

Replacement of East Lake Dam Structures

Problem Statement

- Lake Major watershed supplies greater Dartmouth with drinking water and has experienced dry periods
- Halifax Water imposed water restrictions (2016, 2018)
- Lake levels dropped below those required for fish passage

Objectives

- Assess severity of water need and capacity of East Lake watershed to meet the theoretical demand.
- Design storage and control structures to retain spring runoff.
- Provide mechanism and operations guide for controlled release to Lake Major during dry season (Aug-Sep).
- Supply enough water to Lake Major to maintain fish passage and future plant demand.

Design Process

- Estimate hydrologic surplus from East Lake watershed.
- Evaluate T=100 year flood event and allow for lake routing.
- Design spillway and sluice gate, for safety and storage needs.
- Design concrete dam structure to withstand hydrostatic, uplift, ice, and earthquake forces (load combinations), as per Canadian Dam Association (CDA) guidelines.
- Size zoned embankment to retain water at adjacent low-topography saddle.

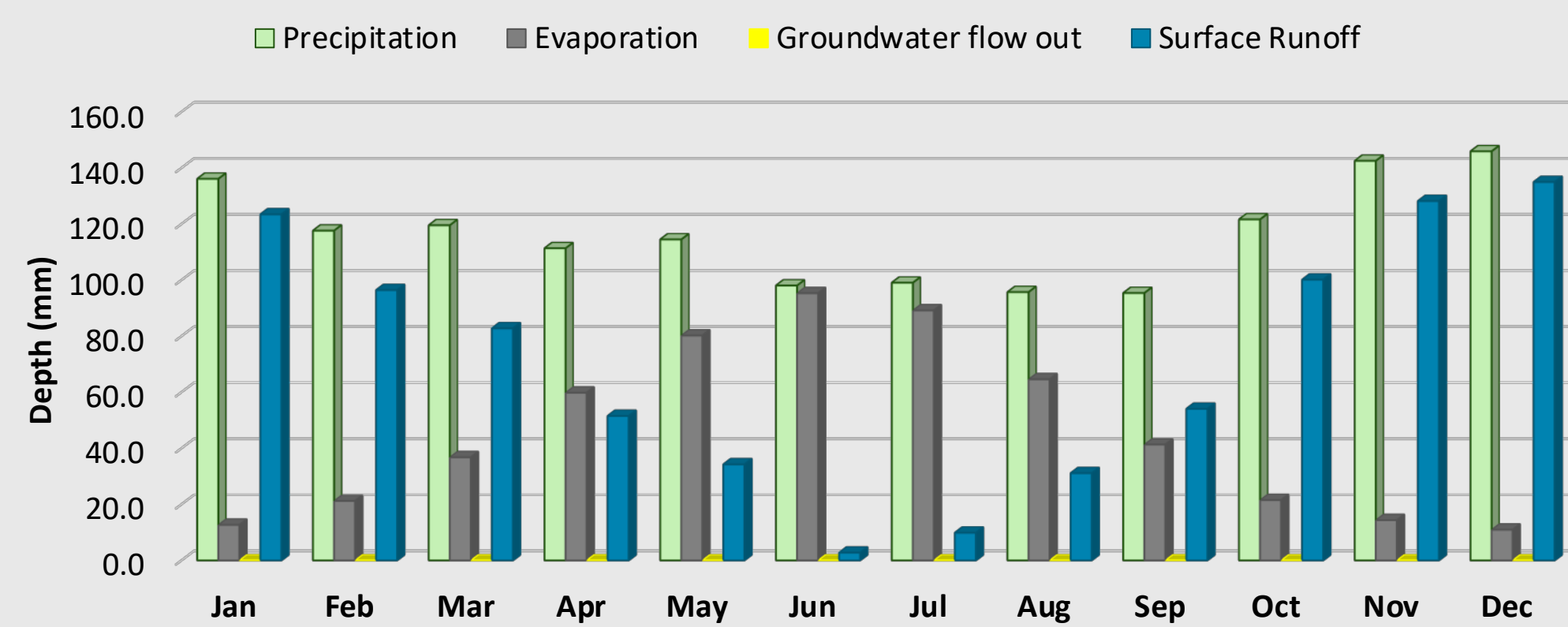
Hydrometeorology

Watershed area: 21 km² East Lake area: 0.9 km²

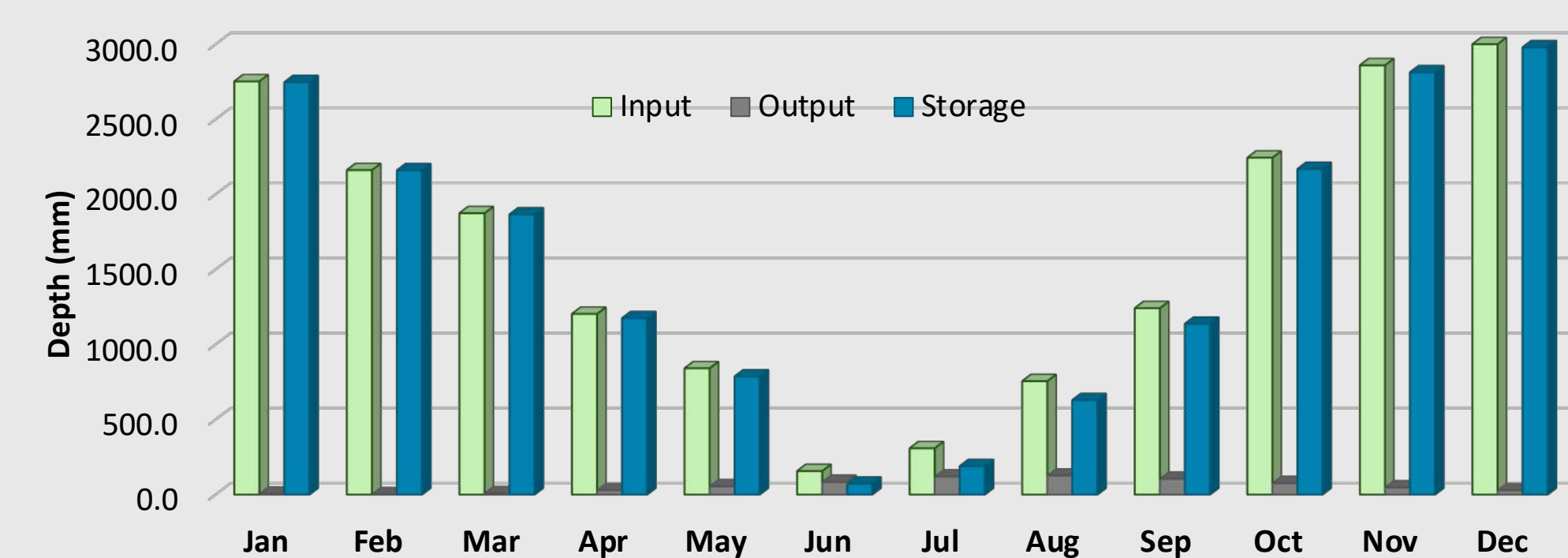
Annual Mean (mm)

Precipitation	1397
Rainfall	1212
Snowfall	191
Watershed Evaporation	548
Lake Evaporation	681
Surface Runoff	849

