National Water and Wastewater Conference 2024

Managing Smart for the Future:

How Toronto Water is Reducing CSOs with Phased Implementation through Digital and Automation Technology

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TORONTO Water

TETRA TECH

Presentation Outline

Project Background

Real Time Control Overview

Gate Control Strategy Development and Evaluation

Detailed Design Considerations

Project Status and Next Steps

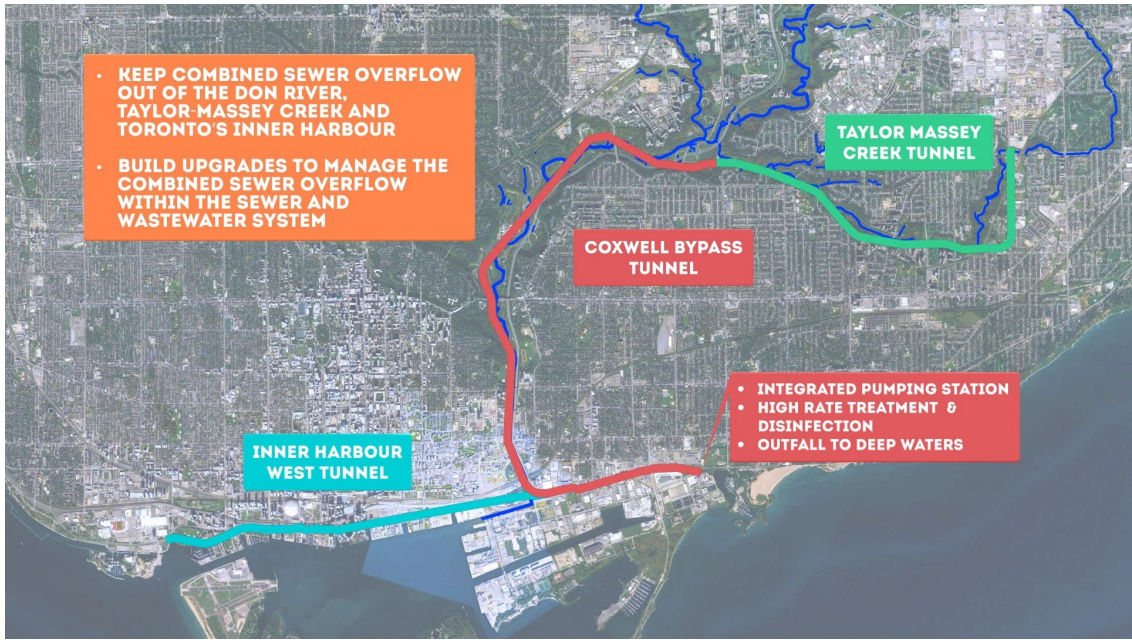
Project Background

Don River and Central Waterfront Stormwater Management Program

Real time control is an integral part

Project objectives:

- Providing better flow distribution within the Interceptor System;
- Reducing the total system-wide CSO volume to the Ontario Lake; and
- Delivering a working and reliable RTC system without impacting operations
- Minimizing project and RTC system risks

