Community-based climate change adaptation cost-benefit analysis for infrastructure

Lessons learned

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Deloitte.

The adaptation paradigm for First Nations infrastructure

Budget 2016 highlights

Strengthening water, wastewater & solid waste infrastructure over 5 years **$2.2B**

Improved housing over 2 years **$550M**

Investing in community infrastructure over 2 years **$255M**

Decisional challenges

- **HOW TO FACTOR CLIMATE CHANGE** in long-term, costly planning decisions about First Nations community infrastructure and disaster risk reduction?
- **HOW TO MAKE THE RIGHT ADAPTATION DECISION** without knowledge of future climate change loss and damage and of adaptation benefits?
- **HOW TO CHOOSE** between different available adaptation responses?
- **HOW TO KNOW** if adaptation will achieve value for money?

Source: INAC *Budget 2016 Highlights* (2016)

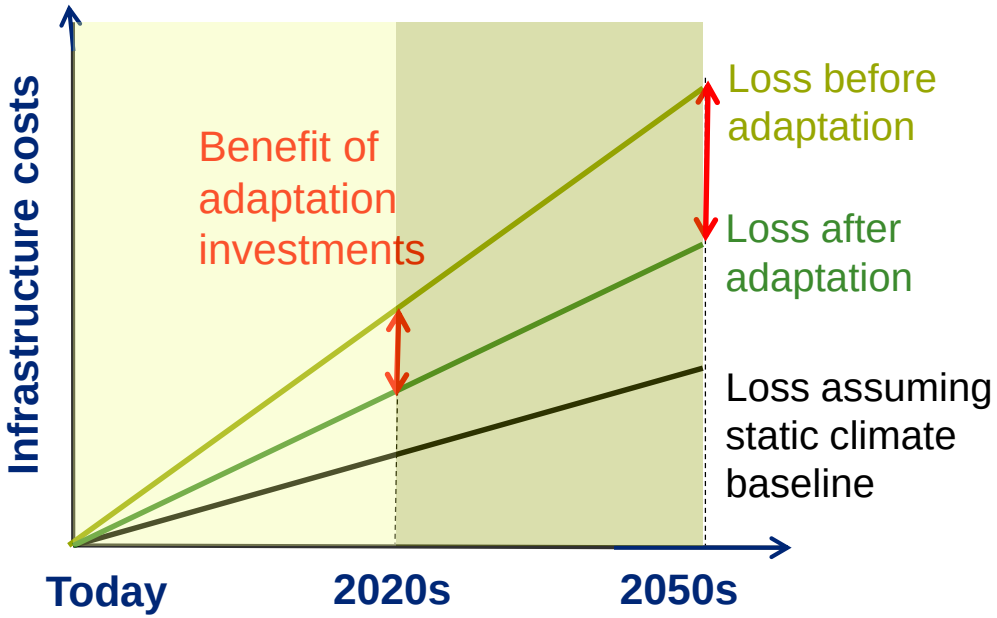
Goals of a climate change adaptation CBA

What is a CBA?

- Well-know approach to assess the economic worth of a project
- Compares lifecycle costs and benefits to calculate Net Present Value

Specifity for First Nation adaptation

Information produced by a climate adaptation CBA



- ✓ Based on probabilistic flood loss estimation
- ✓ Uses HAZUS depth-damage curves
- ✓ Identifies data gaps specific to First Nations and ways to move forward
- ✓ Based on consultation to elicit Traditional Ecological Knowledge
- ✓ Quality outputs depend on quality inputs

