Associated Engineering

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2020 Ice Jam Flood Event

Performance of Municipal Infrastructure

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Outline

- Introductions and Purpose
- Background and Flood Standards
- Overview of the 2020 Ice Jam Flood Event
- Infrastructure Performance
  - Lower Townsite
  - Water Treatment Plant
  - Taiga Nova
- Key Findings and Recommendations

Purpose

Provide an independent assessment of how key Municipal infrastructure performed during the 2020 Flood event, substantiated by first-hand field observations and follow-up analysis by Associated Engineering staff.

Background and Flood Standards

RMWB Flood Standard - History

- Based on Alberta Environment (1993) and Trillium (2000) Reports:
  - 1:100 year – 250.0 m
  - 1:40 year – 248.5m
- Trillium (2000) recommended dykes built to 1:100 year standard with an incremental approach of initially building to 1:40 year.
- 2007 to 2010 - RMWB constructed East Loop Road (i.e. Clearwater Drive east of Riedel) to nominal 248.5m
- Land Use Bylaw established development controls below 250m (249m for commercial)

RMWB Flood Standard – Recent History

- Hangingstone River flood in 2013 and LTS redevelopment plans led to renewed discussion about flood protection
- After Wildfire, December 13, 2016 letter from GOA affirmed 1:100 year flood standard of 250.0m
- Clearwater Drive (west of Riedel) built to nominal 250.5m (includes 0.5m freeboard)
- Current flood mitigation program (i.e. Reach 7, 8, 9 etc.) constructing to 250.5m

Current Infrastructure Status

- Key infrastructure built to 1:40 year (248.5m)
  - Clearwater Drive (East of Riedel Street)
  - Saline Creek Drive (Mills Avenue to Waterways)
  - Lift Station 1A (249.0m)

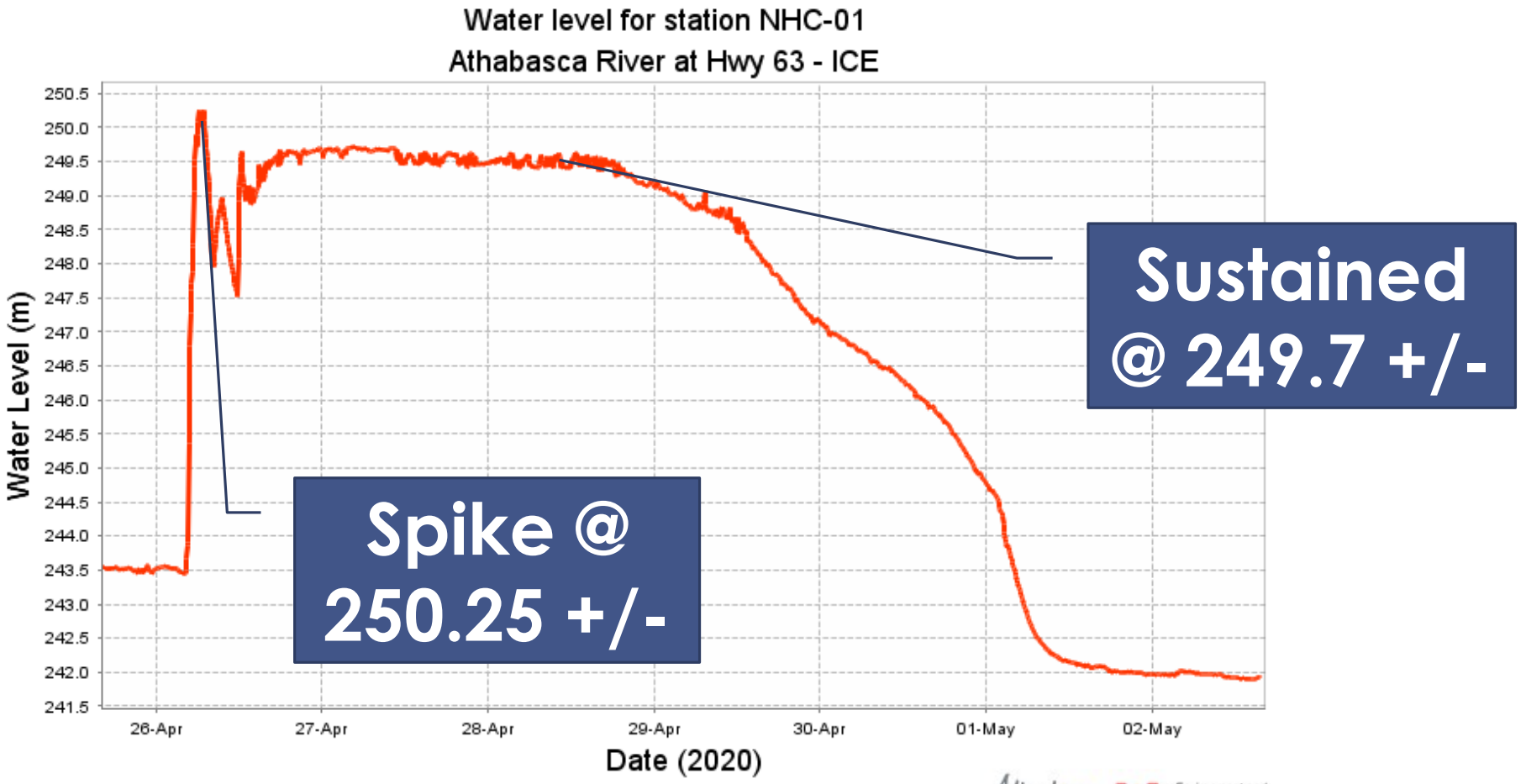
- Key infrastructure built to 1:100 year (250m +)
  - Reach 1 (completed 2014, to 250.0)
  - Clearwater Drive (west of Riedel Street) built to 250.5
  - Reach 9 construction underway (250.5m)