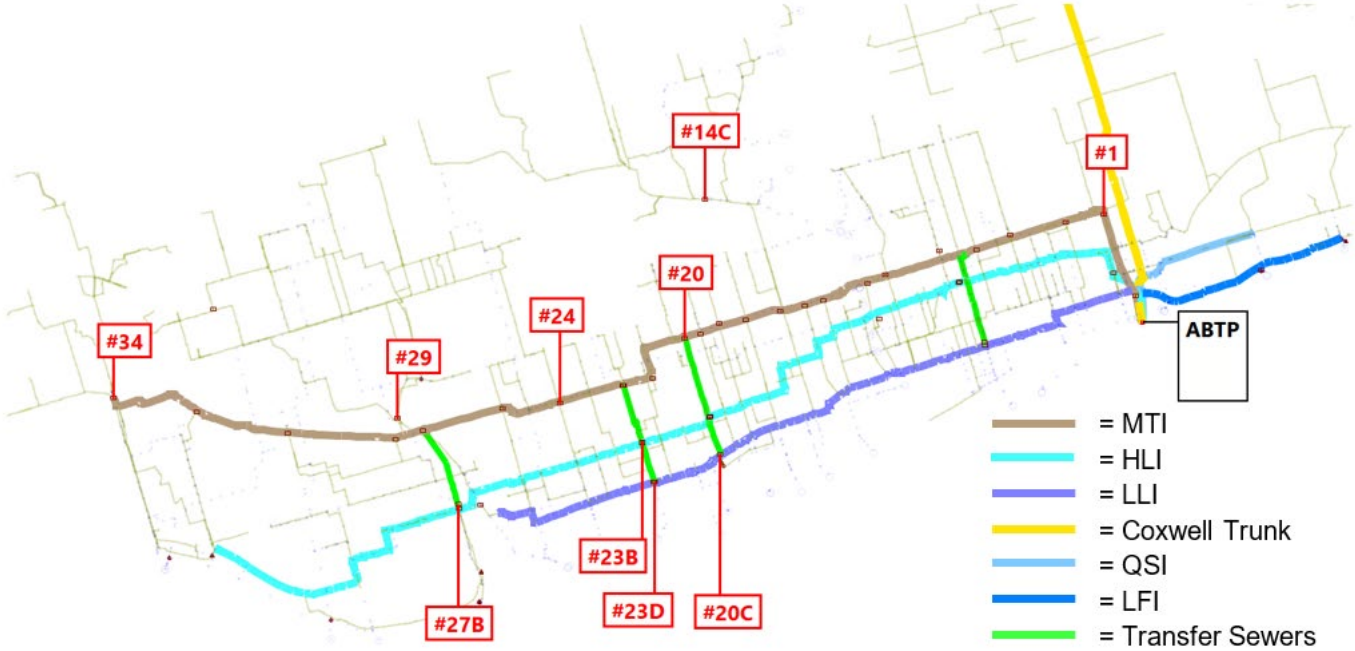


Project Scope

Toronto Interceptors Real Time Control System Implementation Project

- Ten (10) Mid-Toronto Interceptor Flow regulation chambers

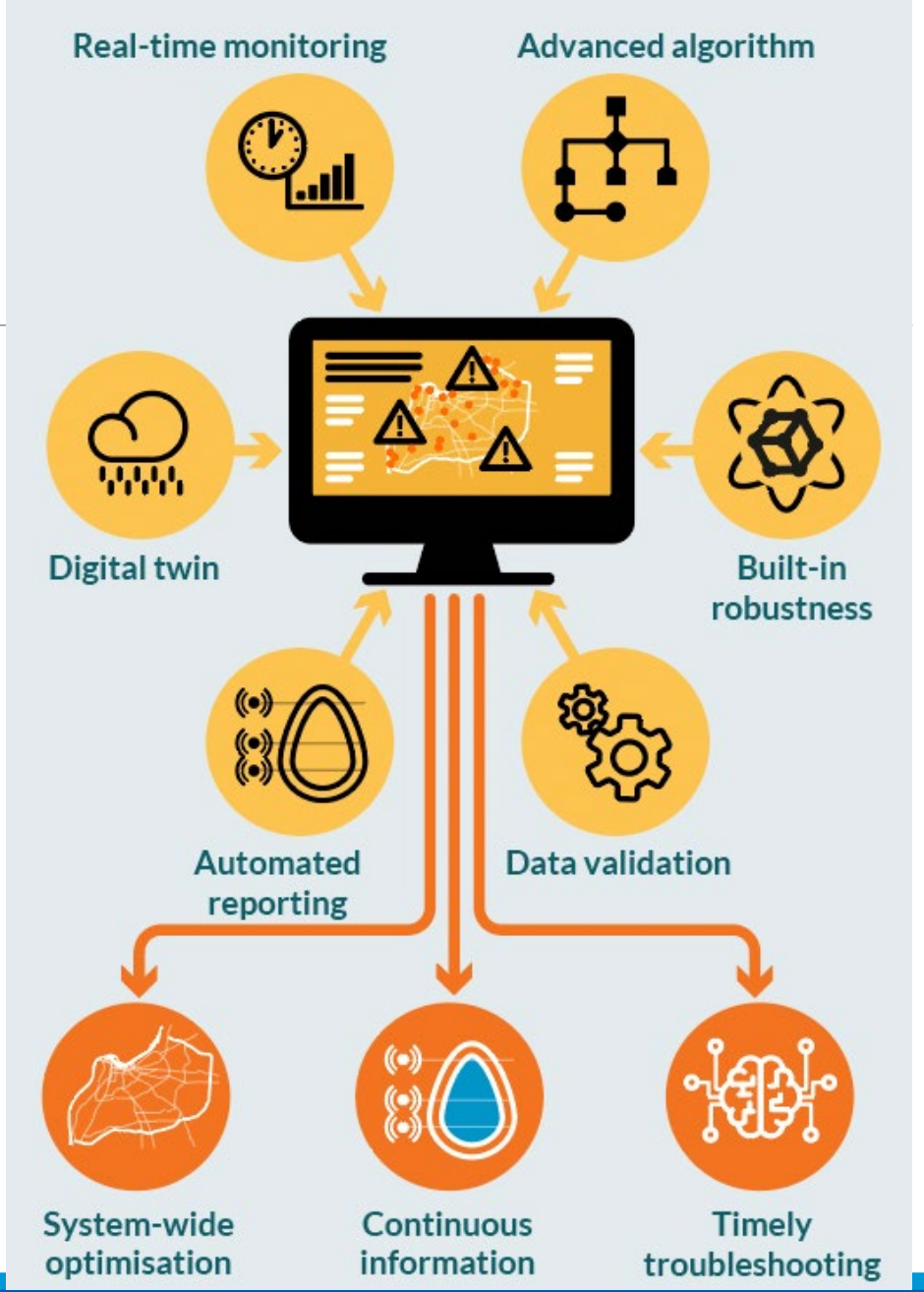
- Condition assessment
- Preliminary design
- Model calibration
- Gate control strategy
- Detailed design
- Construction
- Commissioning
- Post-construction warranty



RTC Overview

Definition of RTC

*"A system that dynamically **adjusts** the operation of a facilities in response to online measurements in the field to maintain and meet the operational objectives, both during dry and wet weather conditions."* – USEPA