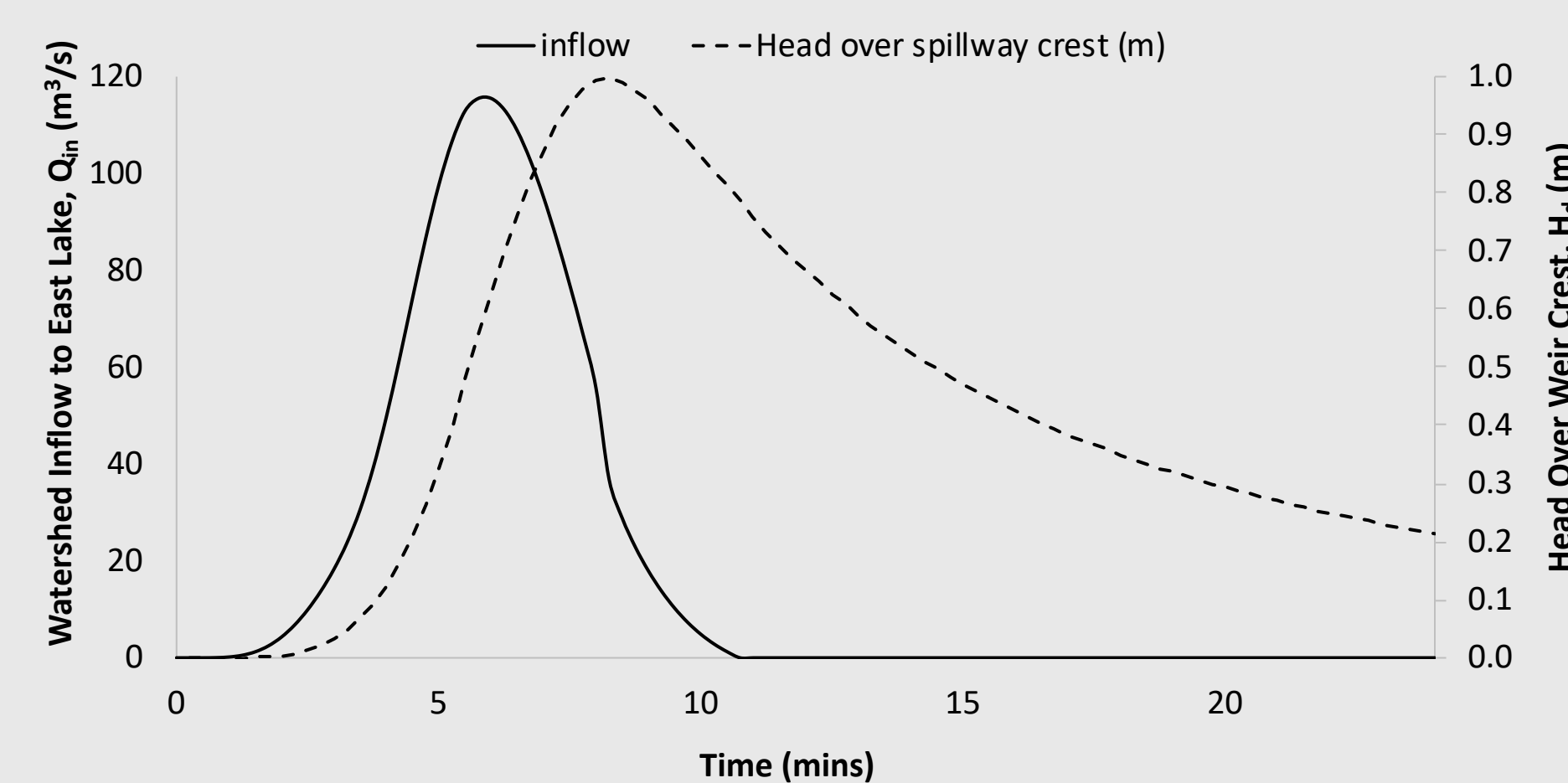
Watershed Surrounding East Lake



East Lake

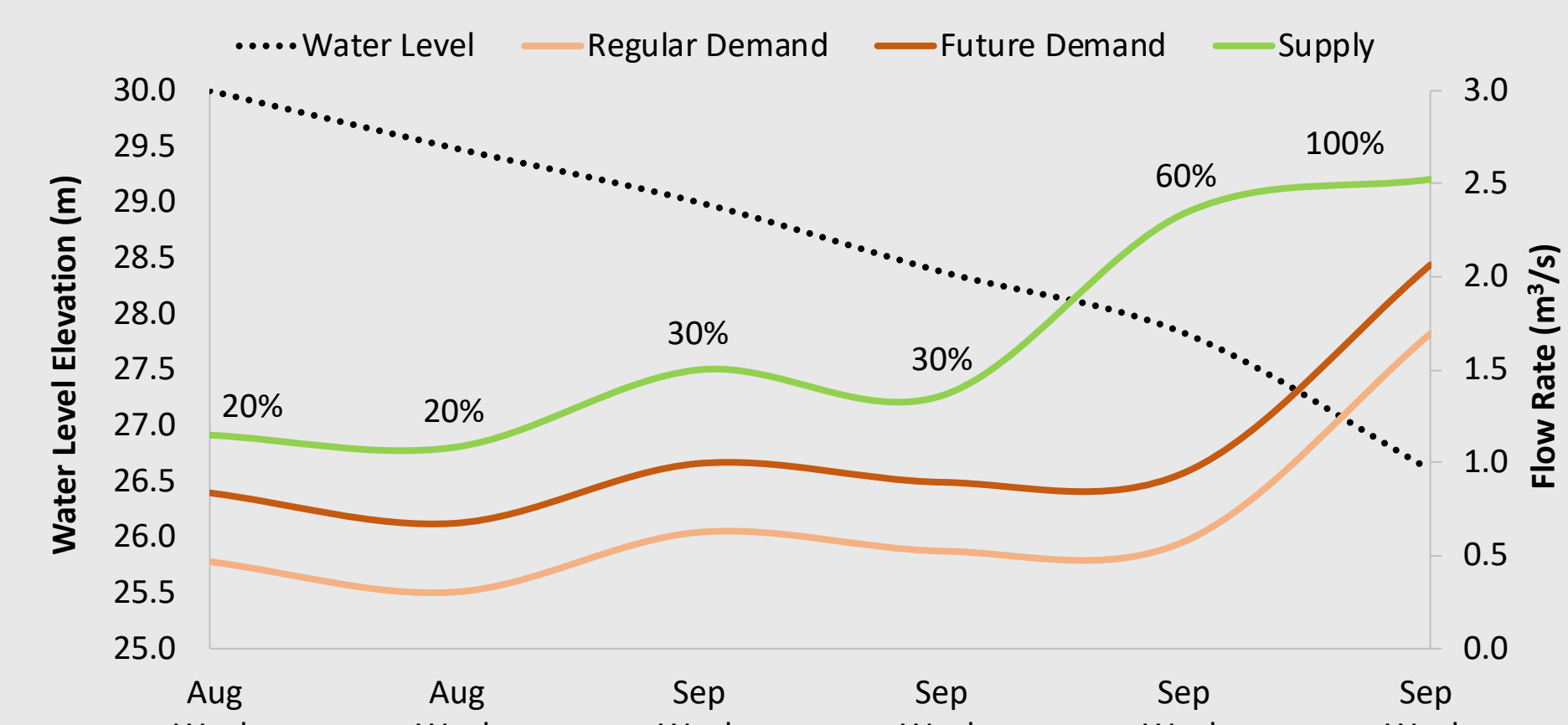