2020 Ice Jam Flood Event

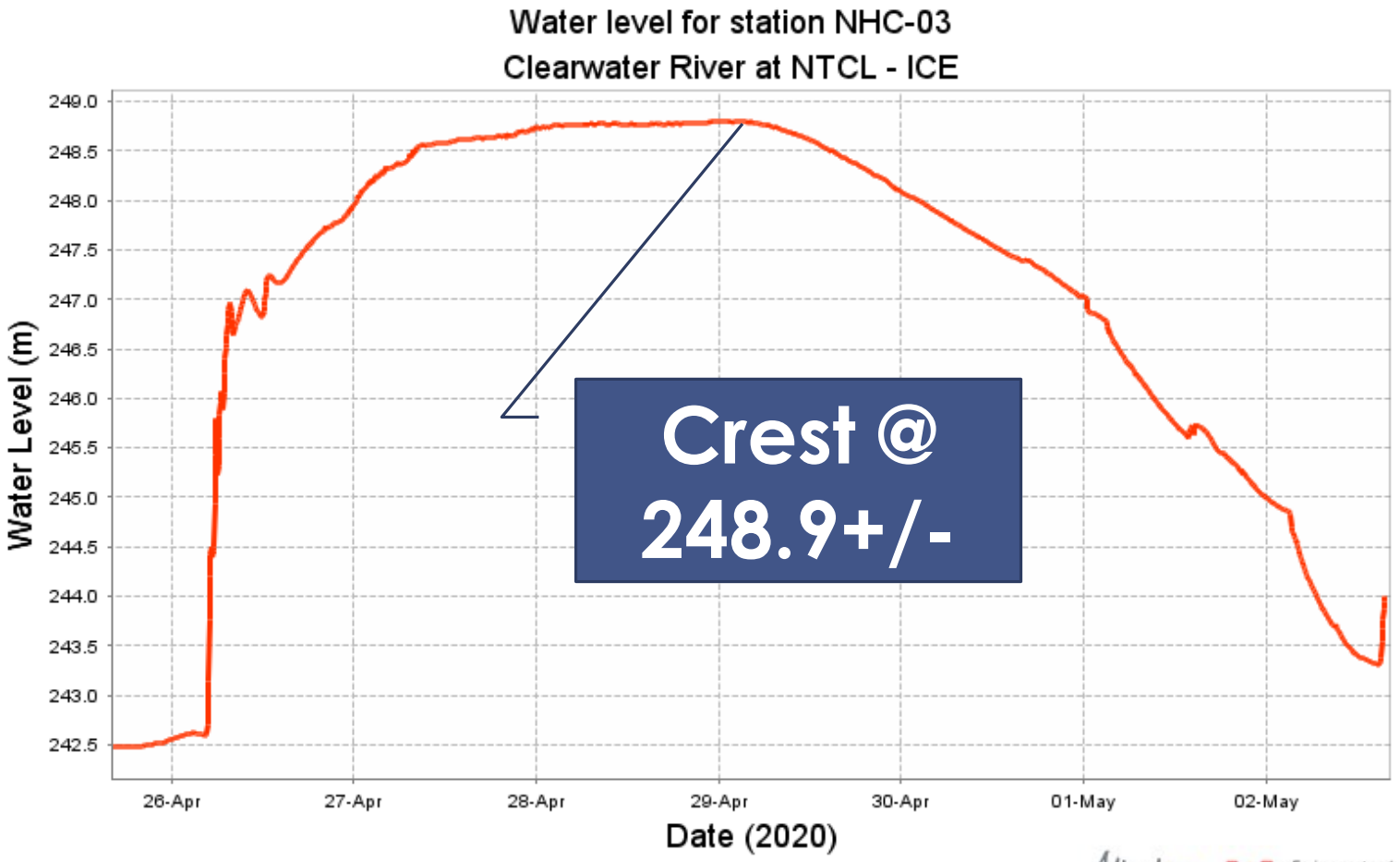
2020 Ice Jam Flood Event

- Athabasca River started to break on April 26, 2020
- Ice Jam formed downstream of confluence of Athabasca and Clearwater Rivers, causing water levels to rise
- Water levels spiked to 250.25 at Athabasca Bridge / WTP
- Water levels peaked at 248.9 +/- on Clearwater
- Approximately 5 days for water levels to recede

Flood Stage at Athabasca River Bridge



Flood Stage at Clearwater River

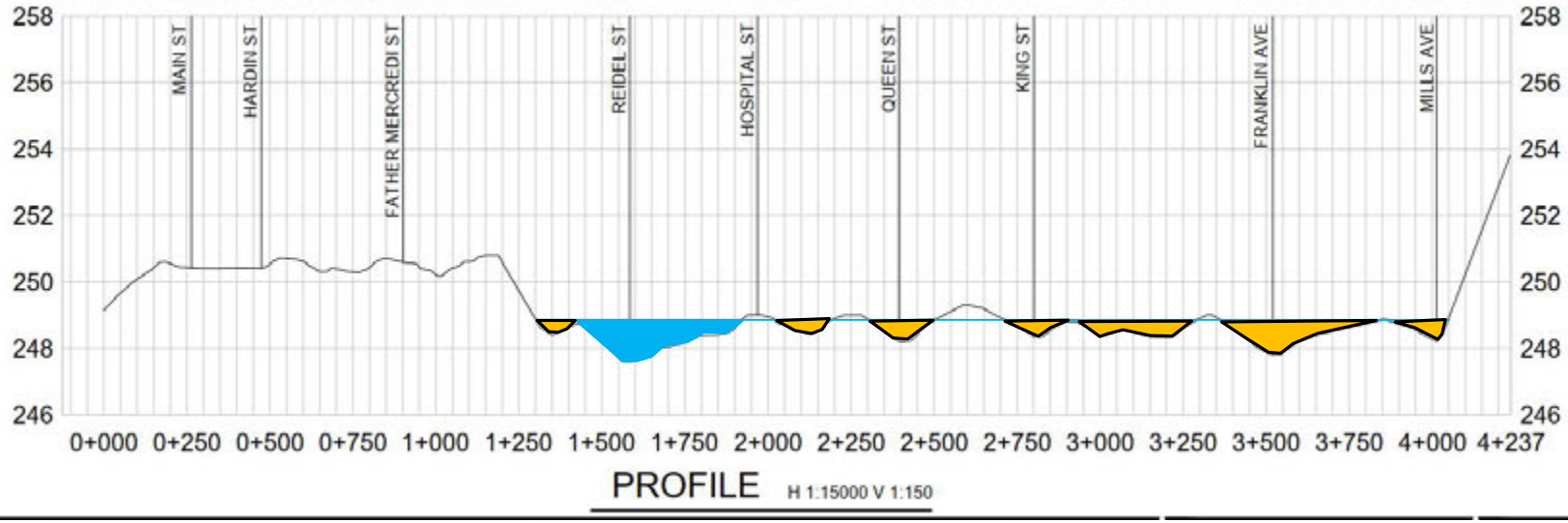


Lower Townsite Flood Pathways - Overland

Floodwater Pathways - Overland

- By 11pm on April 26 water was approaching 248.0 level, and was at or close to breaching Clearwater Drive at the following locations:
  - Mills Avenue (248.1m)
  - Franklin Avenue (247.9m)
  - King Street (248.5m)
  - Queen Street (248.3m)
  - Riedel Street (247.7m) – already breached
- Crews mobilized to build Emergency Clay Dykes on CWD