Benefits of adaptation CBA to decision-making

Vulnerability context

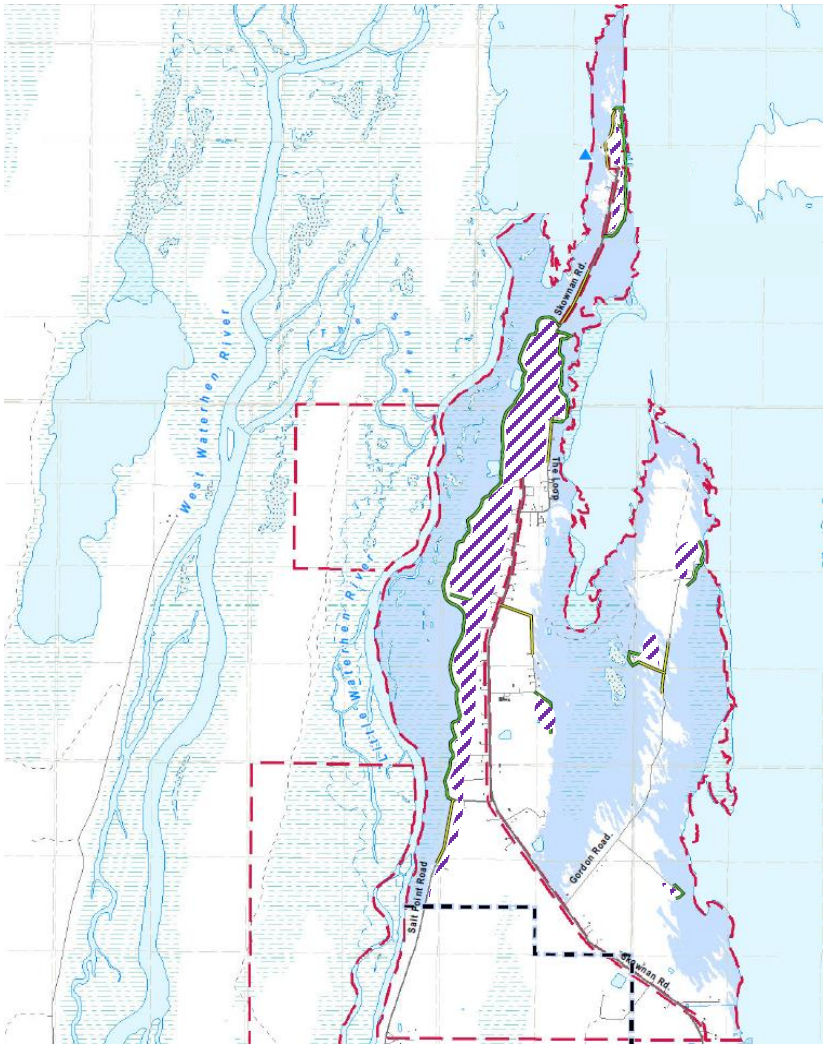
- Community of 700+ residents vulnerable to river/lake flooding due to flat elevation
- Large loss of hay land; in 2011 a severe flood resulted in costs worth $700K
- Climate models project higher mean maximum runoff in Winter, Summer and Fall though there is some uncertainty

Adaptation question

- In 2014, the community invested $3.3M in a temporary earth dike
  - ➢ **What is the value for money of this adaptation investment?**

Reserve boundaries
Areas under water in 1/100-year flood
Temporary dike
Areas protected by the dike

Inundation map of First Nation today



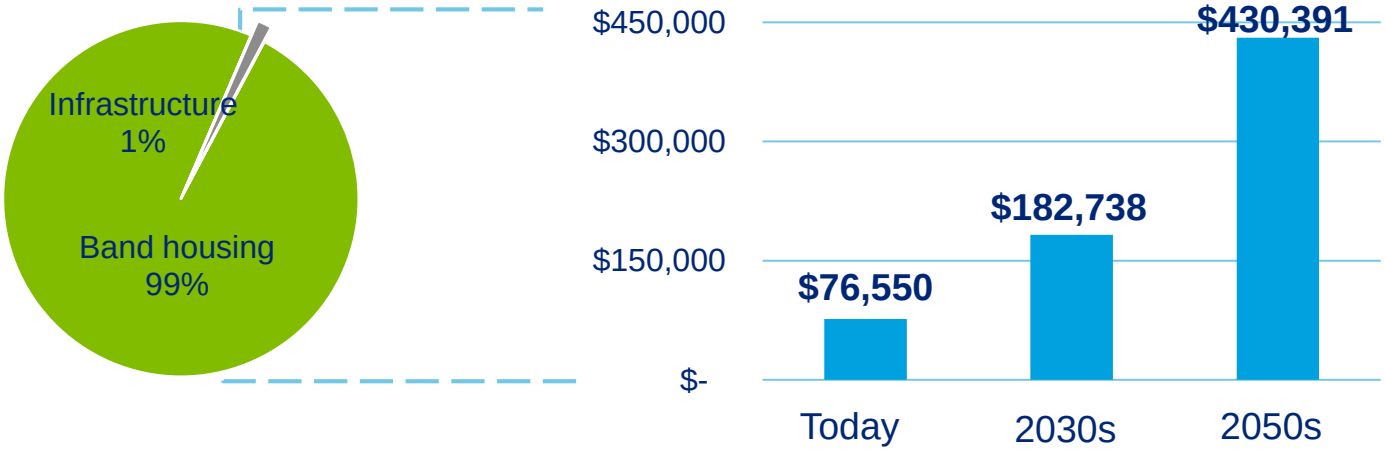
Source: Neegan Burnside (2015)

