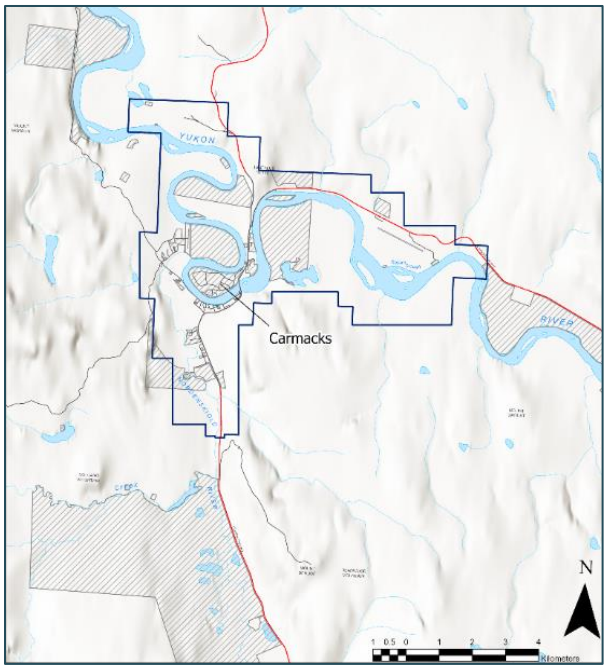
Carmacks flood hazard mapping



Mapped areas of interest *(outlined in dark blue) Identified with input from Government of Yukon and Little Salmon / Carmacks First Nation.*

What are flood maps and why are they useful?

Flood maps are prepared by engineers and show an area that may be covered by water or where water reached during a past flood event. These maps describe the level of flood hazard in different areas of a community.

The information produced through flood mapping studies can be used in the design of mitigation measures, emergency preparation, and community development planning. Final flood maps are publicly available for use by community members and all levels of government.

Mandate & funding

Mapping for communities at risk of flooding was established as an action in *Our Clean Future: A Yukon strategy for climate change, energy and a green economy*. Natural Resources Canada is supporting this work through the *Flood Hazard Identification and Mapping Program*.

Study timeline

Planning for flood mapping in Carmacks began in December 2022. The Government of Yukon hired Stantec Consulting Ltd. to complete the study, with input from the Little Salmon/Carmacks First Nation and the Village of Carmacks.

Here's how the work was completed:

- April 2023: Stantec hired; site visit completed.
- Summer-fall 2023: shoreline and riverbed surveying; background analysis; hydrologic and hydraulic modelling; mapping.
- Winter 2023-2024: public engagement on draft maps; preparing final deliverables.
- June 2024: final maps and reporting completed and shared with the public.