Clearwater Drive



Emergency Dyke Construction CWD @ Franklin

Emergency Dyke Construction CWD @ Franklin

Emergency Dykes Summary

- All of the emergency dykes successfully constructed EXCEPT for Riedel Street
- Emergency dykes were holding back ~1m of water
- Water still rising inside of the dykes
- At 1:30 pm April 27, emergency dyke construction abandoned due to rising waters and concern for worker safety

Lower Townsite – Underground Flood Pathways

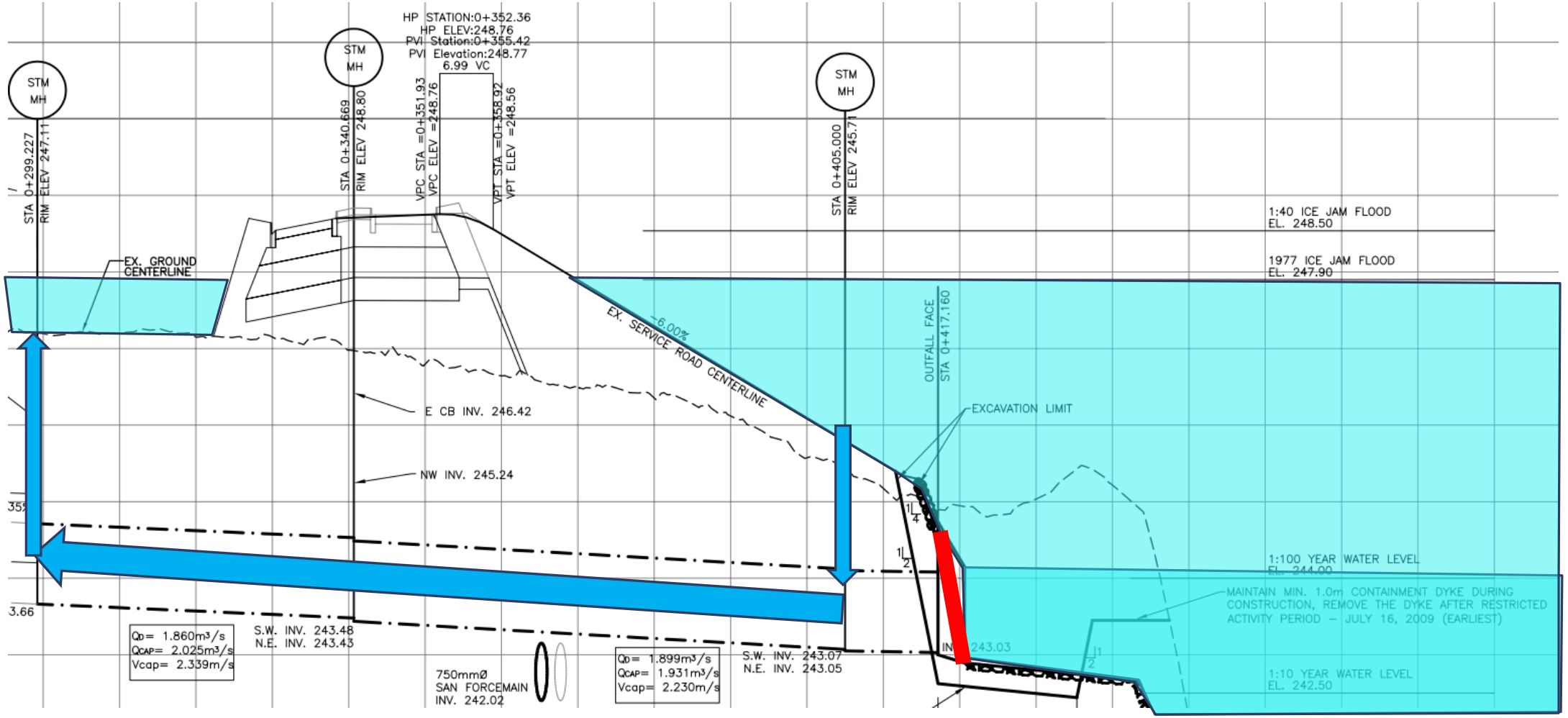
Storm Outfalls and Flapgates

- Storm sewers from Lower Townsite discharge directly to the river
- Outfalls include a flapgate, which opens to allow flow out, but closes to prevent backflow from the river.
- No evidence flap gates failed during 2020 flood

Underground Floodwater Pathways

- Flood water was observed inside of the dykes before overland breaches occurred.
- Water continued to rise inside of dykes, despite emergency dyke construction.
- Underground pathways allowed water to bypass the flap gates flooding both the storm and sanitary sewers.
- Once inside the dyke system, water will keep flowing until equalization

Underground Flooding Pathway Example



Main Street Outfall

Main Street Outfall

Hardin Street Outfall

Hardin Street Outfall

Flooding @ Hardin and Main St

Franklin Avenue Storm Outfall

- Note: Final alignment of permanent or temporary dykes may solve the backflow problem here