Benefits of adaptation CBA to decision-making (cont.)

Findings

- Annual Expected Loss (AEL) projected to double by 2030s and increase sixfold by 2050s without adaptation
- Band housing bears largest portion of future damage and loss
- Septic costs and structural building loss are today's main sources of costs; the share of building loss in total costs will increase

Right: Increased Annual Expected Loss (AEL) due to climate change
Left: AEL by asset type

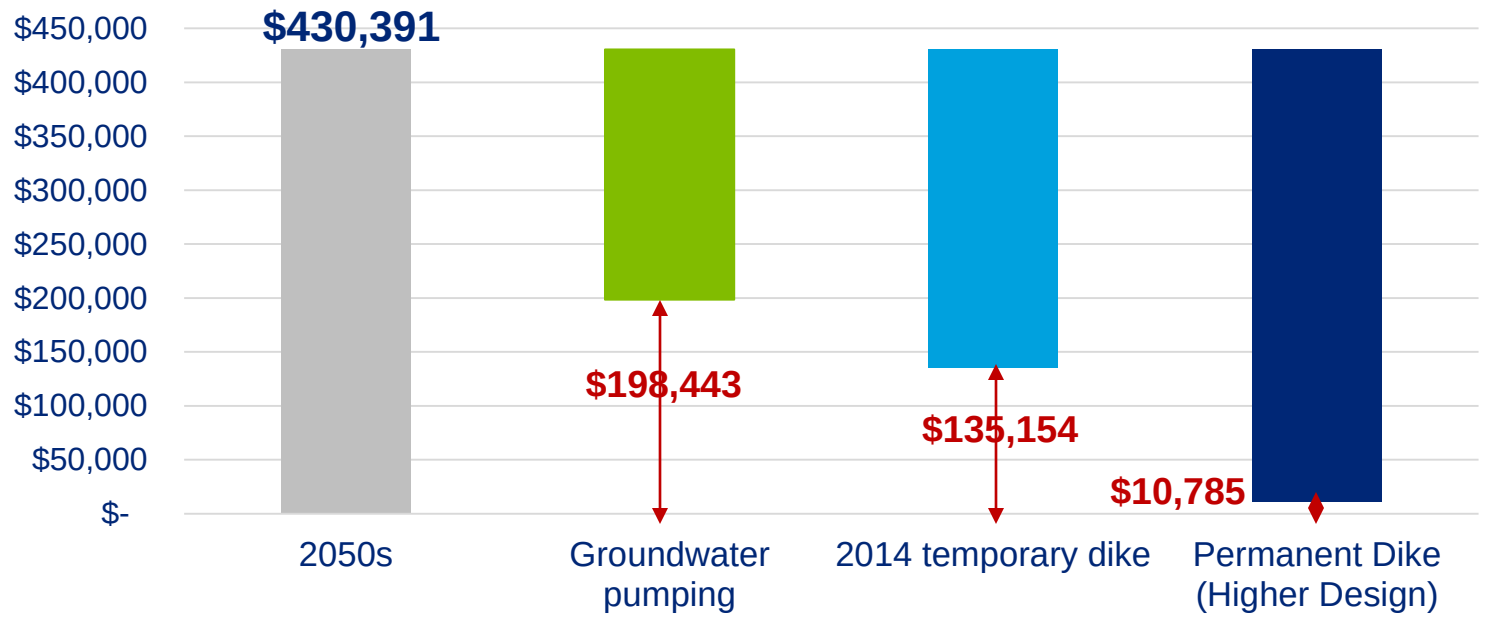


