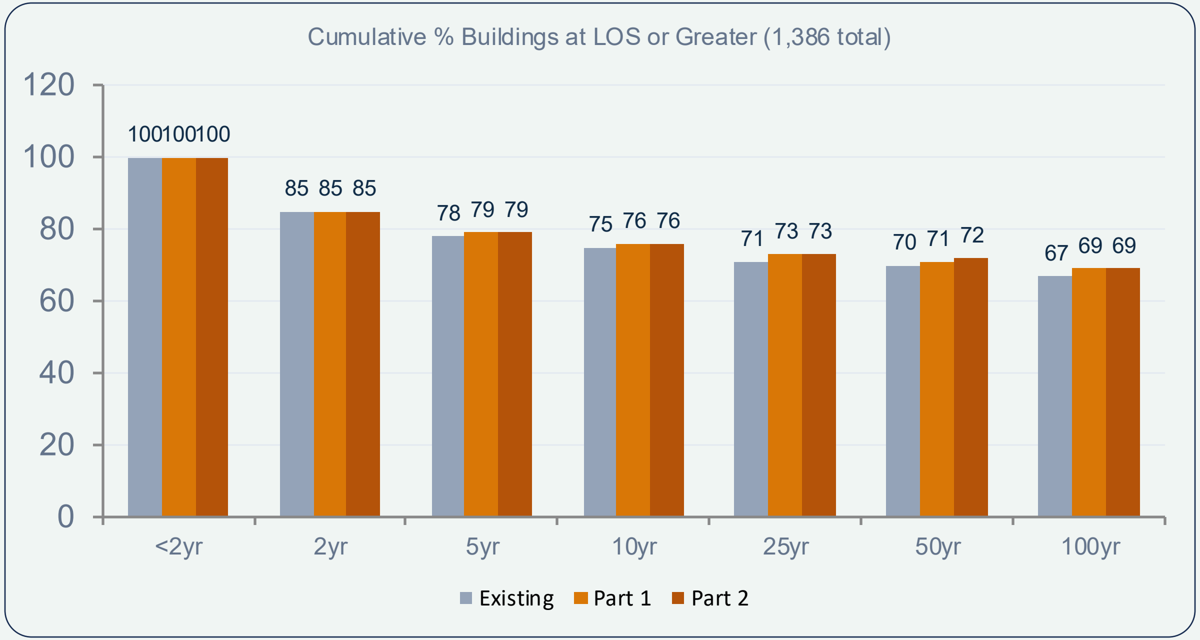
27% → 53% (Part 2)

Part 2 nearly doubles MHs protected at 100yr (70 → 137).

Highest gains at 25-50yr events.

MHs at 25yr LOS or greater: Existing 119 → Part 1: 175 (+22%) → Part 2: 187 (+26%)

Major System LOS: Existing vs. Proposed



Limited Gains (+2%)

Improvement is modest because:

No dedicated overland flow route exists from Riverside Park.

ICDs improve minor system but increase surface ponding in ROW.

Driveway humps redirect flow downstream causing new impacts.

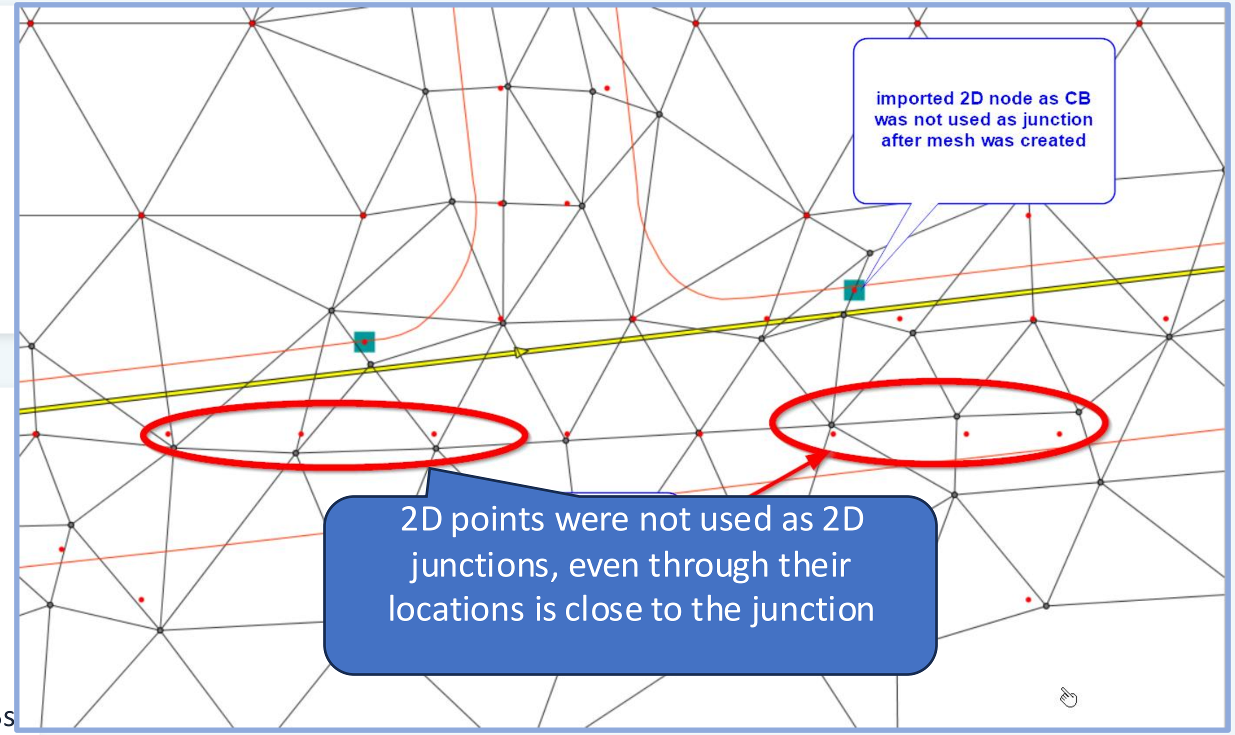
Part 2 provides no additional benefit to major system LOS.

For major system, particularly for depressed driveways and low-point properties, private-based solutions are the most appropriate recommendation.

CHALLENGES/LESSONS LEARNED IN PCSWMM 2D-1
Incorporate CBs into 2D mesh

Issue

- PCSWMM currently does not have capability to incorporate CBs into 2D Mesh
- Incorporating 2D points as CBs after generating points still does not work



Solution

- Generate 2D points and build mesh
- Relate the 2D node with CB points proximity and elevation
- Update the 2D node inverts with CB inverts
- Assign Catchment outlets to corresponding CBs in 2D nodes
- Identify the outlet MH ID and assign to the CB outlet

Alternate- Add this feature in PCSWMM 2D

Thank You

Questions & Discussion

AECOM Canada — City of Ottawa Riverside Park Project Team

Riverside Park | PCSWMM 2D Modelling | Urban Flooding and Mitigation