Riedel Street / Riverwalk Villas

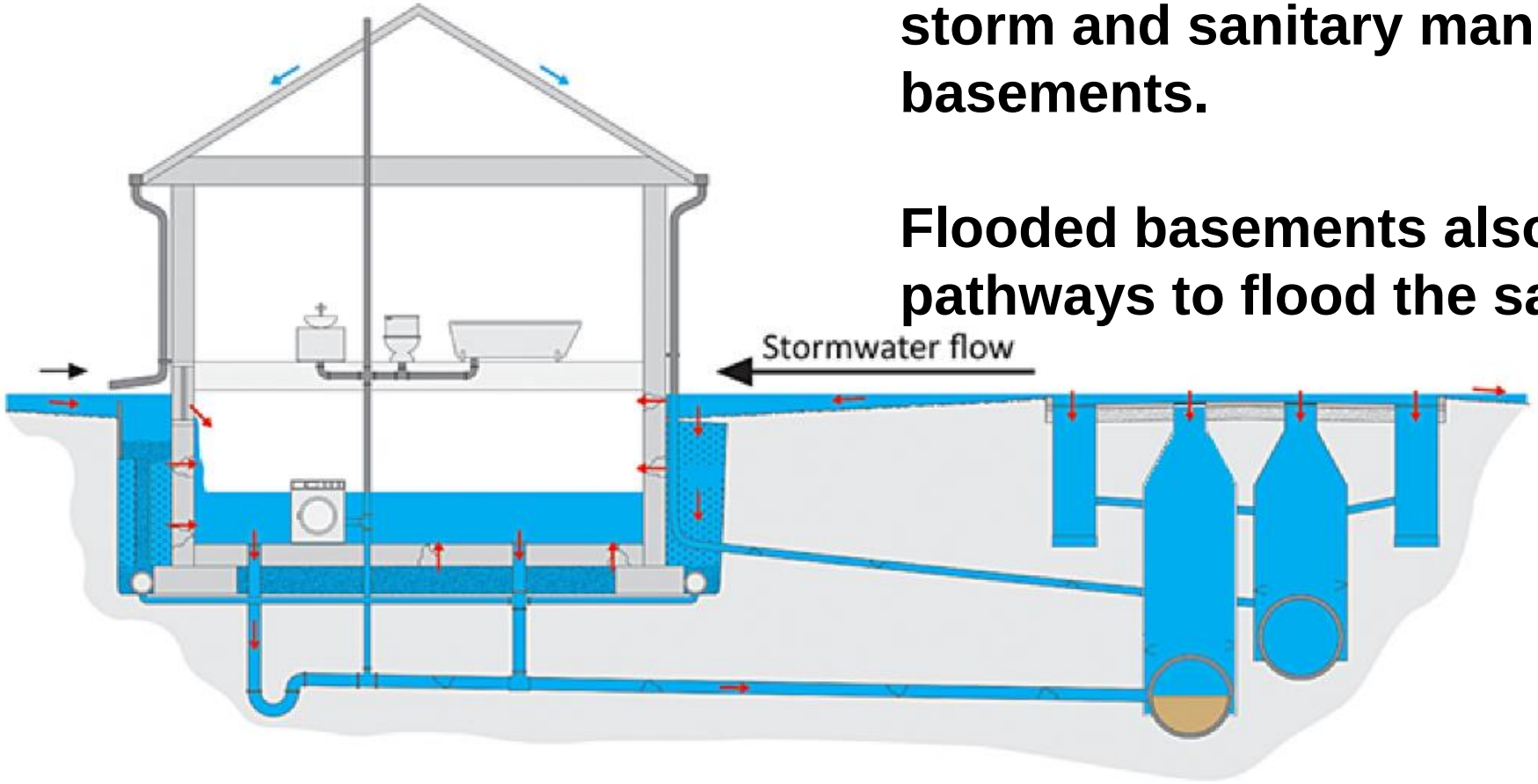
Underground Parkade Air Vents

Catch Basin with Grated Cover

Storm Outfall w Flapgate

Riedel Street - Water Flow

River Water Flood Damage



Flood water will follow path of least resistance to fill low points, including storm and sanitary manholes, and basements.

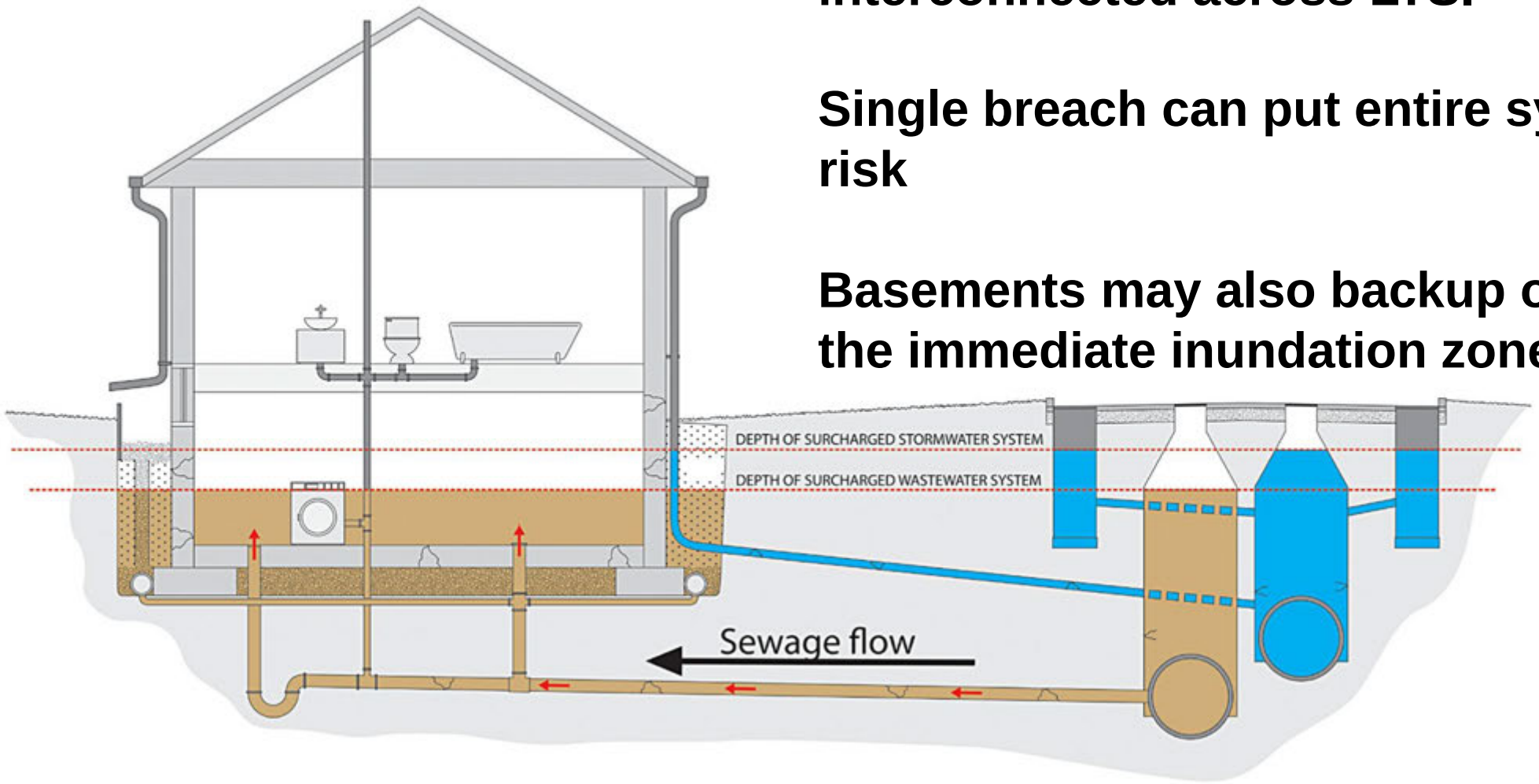
Flooded basements also provide more pathways to flood the sanitary system.