Source: Neegan Burnside (2015)

Benefits of adaptation CBA to decision-making (cont.)

Findings

Reduced Annual Expected Loss (AEL) after adaptation in the 2050s (coloured bars)



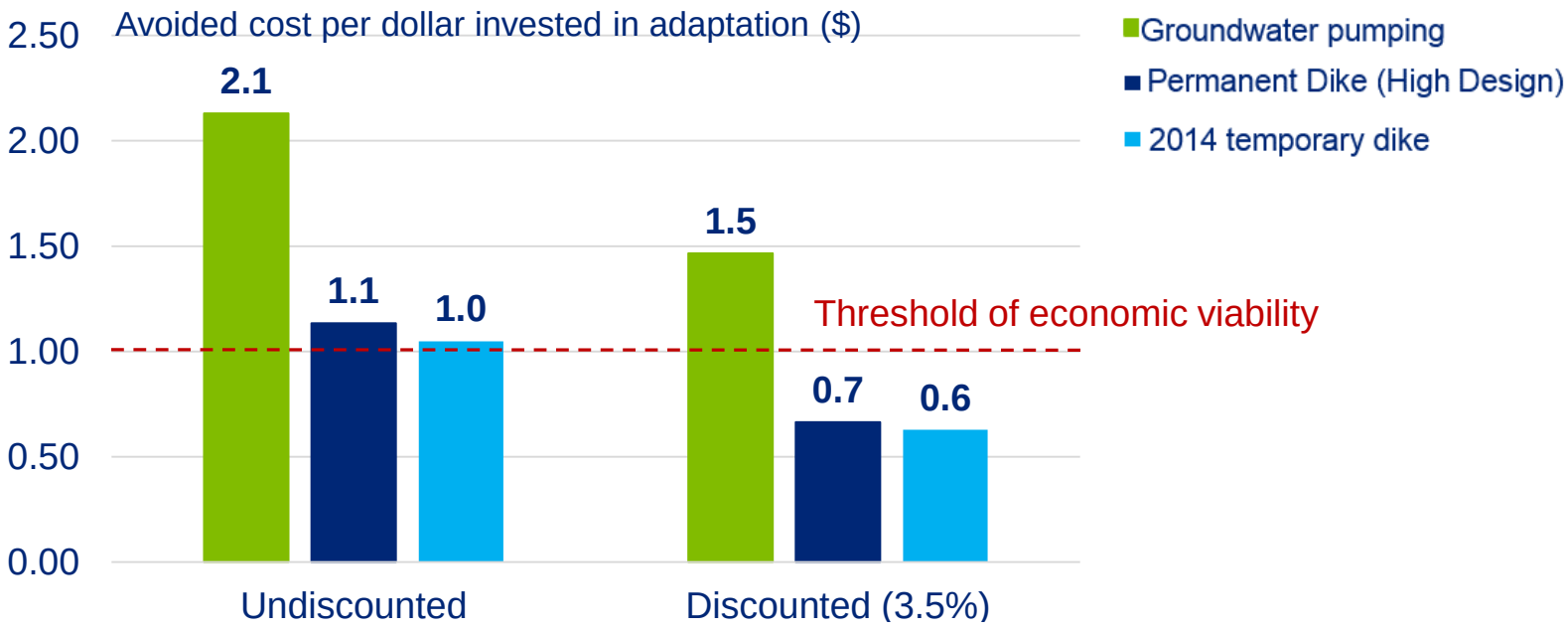
Implications for decision-makers

- Adaptation can reduce vulnerability to climate change by reducing future flood loss
- Building a permanent dike can protect the community almost entirely through to the 2050s; but at what cost? Is it the most economically sound decision?