Hydrologic Analysis of T=100 Year Event



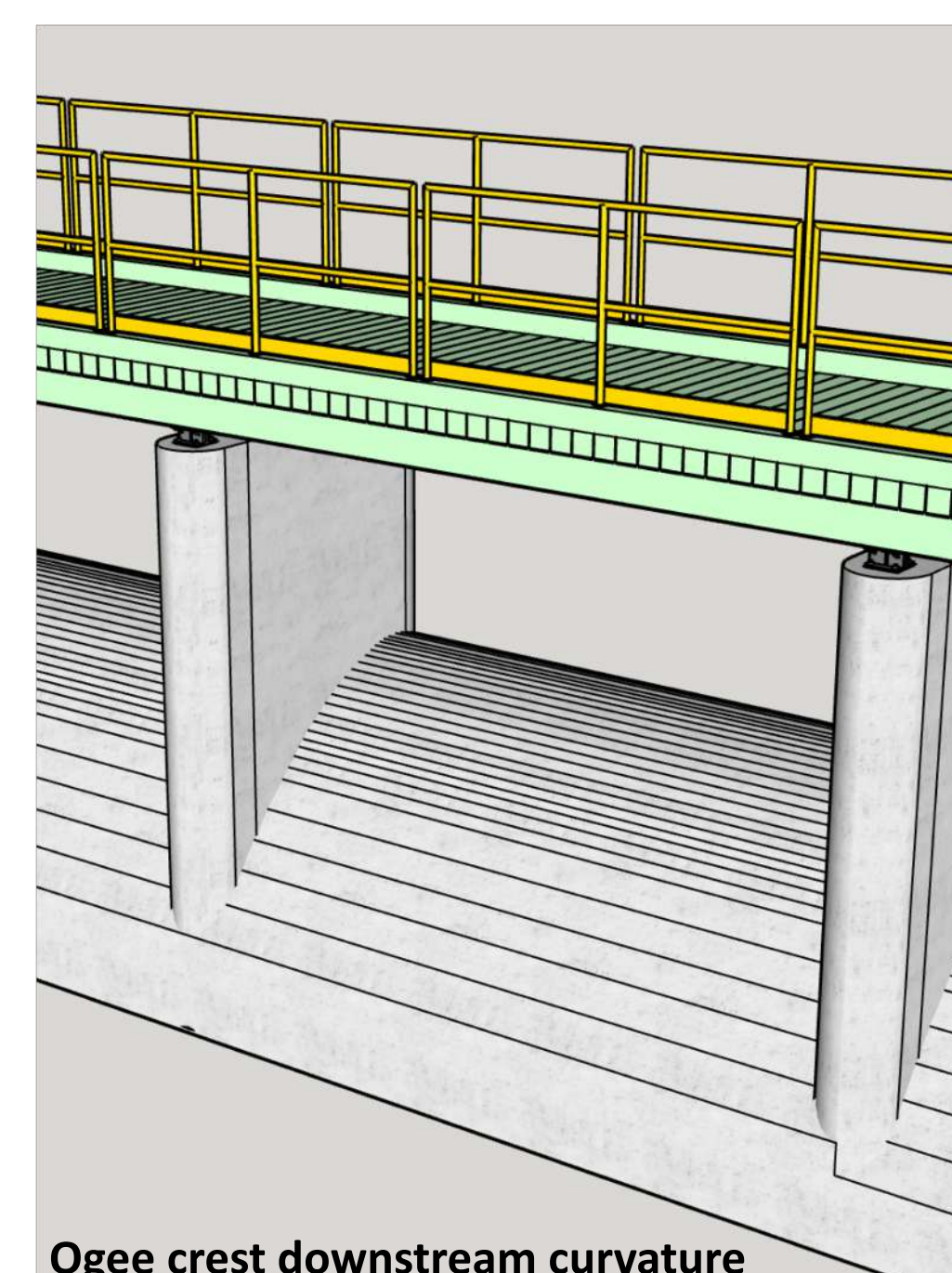
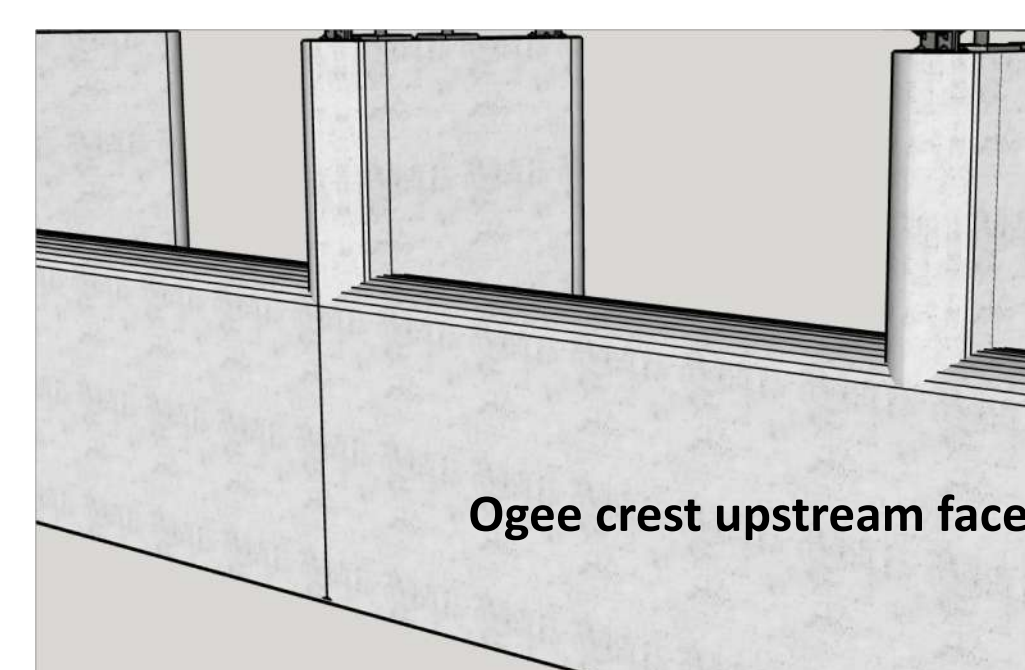