RTC Driving Forces

Increase in regulatory and water quality requirements

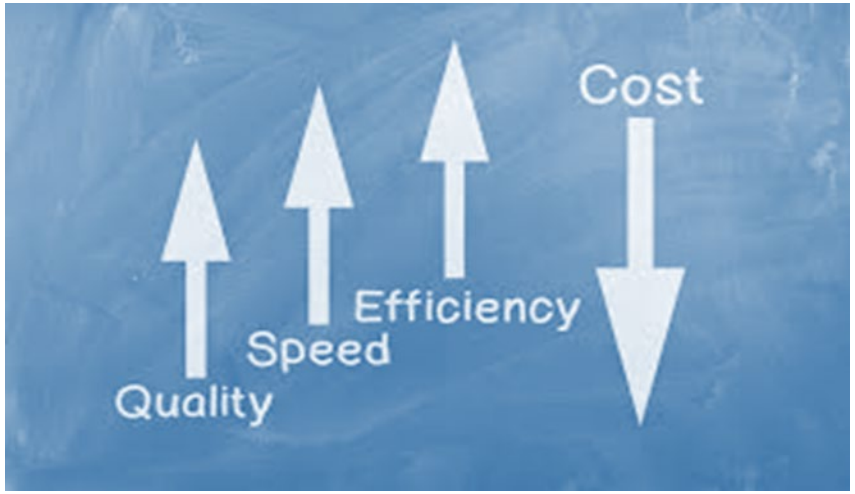
Fiscal pressures

Limited construction alternatives

- Urban density, land values

Climate changes

- Local flooding

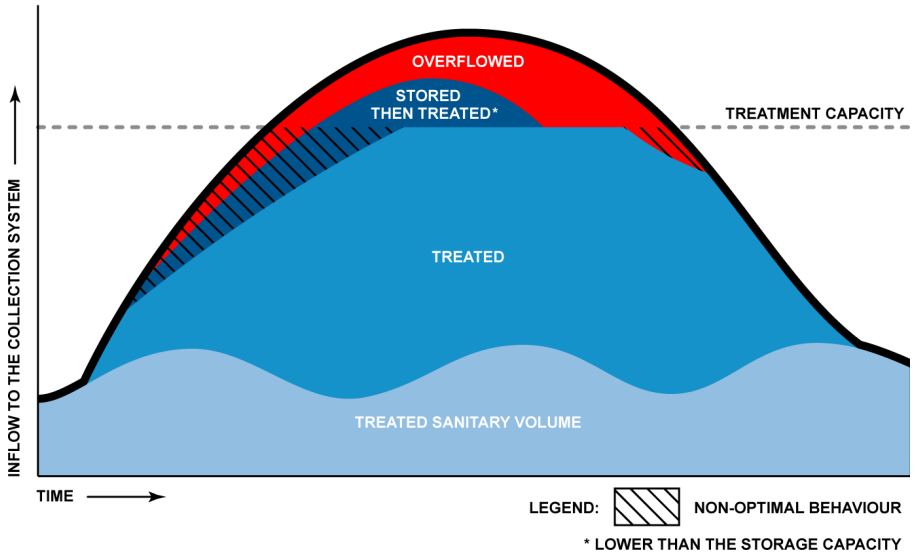


Improve efficiency and overall system performance

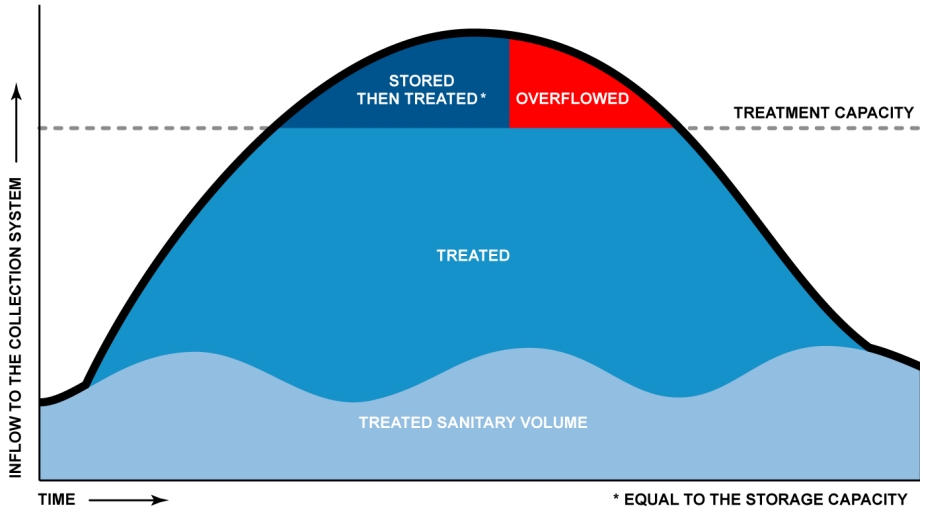
RTC Optimization

- RTC system performance objective
- Adapt to all system and weather changes

Static Control without RTC



Optimal RTC



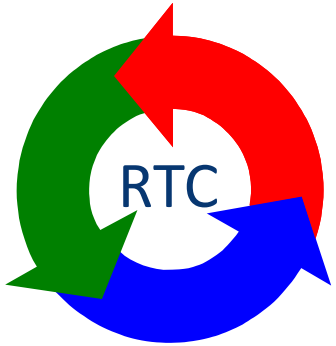
Operational Benefits

Dry Weather: Eliminate SSO,
reduce operation expense, save energy

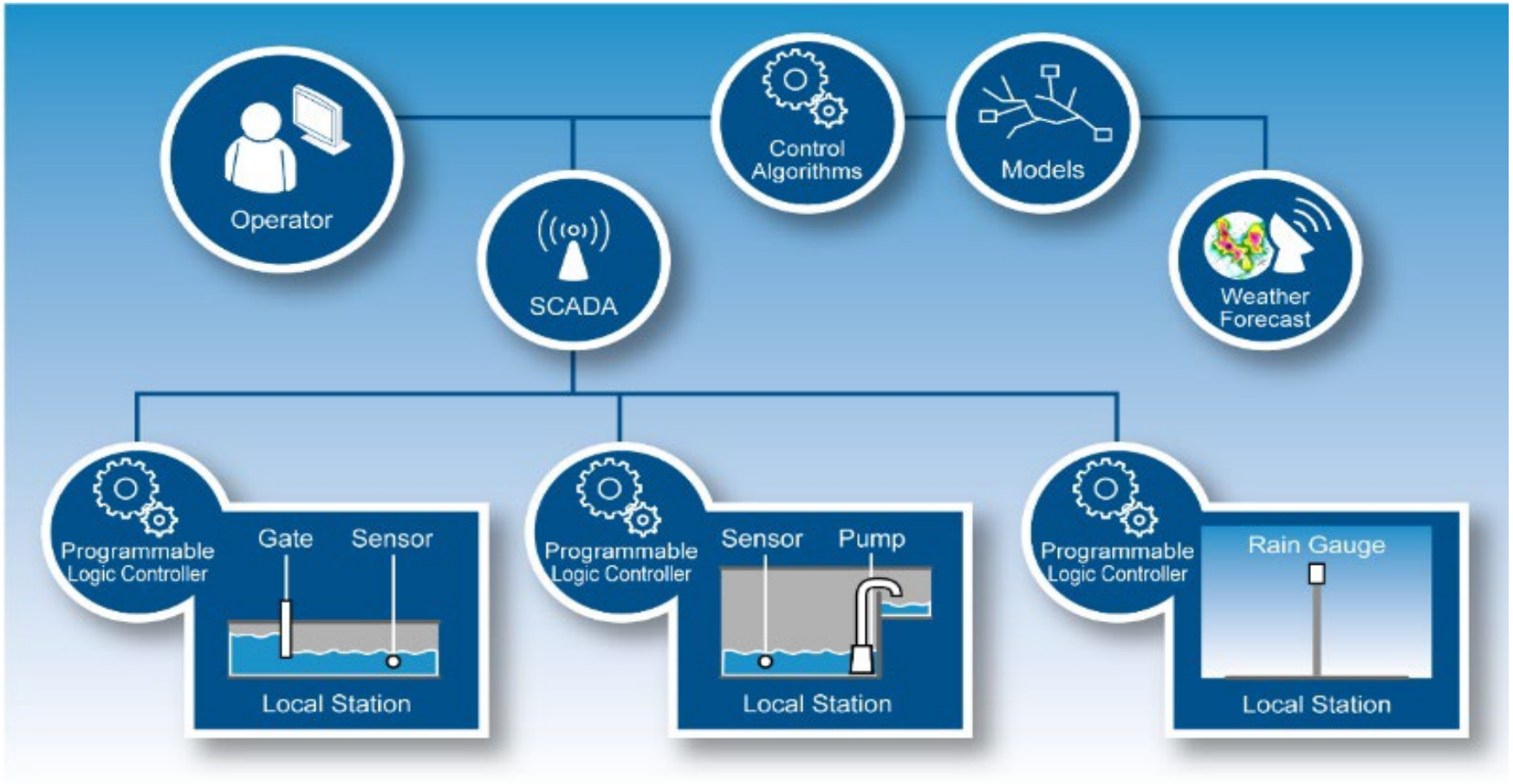
CSO/SSO events: Control of overflows,
better balance flows to WWTP

Critical events: Early warning,
reduce risk of flooding

Partial system unavailability: equipment failure,
shut-downs, maintenance, etc.