Benefits of adaptation CBA to decision-making (cont.)

Findings

Adaptation Benefit-to-Cost ratios (out to the 2050s)

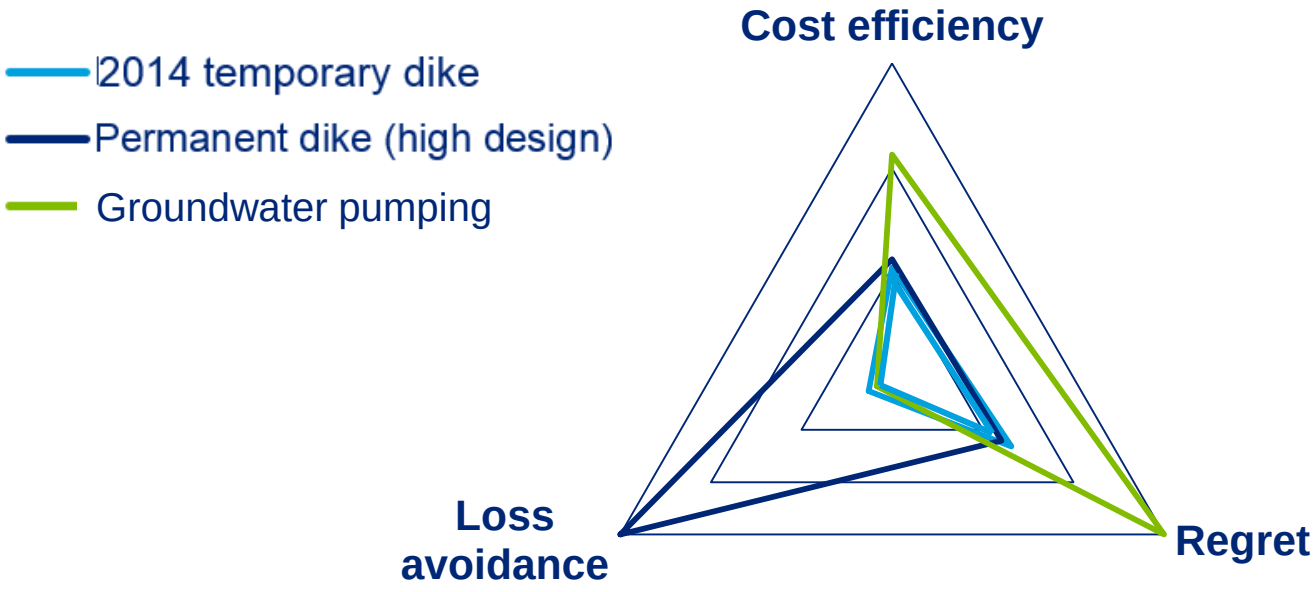


Implications for decision-makers

- Each dollar invested in the 2014 temporary dike will only save 60 cents between now and 2055 (at a 3.5% discount rate)
- Other adaptation solutions could achieve more ‘bang for the buck’

How to use CBA in long-term community planning

- Climate change adaptation CBA provides several indicators for making sound long-term planning decisions:
  - ☑ **Based on loss avoidance**, permanent dike stands out as the best option
  - ☑ **Based on cost-efficiency**, other solutions have more ‘bang for the buck’
  - ☑ **Based on regret** lower cost solutions are more attractive

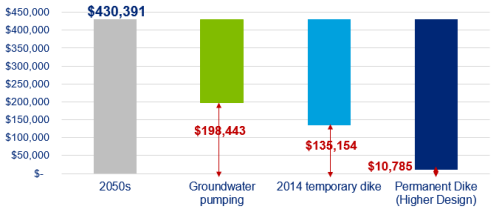


Climate adaptation CBA as an essential tool to long-term community planning

HOW TO FACTOR CLIMATE CHANGE in long-term, costly planning decisions?