Sewage Back-Up Damages

Sanitary Sewer collection system is interconnected across LTS.

Single breach can put entire system at risk

Basements may also backup outside of the immediate inundation zone.



Longboat Landing

- Storm system is separate from rest of Lower Townsite (dedicated outfall)
- Original storm pond & outfall washed out in 2013 Hangingstone River floods
- Developer was approved to reinstall back flow preventer
- Inspection on November 30 identified that no backflow preventer was in place.

Longboat Landing

- Flood waters breached Denholm Gate and Fontaine Crescent from river
- Flood extent and damage independent of absent flap gate.

Cases of Successful Flood Mitigation

Successful Flood Mitigation

- No bridges damaged
- No flooding from Athabasca River / MacDonald Drive Causeway (i.e. 250.25 “spike” didn’t inundate downtown)
- No Flooding at River Park Glen (Reach 1)
- Lift Station 1A protected by 2013 dykes
- Hospital did not flood

Reach 1 / River Park Glen

Lift Station 1A

- Floor slab at flood risk
- Dykes Constructed around LS1A in 2013 to 250.0
- Dykes prevented flooding and submergence of mechanical and electrical systems

Hospital

- Bay doors and mechanical room at risk of flooding.
- Manholes plugged with sandbags to slow flood waters.

Water Treatment Plant

Water Treatment Plant – Infrastructure

- Outfalls damaged by river ice
- Sluice gate at outfall not sealed
- Flap gates bypassed at clearwell overflow piping

Water Treatment Plant – Failure Mechanisms

- River Water flowed into a Clearwell storage cell and quickly entered the pumping chamber. This was due to the close proximity of the overflow trough to the pump chamber.
- Operations had limited information that the Clearwell had been breached so contaminated water was pumped through the distribution network.

Water Treatment Plant – Failure Mechanisms

- Operations attempted to isolate the affected Clearwells but could not due to buildup of precipitate on the isolation valves.
- Boil Water Order implemented in coordination with AHS / AEP

Water System Recovery

- Water System Recovery Program undertaken by Municipal operations with contractor support.
- Entire water distribution system cleaned and disinfected, with all Boil Water Orders lifted by June 22, 2020.

Water Treatment Plant – Repairs and O&M

Inspections and Repairs completed:

- Sluice gate and flap gates repaired
- Dive team removed precipitate from valves

"Short Term Flood Mitigation" study identified Recommendations, including O&M improvements.