RTC System Architecture: Local to Global System



Gate Control Strategy Development

Identify opportunities and constraints for existing conditions

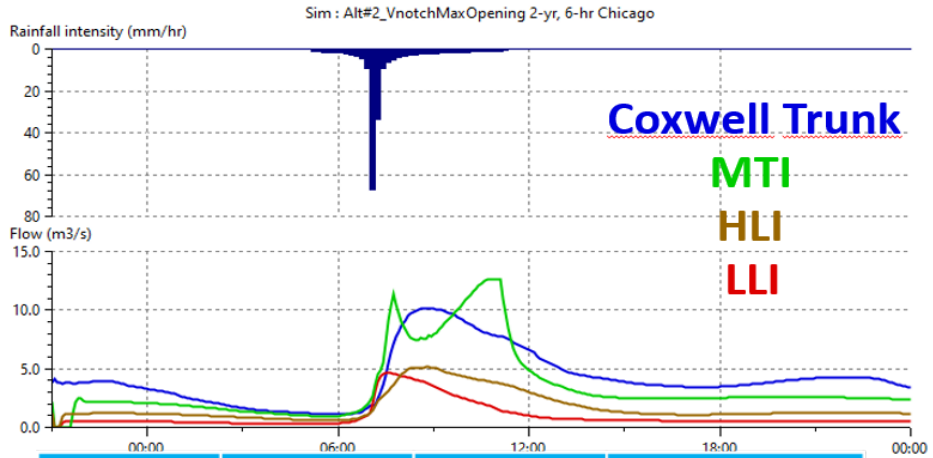
Operation at ABTP Inflow Pump Stations

Coxwell inflow

Control T building wet well level to prevent street flooding

- 70 m AD is a critical level

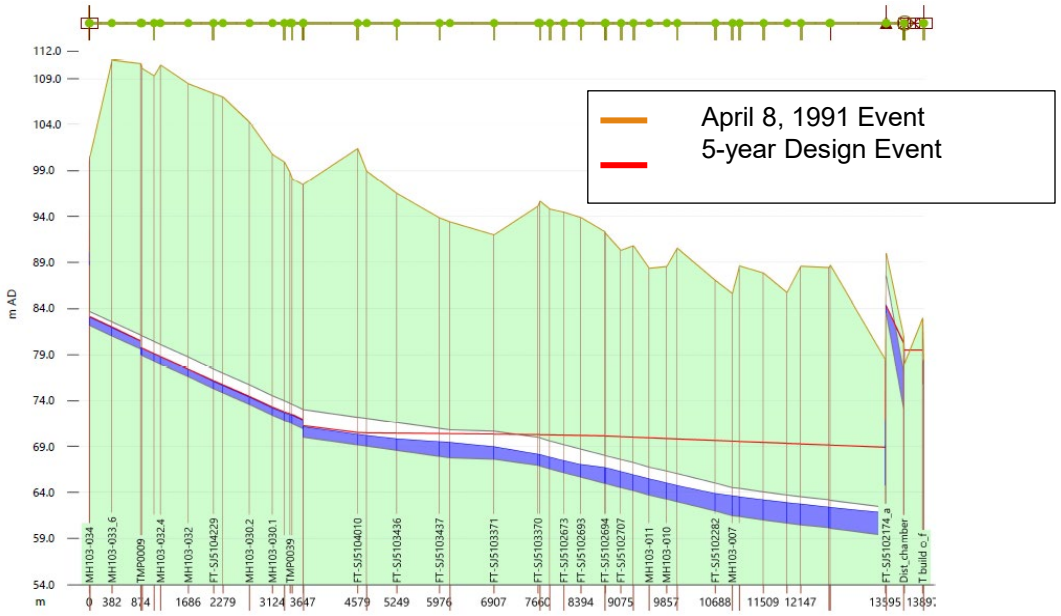
Control HGL upstream of gate

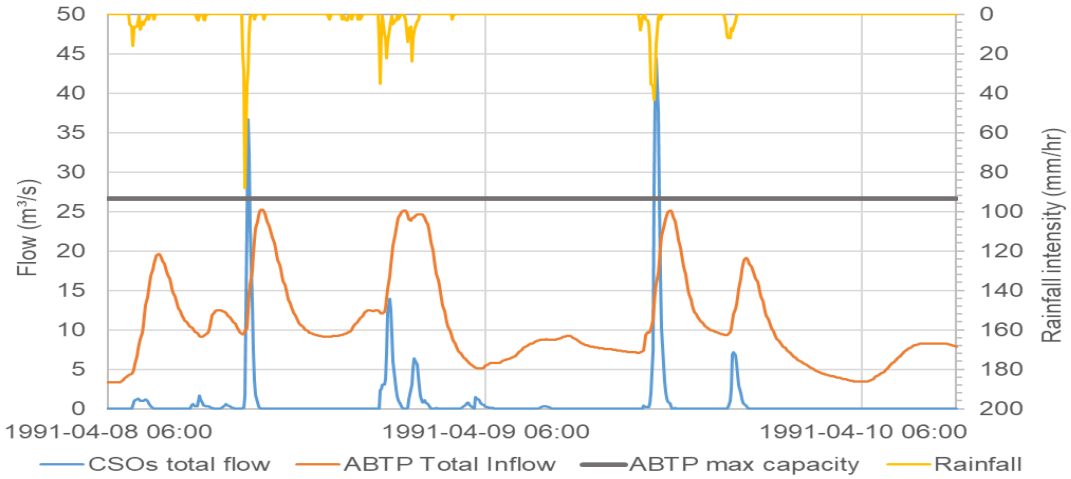


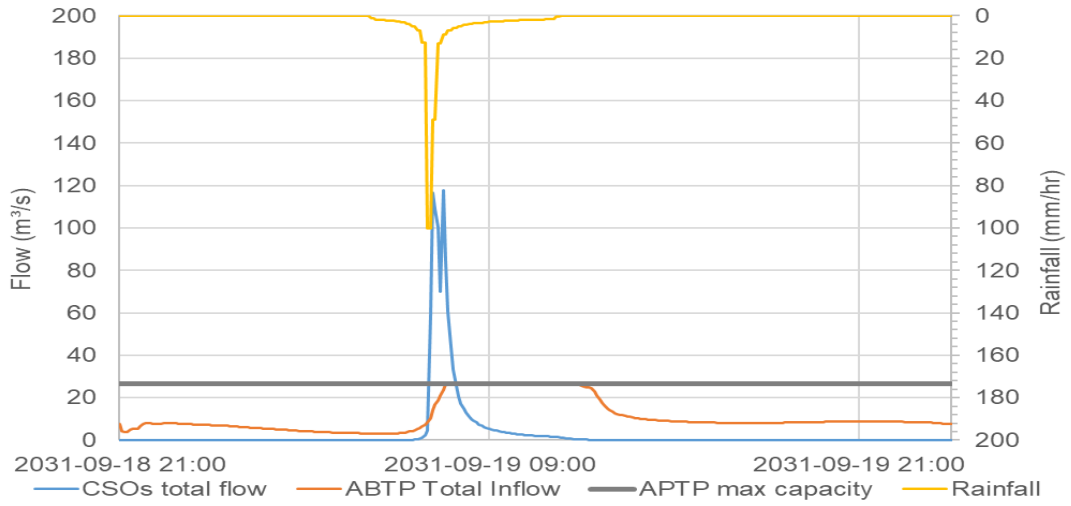
Pump Station	Capacity (m^3/s)	ABTP RSP Vital Set Points (m) (1)	Drawdown Level Target (m AD) (2)
T Building - MTI	12.62	62 to 64 m	63.711
M Building - HLI	4.73	77.4 m	77.111
M Building - LLI	7.36	71.4 m	71.111