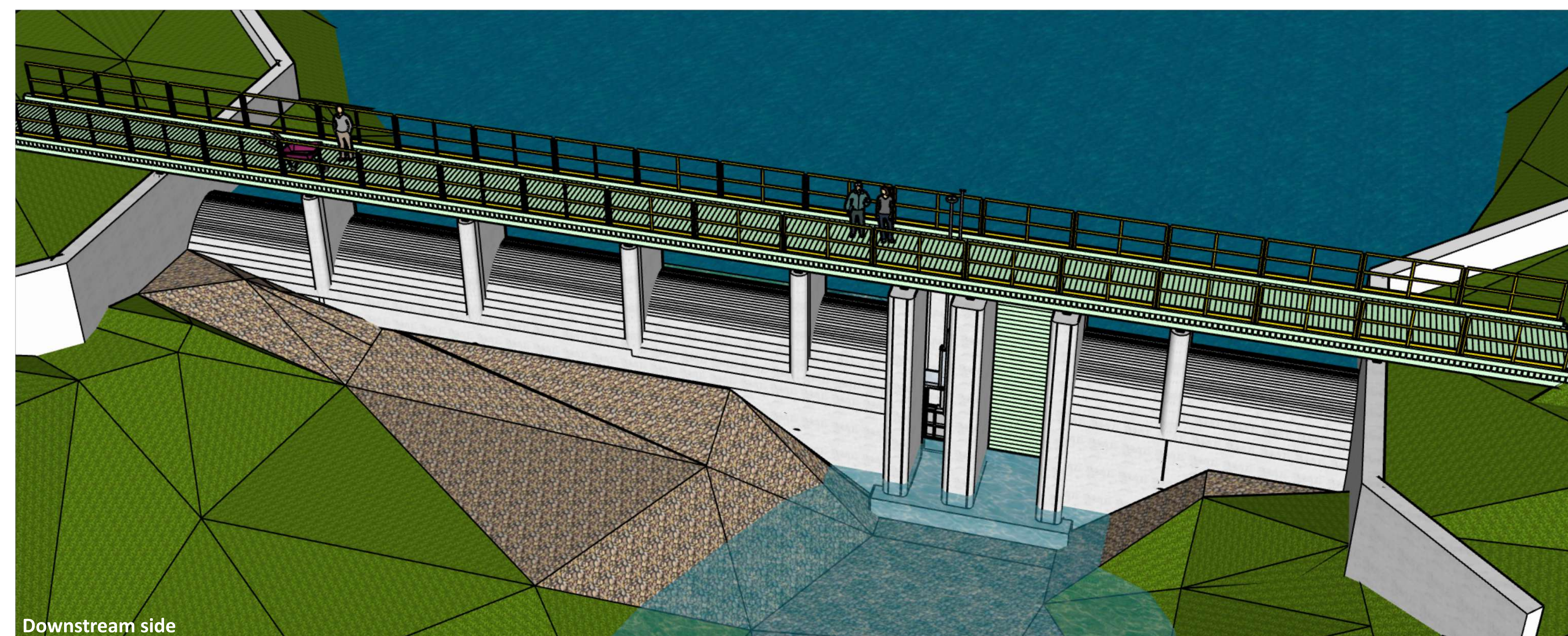
- Spillway and earth embankment designed to withstand 1.0 m surcharge over crest