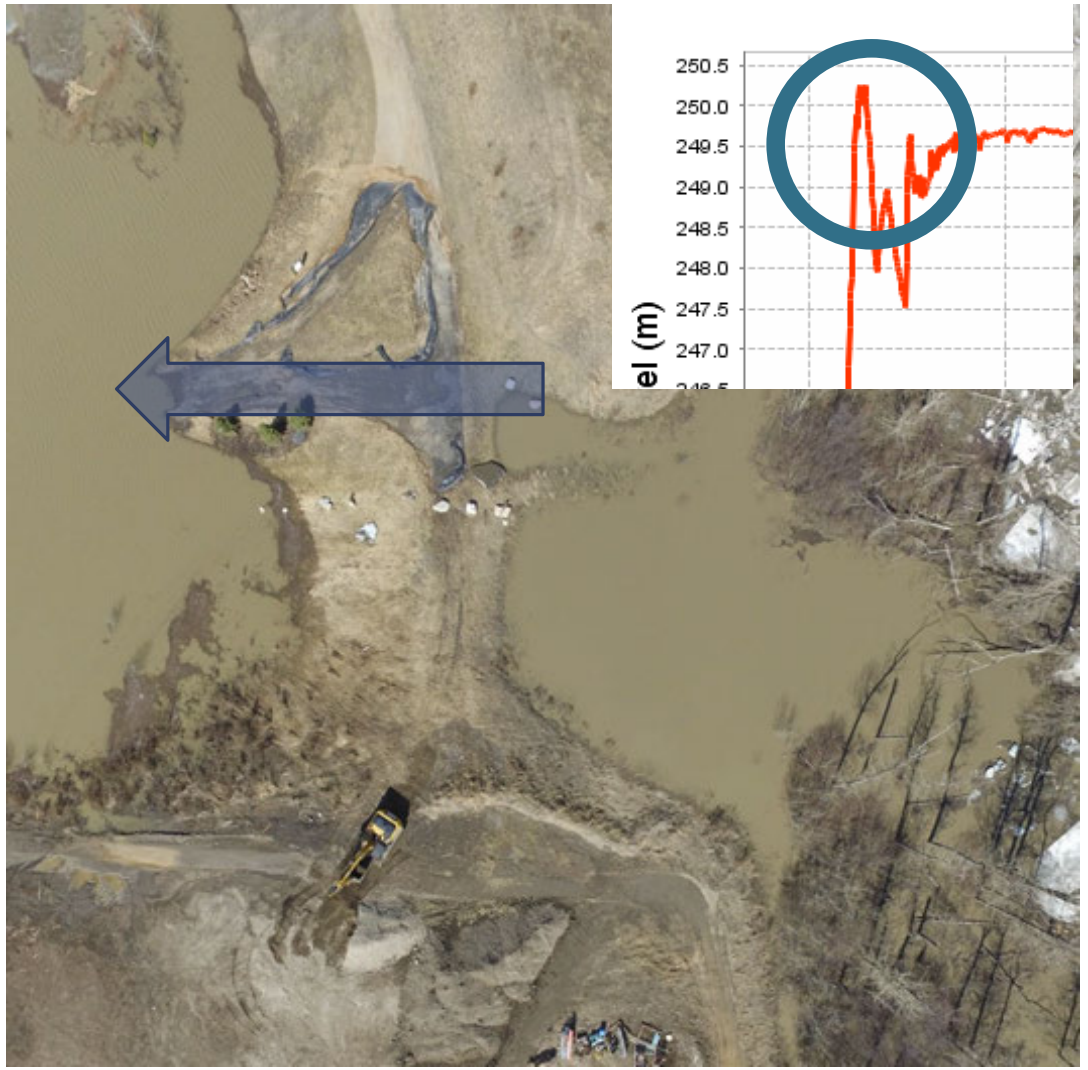
Taiga Nova Eco-Industrial Park

Taiga Nova Eco Industrial Park

- First Community to be flood-impacted (mandatory evacuation order 10:23am April 26)
- Two flooding mechanisms:
    1. Initial dyke breach
    2. Backflow from WWTP outfall

Taiga Nova Eco Industrial Park

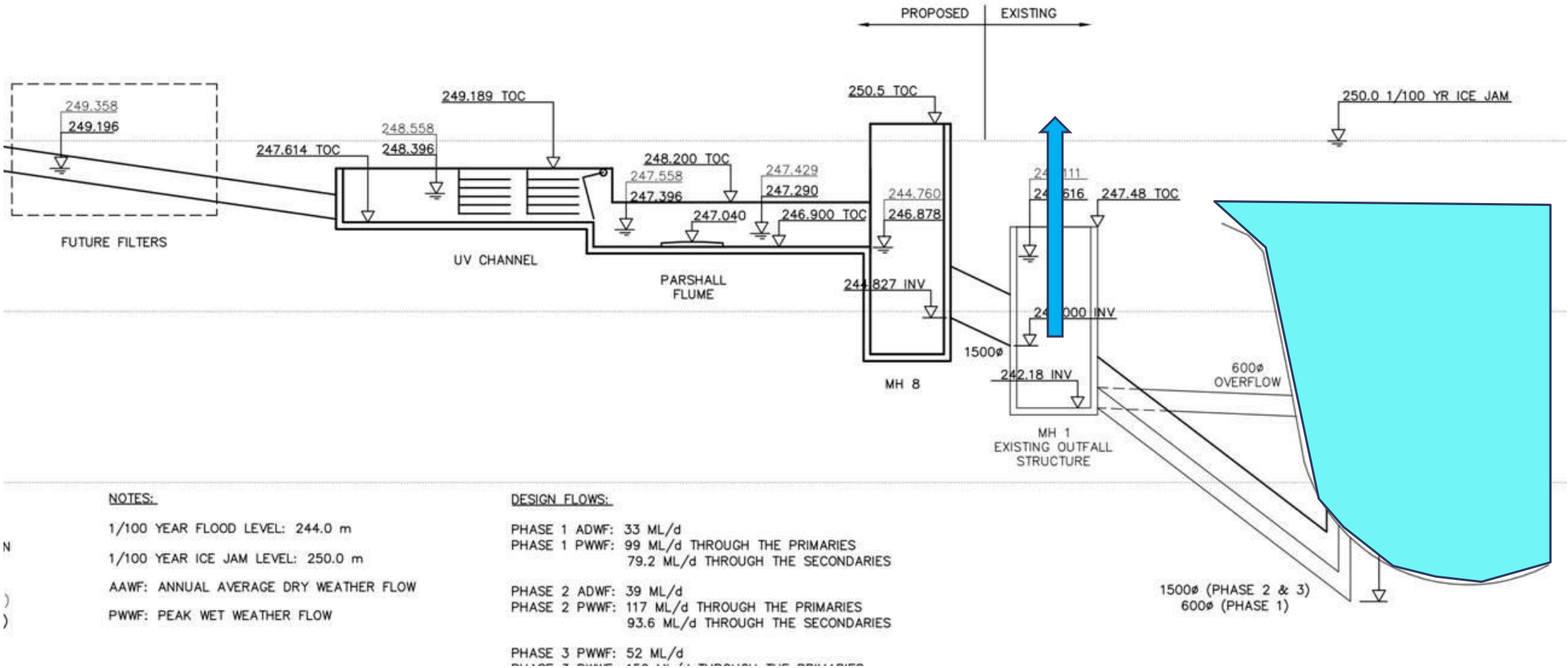
- Initial “spike” on Athabasca River caused water levels to breach dyke at storm pond
- Visible erosion in drone photos
- Storm pond backed up, causing flooding in eco park
- Breach was temporary – river dropped below dyke crest



Taiga Nova Eco Industrial Park

- After “spike”, Athabasca River levels at Taiga Nova stabilized around 247.5 +/-
- Dykes and flap gate did not fail, as maximum water level inside eco park was 245.7 (2m lower than river)
- High river level contributed to flooding, via WWTP outfall pipe (no flap gate)
- Water was reported flowing from manholes, with enough force to remove MH covers.

WWTP & Taiga Nova – Underground Flow Path



NOTES:

