

Climate Change and the Newfoundland & Labrador Marine Tourism Industry

Cost Benefit Analysis of Infrastructure Adaptation



Natural Resources
Canada

Ressources naturelles
Canada

Canada

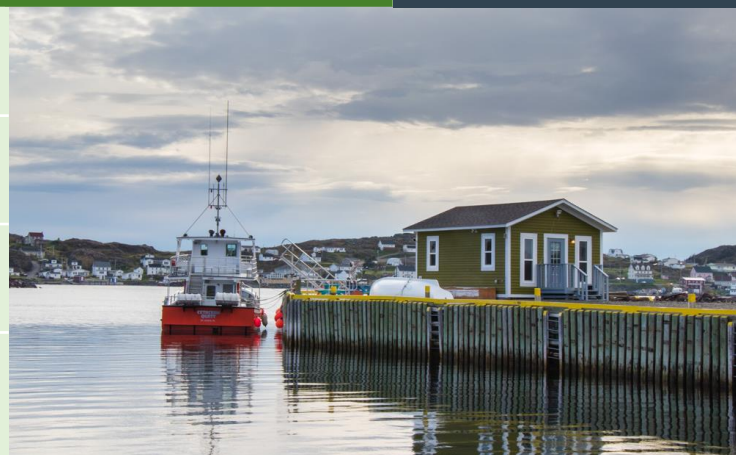


Funded by the Department of
Environment and Climate Change

Twillingate

Business Profile

| | |
|------------------|---------------------------------------|
| Name | Iceberg Quest |
| Location | Twillingate |
| Services | Iceberg and Whale Watching Boat Tours |
| Operating Season | May - September |



Coastal Climate Change Risks

- ▶ Climate change is projected to cause rising sea levels, increased storm surge, and increased wind and wave action throughout Newfoundland and Labrador.
- ▶ Without implementing climate resilience measures, coastal infrastructure is anticipated to be at higher risk of damage due to climate change impacts.



Potential Climate Change Impacts

- ▶ Damage to coastal infrastructure such as buildings and wharves from wave action, overtopping, and flooding.
- ▶ Increased annual maintenance costs.
- ▶ Operational disruptions, prolonged closures for maintenance or repair, and potential revenue loss.
- ▶ Increased health and safety concerns.

Climate Adaptation Focus – Wharf Upgrades to Account for Rising Sea Levels



- ▶ Since 2016, Iceberg Quest has been conducting phased upgrades to their wharf including expanding its footprint and raising its elevation to accommodate future sea level rise projections.
- ▶ The upgraded wharf was constructed at approximately 2.9 m elevation, but settlement has reduced the elevation of the wharf and the sea-facing armour stone protection by several centimeters.
- ▶ In 2022, additional upgrades were made to the armour stone to raise its elevation, effectively creating a sea wall that protects the wharf and its buildings from overtopping, flooding, and erosion.

Business-as-Usual Option

- ▶ Armour stone is maintained at its settled elevation without conducting upgrades.
- ▶ Wharf and buildings are regularly subjected to flooding and damage from wave overtopping, resulting in significant annual maintenance costs.



Adaptation Scenario

- ▶ Capital investment to increase the elevation of the armour stone to accommodate climate change projections for sea level rise.
- ▶ Upfront investment reduces the long-term, repetitive repair and maintenance costs, and minimizes operational disruptions.