Water Demand



- Supply versus demand, modelled using 2016 drought (percentages are gate positions, by week)

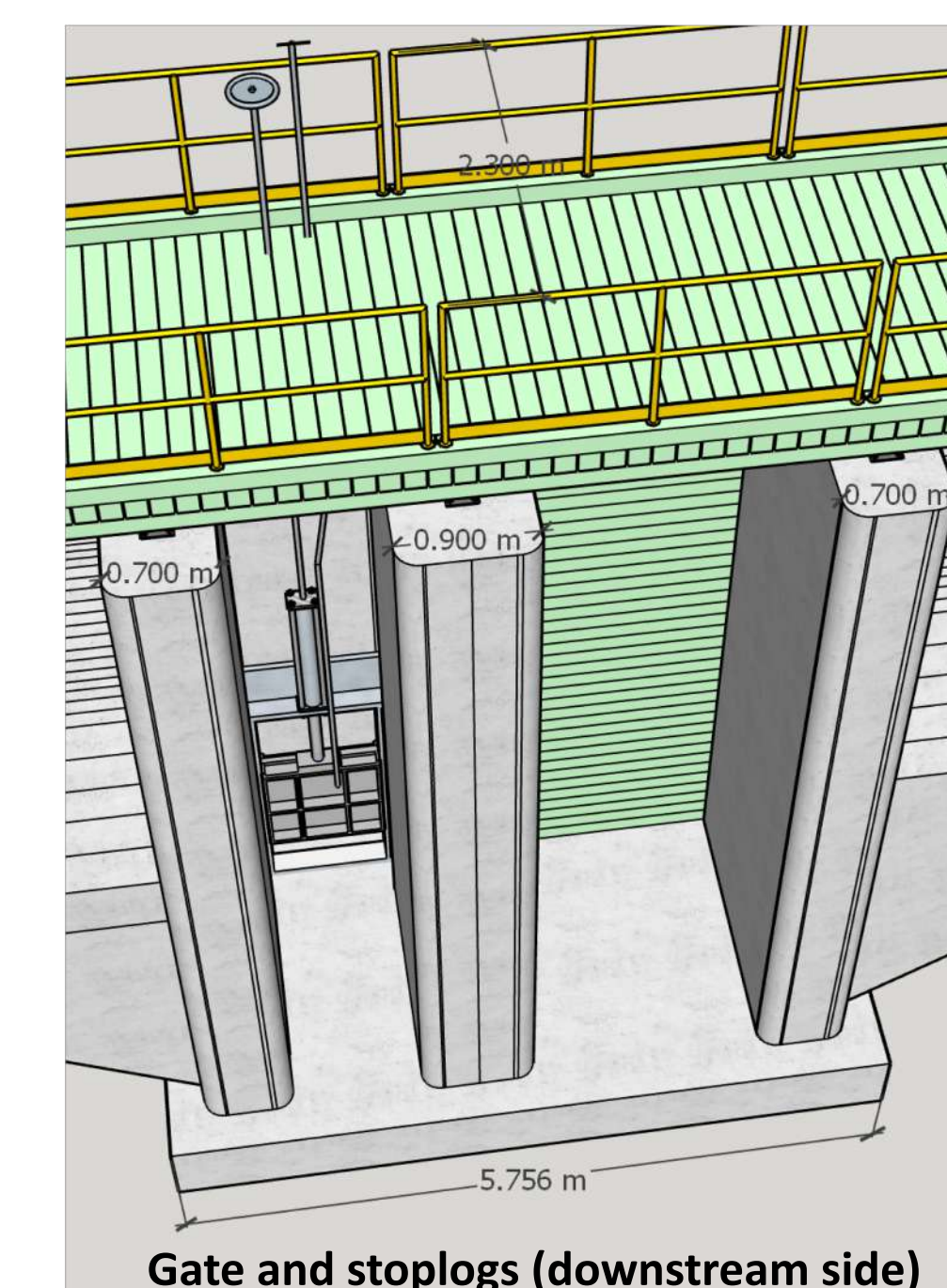
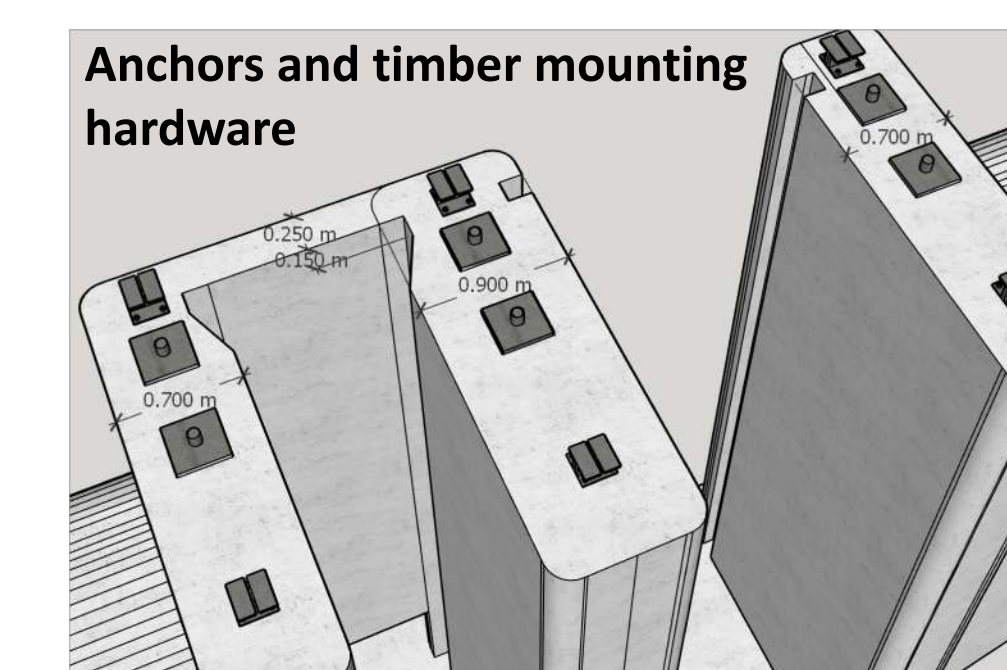
Concrete Dam