Opportunity to Maximize Flow Interception

CSOs are occurring before treatment capacity (2300MLD) is reached for April 8, 1991 event and 5-year event







RTC Performance Evaluation Criteria

Small difference criteria set to **0.5%**

- Over +/- 0.5% difference = deep colors
- Less +/- 0.5% difference = pale colors

- Green = better
- Red = Worse

Criteria	Sub-Criteria
Overflow	Total System CSO
	Overflow at Chamber 1
	Overflow at Chamber 14
	Overflow at Chamber 20
	Overflow at Chamber 24
	Overflow at Chamber 29 (1 of 2)
	Overflow at Chamber 29 (2 of 2)
	Overflow at Chamber 34
H upstream of gates	Chamber 1
	Chamber 14
	Chamber 20
	Chamber 24
	Chamber 29
	Chamber 34
MTI Interceptor water level	MH103-027
	MH103-007
HLI Interceptor water level	Chamber 27B
	Chamber 23B
LLI Interceptor water level	Chamber 23D
	Chamber 20C
Wet well levels	M Building wet well level (HLI)
	M Building wet well level (LLI)
	T Building wet well level (MTI)
ABTP flow	Peak flow
	Peak flow duration
	Total volume

RTC Alternatives

RTC Alternative 1 objective

- Increase inflow to MTI under normal operation and protect MTI wet well from high levels