1/100 YEAR FLOOD LEVEL: 244.0 m

1/100 YEAR ICE JAM LEVEL: 250.0 m

AAWF: ANNUAL AVERAGE DRY WEATHER FLOW

PWWF: PEAK WET WEATHER FLOW

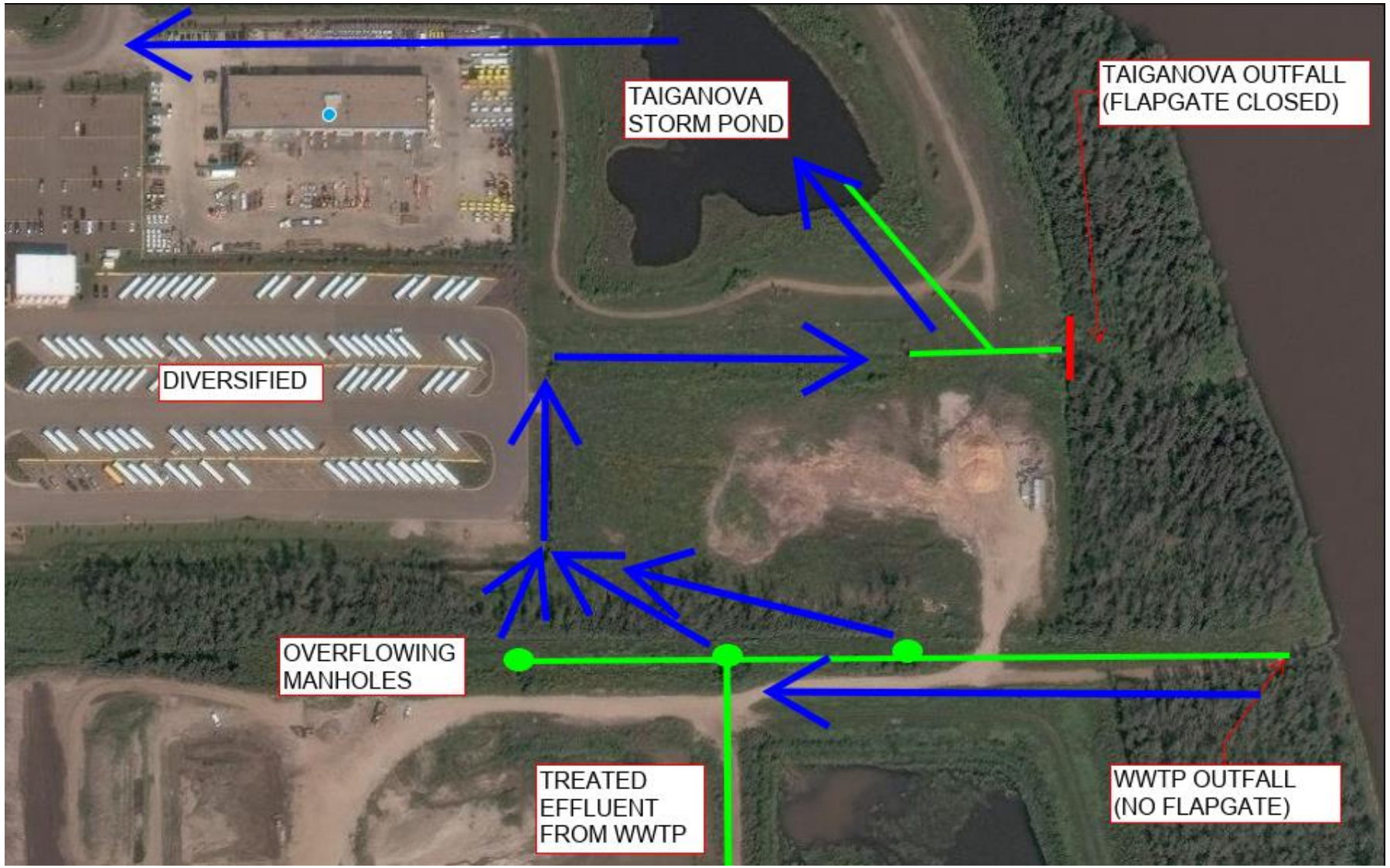
DESIGN FLOWS:

PHASE 1 ADWF: 33 ML/d
PHASE 1 PWWF: 99 ML/d THROUGH THE PRIMARIES
79.2 ML/d THROUGH THE SECONDARIES

PHASE 2 ADWF: 39 ML/d
PHASE 2 PWWF: 117 ML/d THROUGH THE PRIMARIES
93.6 ML/d THROUGH THE SECONDARIES

PHASE 3 PWWF: 52 ML/d

WWTP Outflow Pipe to Taiganova Flow Path



Key Findings

Key Findings:

1. A comprehensive Flood Protection System was not in place at the time of the 2020 River Breakup Flood Event.
2. Flood infrastructure composed of pieces, built to different standards (1:40 vs 1:100), not a single comprehensive system.
3. Flap gates did not fail. However, no process in place to identify underground pathways where water can bypass flap gates.

Key Findings:

4. Recommendations from Trillium (2000) for secondary line of flood defense or active pumping systems never implemented.
5. Incremental approach to establish protection to 1:40 and ultimately 1:100 per Trillium (2000) was still underway at time of 2020 flood.
6. The 2020 flood had a maximum water level of 248.9m, which exceeded the capacity of all infrastructure designed to only 248.5m

Key Findings (cont'd)

7. The attempt to build the emergency dykes along Clearwater Drive was not successful because:

   a) Unable to build emergency dykes at Riedel Street due to flood waters already breaching
   b) Underground water pathways through existing penetrations in the flood protection system
   c) A single point of failure in the system will allow water to enter, and follow sanitary sewer to impact all low-lying areas in Lower Townsite.

Key Findings (cont'd)

8. Underground flood pathways exist at multiple locations that will need to be reviewed and mitigated:

    a) Main Street, Hardin Street Outfalls
    b) Riedel Street / Riverwalk Villas
    c) Wastewater Treatment Plant -> Taiga Nova
    d) Other sites, depending on location and placement of temporary and final dyke alignment