Length: 35m (6% longer than existing)

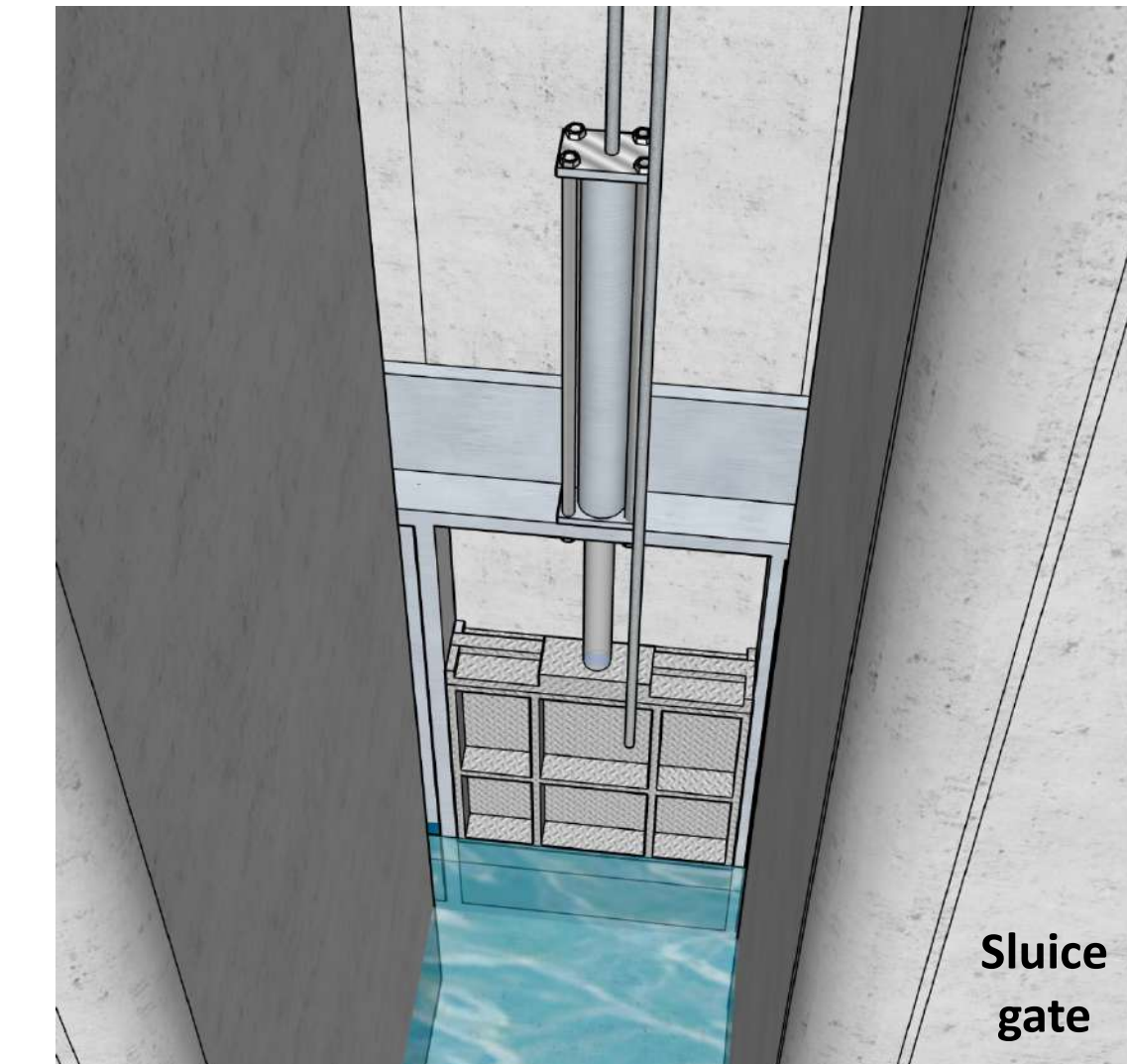
Crest: 5m above foundation (22% higher than existing)

- Uncontrolled spillway crests
- Plunging overflow into downstream channel (bedrock)
- Emergency 2.1 m stoplog section
- Catwalk of pressure-treated timber for operational access to gate control and south side of dam
- Reinforced vertical slab above gate opening (250mm thick with 35M @ 300mm)
- 1m x 1m sluice gate secured to concrete face between middle supports
- Manually-actuated handwheel which is compatible with portable powered actuator
- Rounded piers (2.4 m x 0.5 m)
- Inner piers at 3 m centres from middle supports
- Outer piers 5 m centre-to-centre
- Stabilizing 63mm anchor bolts centred at 0.6 m and 1.2 m from upstream edge of each pier