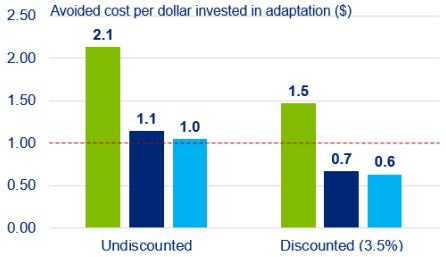
HOW TO MAKE THE RIGHT ADAPTATION DECISION?

- Consider expected loss and damage before and after adaptation



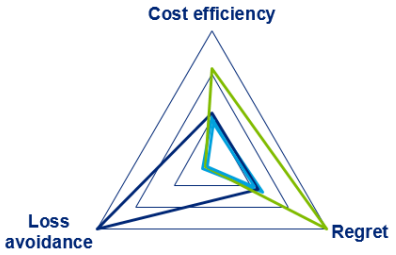
HOW TO KNOW if adaptation will achieve value for money?

- Consider its discounted Benefit-to-Cost ratio



HOW TO CHOOSE between different options?

- Decide what is important to you: maximizing 'the bang for your buck', minimizing loss or minimizing regret



For further details

- **Contact INAC Climate Change Adaptation Program:**

  Adaptation@canada.ca

- **Available resources**

  - Climate Change Adaptation Cost-Benefit Analysis Manual for First Nations
  - Pilot case study project reports
  - Links and references to publically available loss estimation tools and CBA spreadsheets

Adaptation solutions
Permanent dike

Lifecycle costs (2016-2055)

Low-design dike: $7M High-design dike: $7.7M

- Two flood protection standards are considered:
  - Low-design dike: Built in 2016 to protect against **TODAY'S 1/100 FLOOD LEVELS**
  - High-design dike: Built in 2016 to protect against **1/100 FLOOD LEVELS PROJECTED IN 2030s**; and assumes an **UPLIFT IN 2035** to protect against projected levels in 2050s (flexible design)
  - Both assume a 55-year useful life with annual maintenance costs worth 2% construction costs
- Flood protection standard of low-design dike will erode over time with rising floodwaters, whereas high-design dike is expected to protect Skownan out to the 2050s
  - Note: map on the right shows the areas that would be protected by the dike today