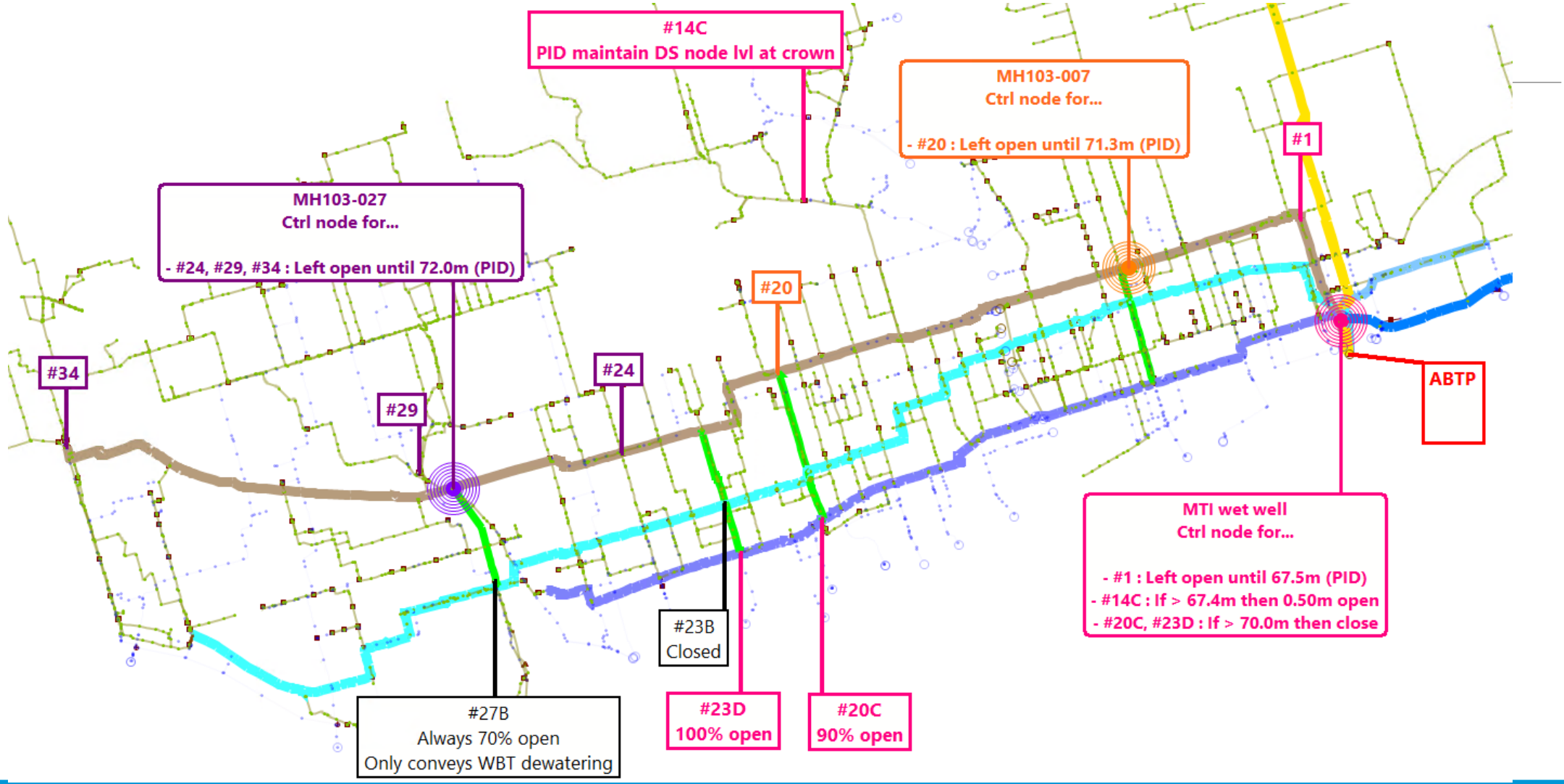
RTC Alternative 2 objective

- Respect ABTP primary treatment at 2300MLD post IPS integration

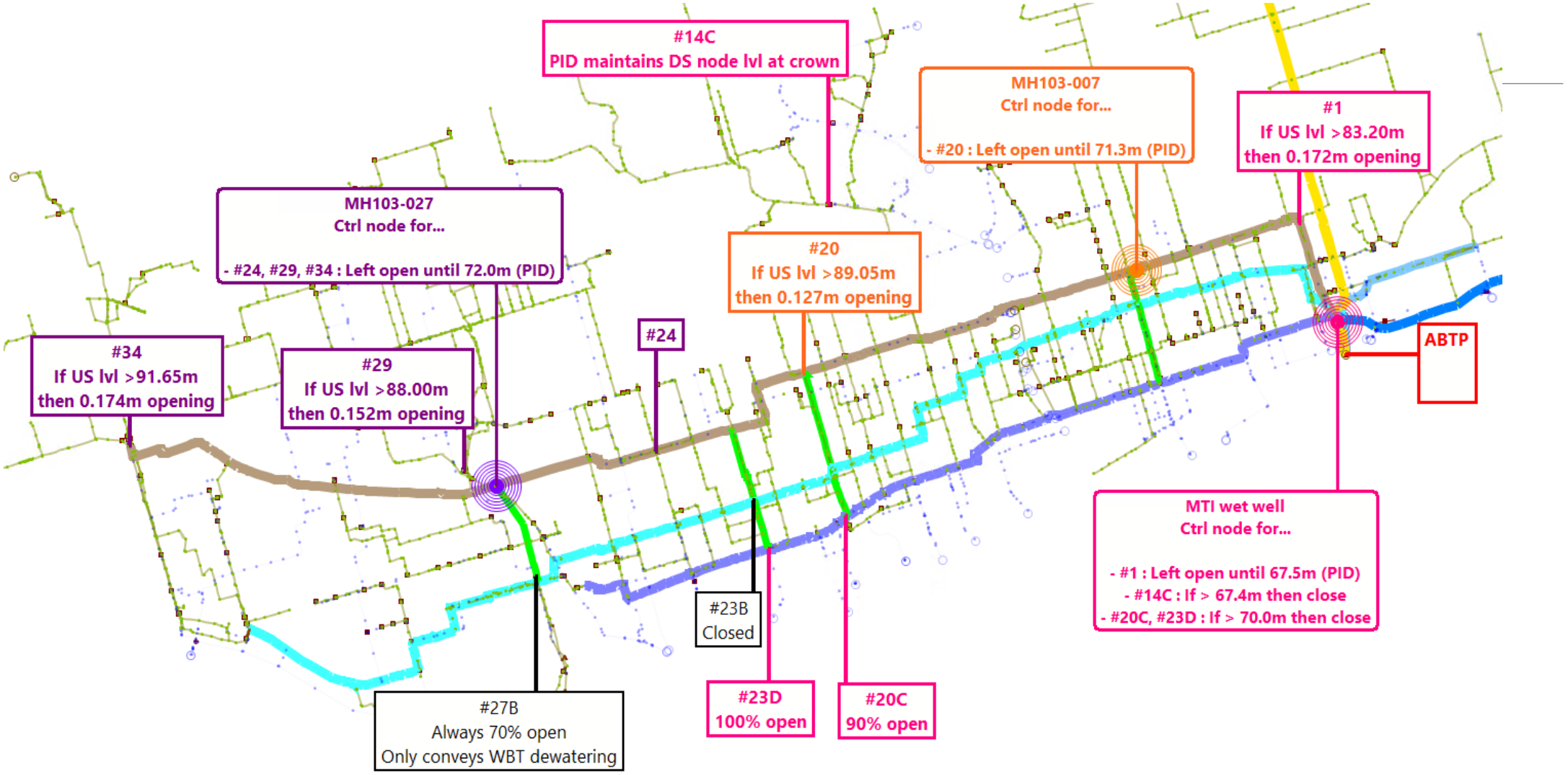
RTC Alternative 3 objective

- Maximize interception to MTI and protect wet well level, fine tune RTC Alt 1 rules
- Alternative 3a has 25% minimum gate opening instead of 0% minimum opening

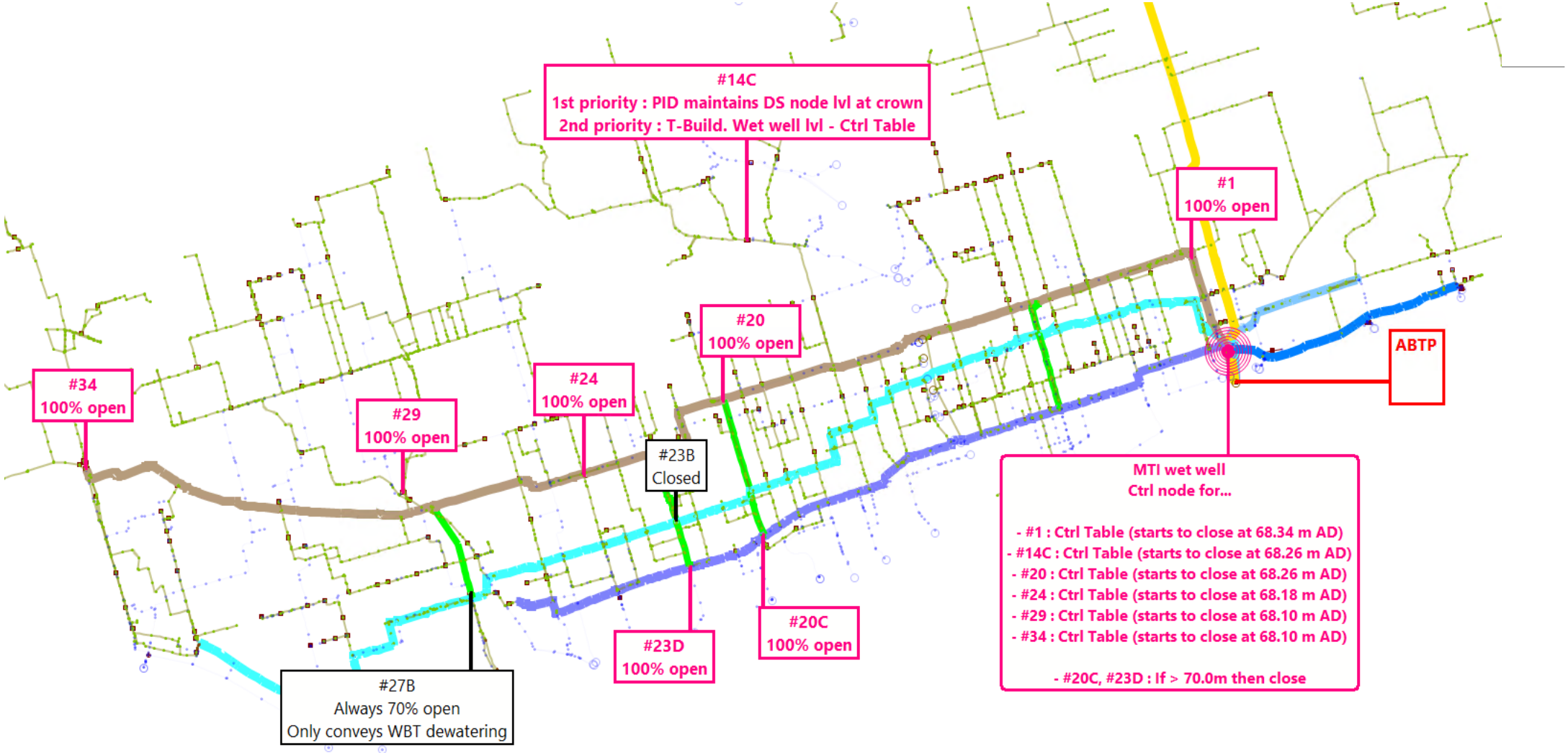
RTC Rules – Summary of Proposed Alternative 1



RTC Rules – Summary of Proposed Alternative 2



RTC Rules – Summary of Proposed Alternative 3



Model Simulation and Stress Testing Scenarios

Normal Operation

- 2y, 5y, 10y, 25y design events; Sept 7, 2016 and Aug 7, 2018 real events

Sensitivity Tests

- To test weather impact – run constructed consecutive rainfall event which used April 8, 1991+5-y design event; and 50-year design event
- ABTP capacity increase from 2300 MLD to 2500 MLD