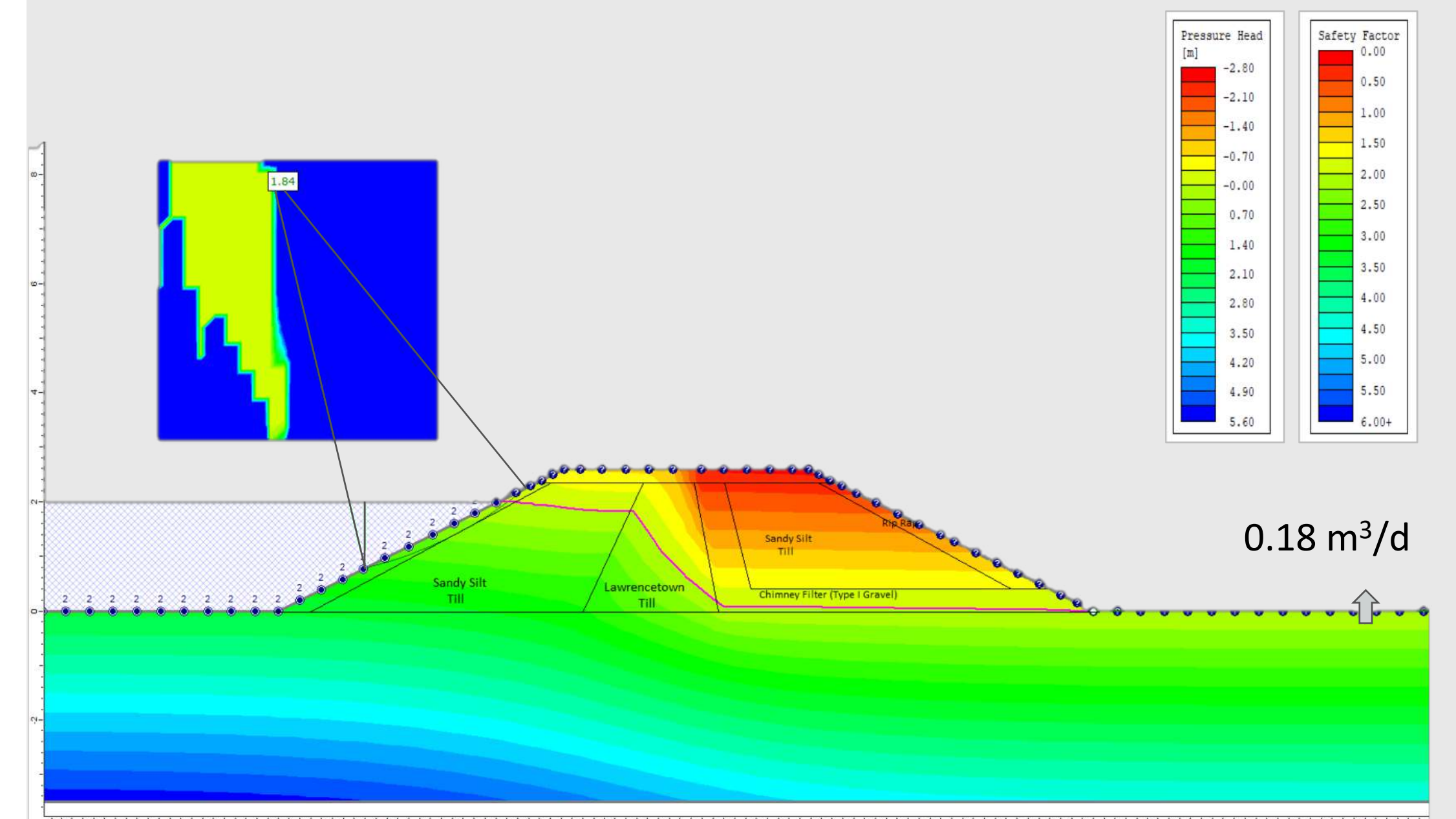
Gate Operation

- Careful management of gate positions must be practiced year-round, to ensure adequacy of storage/releases
- Operators' guide for 1m x 1m sluice gate provided (weekly recommended gate positions)



Earth Embankment

- Earth embankment required for nearby saddle in topography
- Considered Zoned embankment & Homogenous embankment
- Conducted Seepage Analysis & Slope Stability through Slide 2018 (RocScience) using Bishop's Simplified & Janbu Simplified method
- Obtained a FOS of 1.84 at upstream slope and total seepage on the downstream end as 0.18 m³/d/m for the zoned embankment



Conclusions

- Water supply augmentation from East Lake is hydrologically feasible
- Flood event specified by CDA is within structure design capacity
- Release regime must be carefully followed
- Dam satisfies supply needs and safety guidelines (as per CDA)
- Embankment controls seepage & prevents failure from overtopping

Key References

- CDA 2007. Canadian Dam Association, Safety Guidelines.
- Halifax Water. June 2017. Lake Major Source Water Protection Plan.
- Smith C.D. 1985. *Hydraulic Structures*, U. of Saskatchewan, 364 pp.

Acknowledgements

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