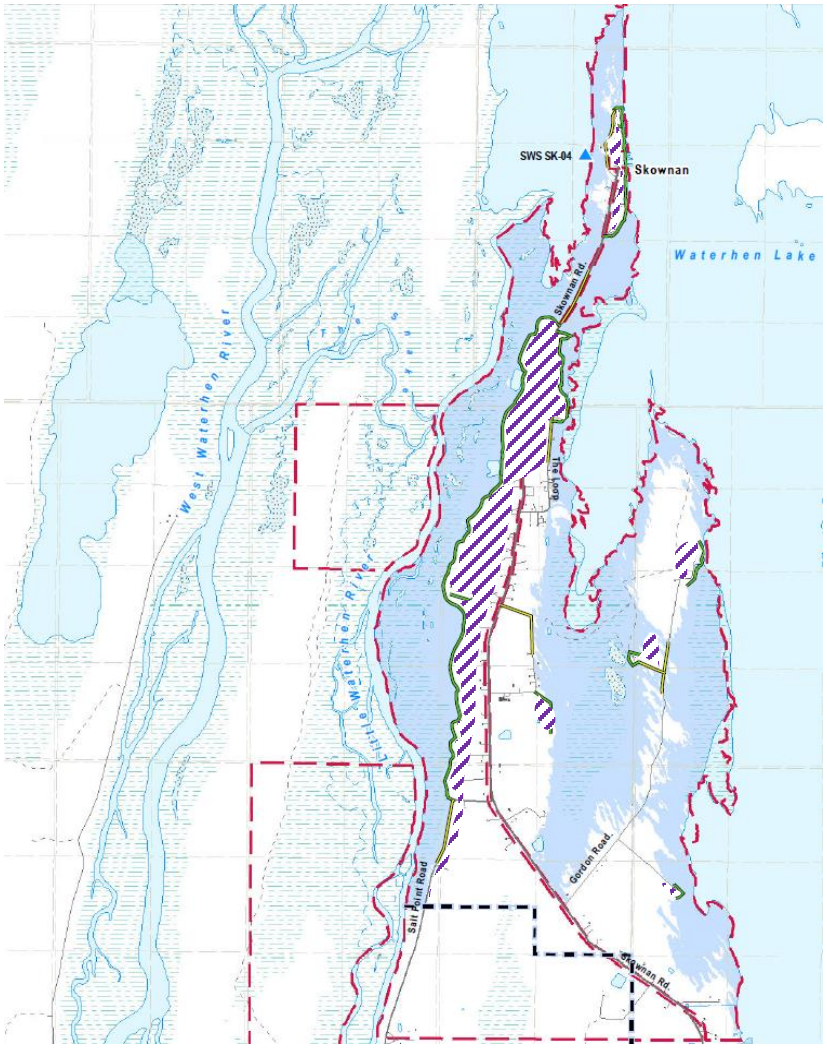
Reserve boundaries

Areas under water in 1/100-year flood

Planned permanent dike

Areas protected by the dike

Inundation map of First Nation today



Source: Neegan Burnside (2015)

Adaptation solutions

Groundwater pumping wells and detention basins

Lifecycle costs (2016-2055)

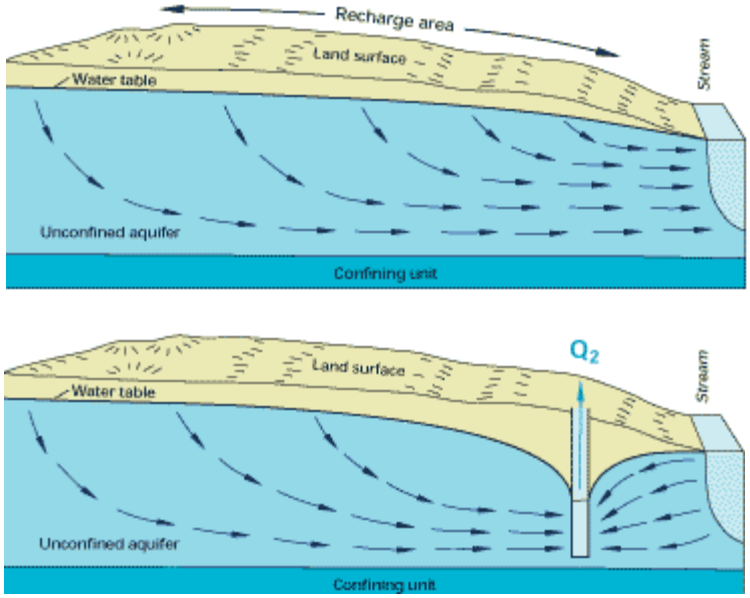
$3M

- FN may be able to reduce its vulnerability to peak river/lake flooding by reducing groundwater levels below river/lake levels (known as ‘stream depletion’)
  - Groundwater and rivers/lakes are interconnected around Skownan (there is an exchange of water whereby groundwater flows into nearby river/lake)
  - Groundwater can be pumped and temporarily stored in detention basins; this can lower groundwater levels
  - Stored water can be slowly released downstream or evaporated
  - Expected reduction in peak river/lake flooding and floodwater volumes by reducing groundwater discharge to river/lake; the exchange of water is reversed, and water now flows from river/lake into the aquifer
  - Environmental engineering assessment is needed to confirm the feasibility and effectiveness of this solution in the First Nation

Effect of groundwater pumping on river/lake levels

Top image: Groundwater level is higher than river/lake, and groundwater flows into river/lake (today’s situation)

Bottom image: Pumping can drop groundwater levels below lake/river levels, and river/lake levels drop because water flows towards aquifer (possible situation after adaptation)



Source: See http://www.water.ca.gov/groundwater/groundwater_basics/gw_sw_interaction.cfm and http://pubs.usgs.gov/circ/circ1186/html/gw_effect.html (2015)