Stress Testing of Failure Conditions

- Pump failure at T building Pump Station (reduced from 12 to 8 m^3/s)
- Gate failure – 12 combinations (fail to open, to close or seize at DWF opening)
- Measurement errors – underestimation and overestimation of depth

Preferred Gate Control Strategy

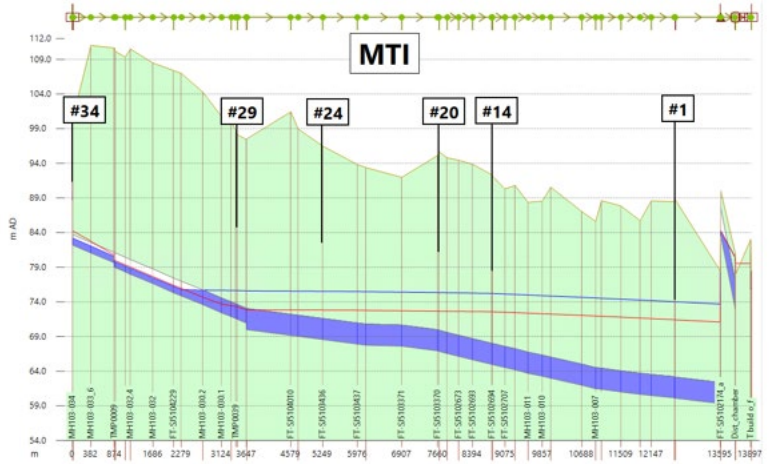
RTC Alternative 3a (25% min gate opening) is selected as preferred strategy

- Under normal operation conditions:
  - RTC Alternative 3a provides most CSO reduction
  - RTC Alt 3_0% and RTC Alt 3_25% provides similar performance
  - RTC Alt3_25% compared to RTC Alt3_0% resulted in slight increases in MTI HGL or T building wet well level without adverse impact
  - ABTP Peak flows are similar to existing conditions without capacity limit

RTC Alternative 3 can adapt to failure conditions and respect hydraulic constraints

		5-year design event					
		MTI PS Drawdown Level @ 61.7m AD Treatment Flow Maximum Capacity = 26.6 m³/s			MTI PS Drawdown Level @ 63.7m AD Treatment Flow Maximum Capacity = Unlimited		
Criteria	**Sub-Criteria**	**Existing**	**RTC Alt 1**	**RTC Alt 2**	**Existing**	**RTC Alt 1**	**RTC Alt 3**
Overflow [m³]	Total System CSO	314588	298525	315828	314279	293049	293049
	Overflow at Chamber 1	6139	10126	10438	6140	6138	6138
	Overflow at Chamber 14C	26234	23390	35229	26232	22695	22695
	Overflow at Chamber 20	5338	3222	4908	5338	3218	3218
	Overflow at Chamber 24	0	259	0	0	0	0
	Overflow at Chamber 29 (1 of 2)	0	0	0	0	0	0
	Overflow at Chamber 29 (2 of 2)	19001	6353	3283	19005	3282	3282
	Overflow at Chamber 34	3582	3447	4186	3583	2331	2331
Water level upstream of gates [m AD]	Chamber 1	83.423	83.423	83.627	83.423	83.422	83.422
	Chamber 14C	91.612	91.471	91.472	91.611	91.47	91.47
	Chamber 20	89.422	89.212	89.561	89.422	89.209	89.209
	Chamber 24	90.479	91.142	89.883	90.479	89.883	89.883
	Chamber 29	88.578	88.018	87.987	88.578	87.986	87.986
	Chamber 34	92.49	91.719	92.886	92.49	91.719	91.719
MTI Interceptor water level [m AD]	MH103-027	71.265	72.094	71.801	71.265	71.887	71.887
	MH103-007	69.567	71.541	70.154	66.415	68.664	68.664
HLI Interceptor water level [m AD]	Chamber 27B	83.994	83.924	83.925	83.993	83.923	83.923
	Chamber 23B	81.461	81.427	81.435	81.461	81.426	81.426
LLI Interceptor water level [m AD]	Chamber 23D	75.255	75.972	74.477	75.255	74.477	74.477
	Chamber 20C	72.686	75.587	71.188	72.711	71.338	71.338
Wet well level [m AD]	M Building wet well level (HLI)	77.134	77.134	77.134	77.129	77.129	77.129
	M Building wet well level (LLI)	72.546	72.548	72.55	72.55	72.541	72.541
	T Building wet well level (MTI)	68.899	70.955	69.516	64.084	66.451	66.451
ABTP flow	Peak flow [m³/s]	26.72	26.73	26.73	32.9	32.87	32.87
	Peak flow duration [s]	15000	15300	15300	0	0	0
	Total volume [m³]	1073155	1091191	1073631	1060756	1084036	1084036

Hydraulic Grade Lines (HGL) – T Building
Pump Failure Conditions – 25yr event



Blue - Existing conditions;
Red - RTC Alt 3 (25% min. Opening)