Coastal Climate Change Projections in Twillingate



Wave Action

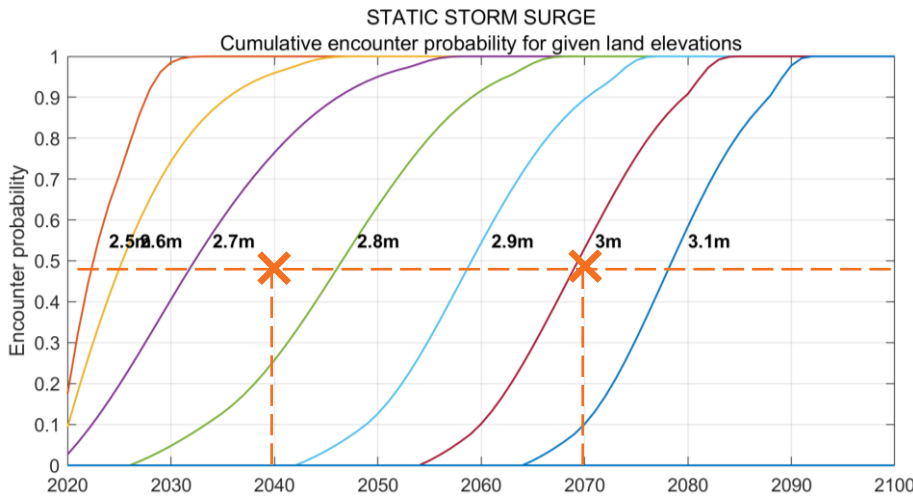
- ▶ Large offshore waves are typically experienced from the north.
- ▶ Location can be classified as having a moderate exposure to waves which is projected to increase to high throughout the century.

Sea Level Rise

- ▶ By 2040 sea levels are projected to increase by approximately 0.16 m above 2010 levels.
- ▶ By 2070 sea levels are projected to increase by approximately 0.44 m above 2010 levels.

Extreme Water Level

- ▶ Extreme Waver Level is the sum of Sea Level Rise + Storm Surge + High Tide.
- ▶ Climate resilient infrastructure is typically designed to accommodate a 50% encounter probability (see orange dashed lines on below figure).



*Coloured lines represent different elevations from 2.4 m to 3.1 m
*Elevations are shown in Chart Datum (CD)

Recommended Minimum Infrastructure Elevations for Climate Resilience

2040

- ▶ 50% encounter probability falls between 2.7 and 2.8 m CD.
- ▶ Recommended minimum infrastructure elevation by 2040 is 2.8 m CD.

2070

- ▶ 50% encounter probability falls between 3.0 and 3.1 m CD.
- ▶ Recommended minimum infrastructure elevation by 2070 is 3.1 m CD.

Cost Benefit Analysis – Increased Elevation of Wharf

Adaptation Scenario

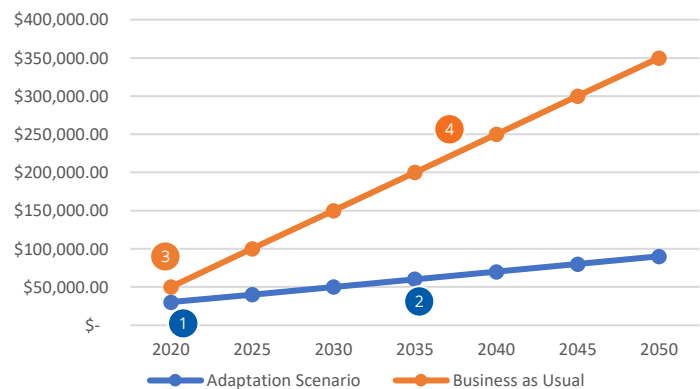
- \$20,000 investment to raise the armour stone protection to approximately 3.9 m.
- Regular annual spring maintenance is required to regrade weathered areas of the wharf and preserve the armour stone wall, including replacing displaced materials.

Annual wharf maintenance costs for are significantly lower due to protection provided by the armour stone wall.

Business as Usual Without Adaptation

- No upgrades to the armour stone are conducted, meaning the elevation of the sea-facing side of the wharf is below the recommended design elevation for sea level rise.
- Over the lifetime of the wharf, significant damages are incurred each year, including flooding and erosion to the wharf surface and the operational buildings that exist on the wharf. Costly maintenance and repairs are conducted each year to address damages and erosion resulting from extreme water levels.

Cumulative Repair and Maintenance Costs



Summary

- ▶ Analysis indicates that a minimal investment to raise the elevation of the armour stone will result in significant savings over the infrastructure lifecycle.
- ▶ Maintenance costs are relatively minor, meaning the initial investment is recouped within the following five years.

Cost to Benefit Ratio

3.9
1