Key Recommendations

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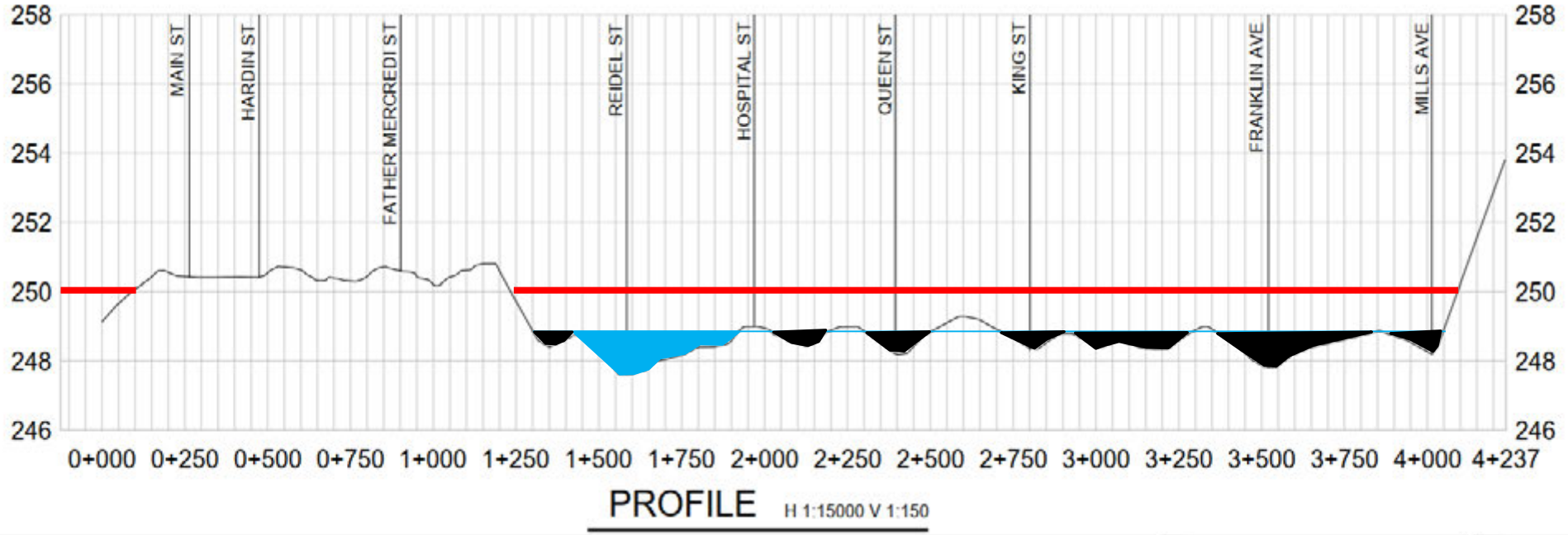
1. Adopt a consistent flood protection standard in accordance with Provincial guidelines and best practices

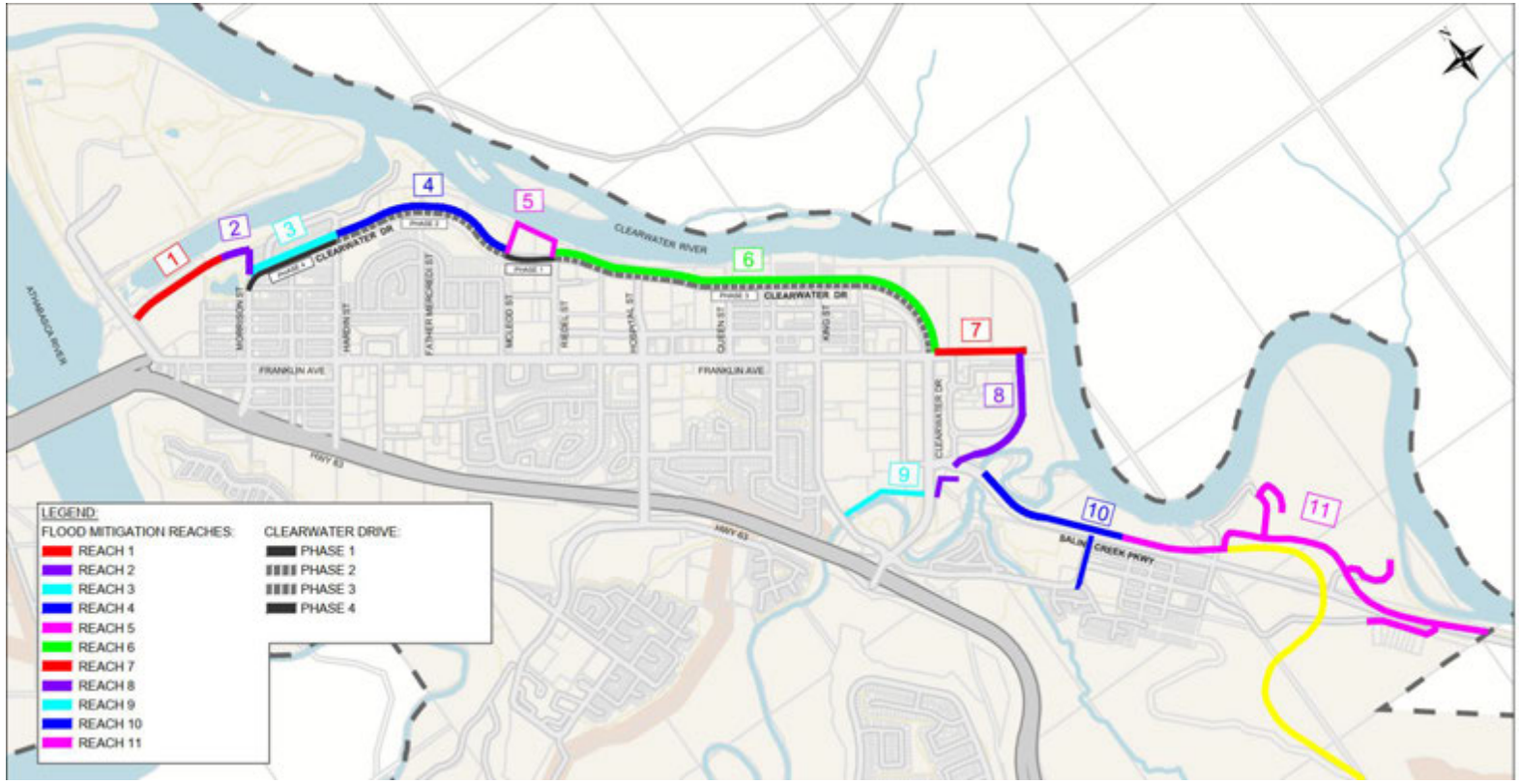


Key Recommendations (cont'd)

2. Implement a comprehensive Flood Protection System

   a) Accelerate design and construction of permanent dykes and flood barriers

   (Program Management)



Key Recommendations (cont'd)

2. Implement a comprehensive Flood Protection System (continued)

   b) Identify and plug all underground flooding pathways
   c) Apply a multi-barrier approach, including redundancy for critical infrastructure (e.g. Hospital), and means of isolation to limit damage in the event of a breach
   d) Implement pumping measures to manage drainage inside of the dykes

Key Recommendations (cont'd)

3. Develop an inspection and maintenance program for the Flood Protection System (i.e. Asset Management)

    a) Pre-River Break, During River Break, Post River Break
    b) Review and monitor existing and proposed infrastructure that may compromise the flood protection system
    c) Multi-faceted approach to public infrastructure, private developments, third-party utilities, grading and landscaping, and natural processes including erosion, vegetation, etc.

Thank You

Special Thanks to McMurray Aviation for aerial imagery