Detailed Design Considerations

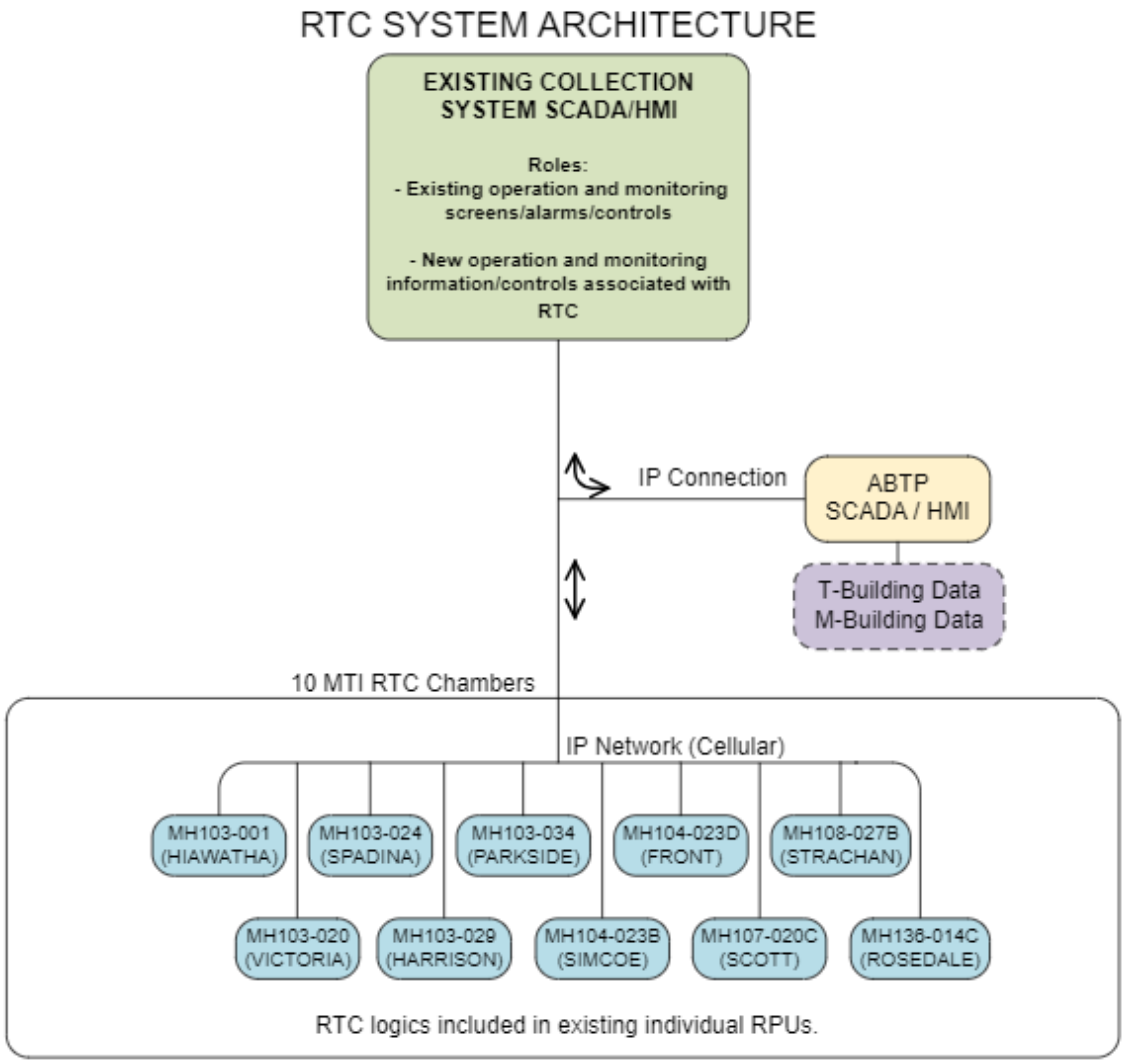
Gate opening

Gate speed

Gate modulation frequency

Control Loop Fine Tuning during Implementation

- Level 1: Field Device Control (LOCAL)
- Level 2: Controller (RPU) Panel (OIT and SCADA)
- Level 3: RTC - Local RTC control rules coordinated with data from other location i.e., ABTP



Retrofit Design of Existing Chambers

Work in Confined Space (CSE) and in Class 1 Div 1 & Div 2

Dismantle and dispose existing hydraulic actuation systems

Cleaning of existing sewer sluice gates and associated shafts that will remain in place

Furnish, Install, Wire, Commission, Train, Warranty new electric actuators (x17, one per gate)

Relocate and Replace ultrasonic level meter with radar level meter at each location

Install new instruments such as hydrostatic sensor, temperature, humidity, motion sensors, limit switches, etc.

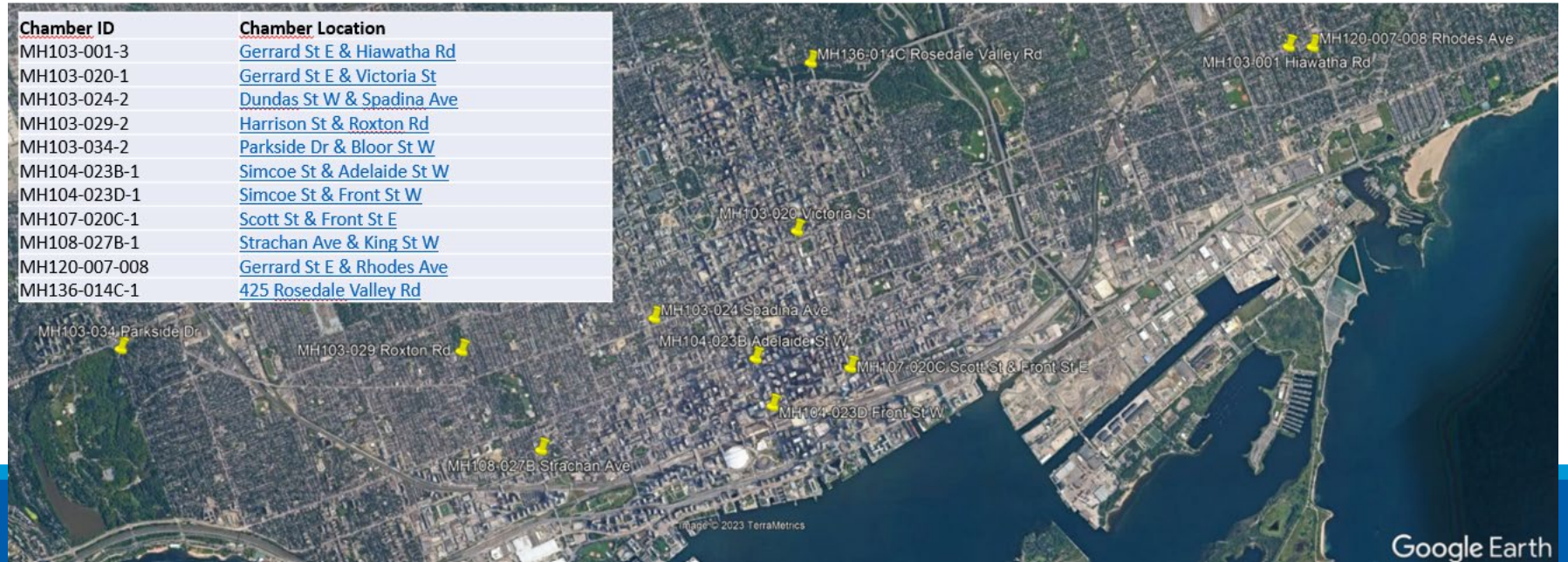
Current Project Status

Expedited RTC implemented at 4 chambers where gates are automated to move based on level

Pre-construction activities, such as torque tests are completed

Traffic management and coordination with city stakeholders, i.e., TTC

Chamber ID	Chamber Location
MH103-001-3	Gerrard St E & Hiawatha Rd
MH103-020-1	Gerrard St E & Victoria St
MH103-024-2	Dundas St W & Spadina Ave
MH103-029-2	Harrison St & Roxton Rd
MH103-034-2	Parkside Dr & Bloor St W
MH104-023B-1	Simcoe St & Adelaide St W
MH104-023D-1	Simcoe St & Front St W
MH107-020C-1	Scott St & Front St E
MH108-027B-1	Strachan Ave & King St W
MH120-007-008	Gerrard St E & Rhodes Ave
MH136-014C-1	425 Rosedale Valley Rd



Next Steps

Construction expected to be completed by 2026

System integration will include HMI update and training

Two-year warranty period will also include post-event analysis and fine-tuning

Review additional data input and data integration needs for next phase

Questions

Presenter Contact

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