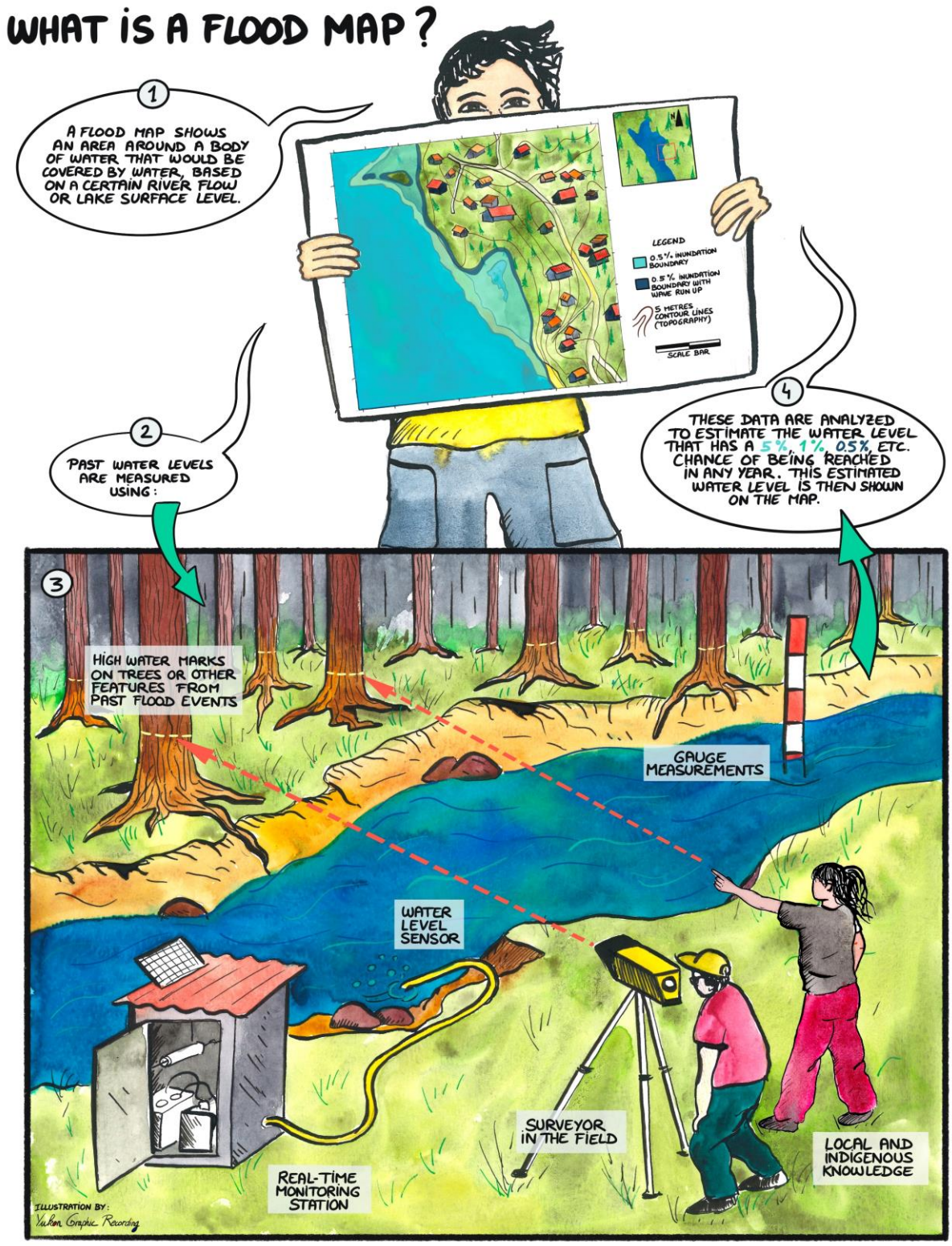
Community involvement

The local community – including the Village of Carmacks and Little Salmon/Carmacks First Nation – were involved in the project from the start:

- Provided input into boundaries of mapped area of interest in late 2022.
- Involvement in information gathering regarding historical floods and helping field surveys in spring and summer of 2023.
- Draft maps were shared online and a public engagement meeting was held (in-person and online) in January 2023 in Carmacks.

FOR MORE INFORMATION:
FloodMapping@yukon.ca / https://flood-atlas.service.yukon.ca/

WHAT IS A FLOOD MAP?



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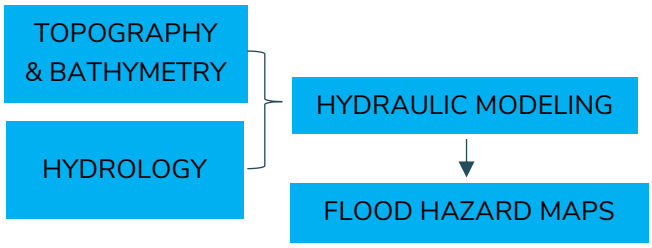
Carmacks study methods

Making a flood map

In order to make a flood map, topographic and bathymetric data (shape of the land and riverbed) are combined with hydrology data (flows in the river) in hydraulic modelling. The hydraulic modelling produces estimates of water levels and inundation extents for different river flows. Those water levels and inundation extents are illustrated on the flood maps.



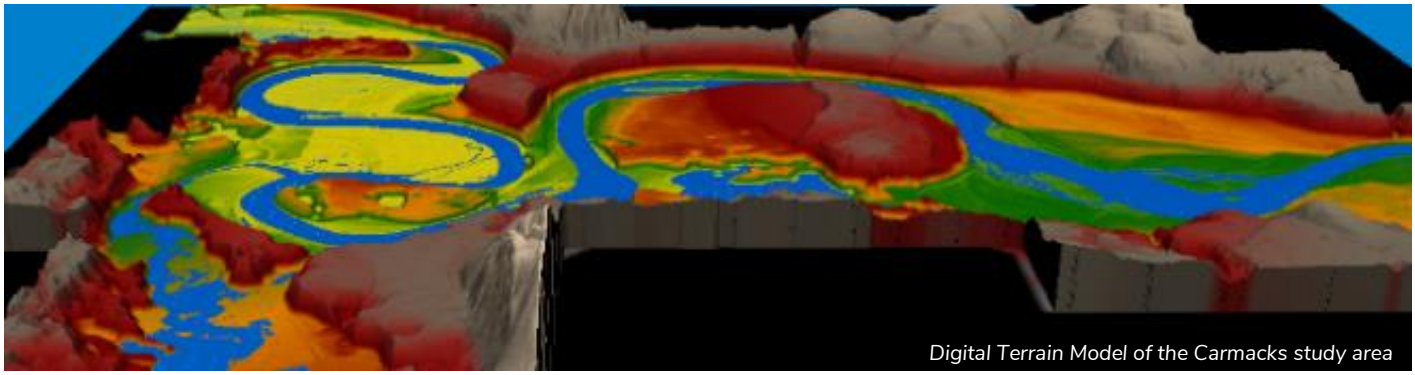
Topography & bathymetry

What is the shape of the land surrounding and underneath the river?

The surface terrain in the Carmacks area was surveyed in June 2019. Additional surveys on the Yukon River and Nordenskiold River were conducted in summer 2023 to collect river geometry data below the water surface for 9 km on the Nordenskiold River and 25 km on the Yukon River.

- Nordenskiold River: 60 cross-sections and 500 m of bathymetric data were collected.
- Yukon River: 29 cross-sections and 9 km of bathymetry data were collected.

This information provided the terrain input for the hydraulic modelling.



Digital Terrain Model of the Carmacks study area

Hydrology

What are the flood flows for each river?

Statistical analysis was completed to estimate the magnitude of extreme flood events on both the Yukon River and Nordenskiold River, using flow data from two Water Survey of Canada stations in the Carmacks area. This hydrologic analysis was completed for freeze-up, breakup, and open water conditions on both rivers using a specialized software program.

Open water conditions produce the extreme flood events on the Yukon River at Carmacks. Both breakup ice jams and open water conditions can produce extreme flood events on the Nordenskiold.

Understanding AEPs & return periods

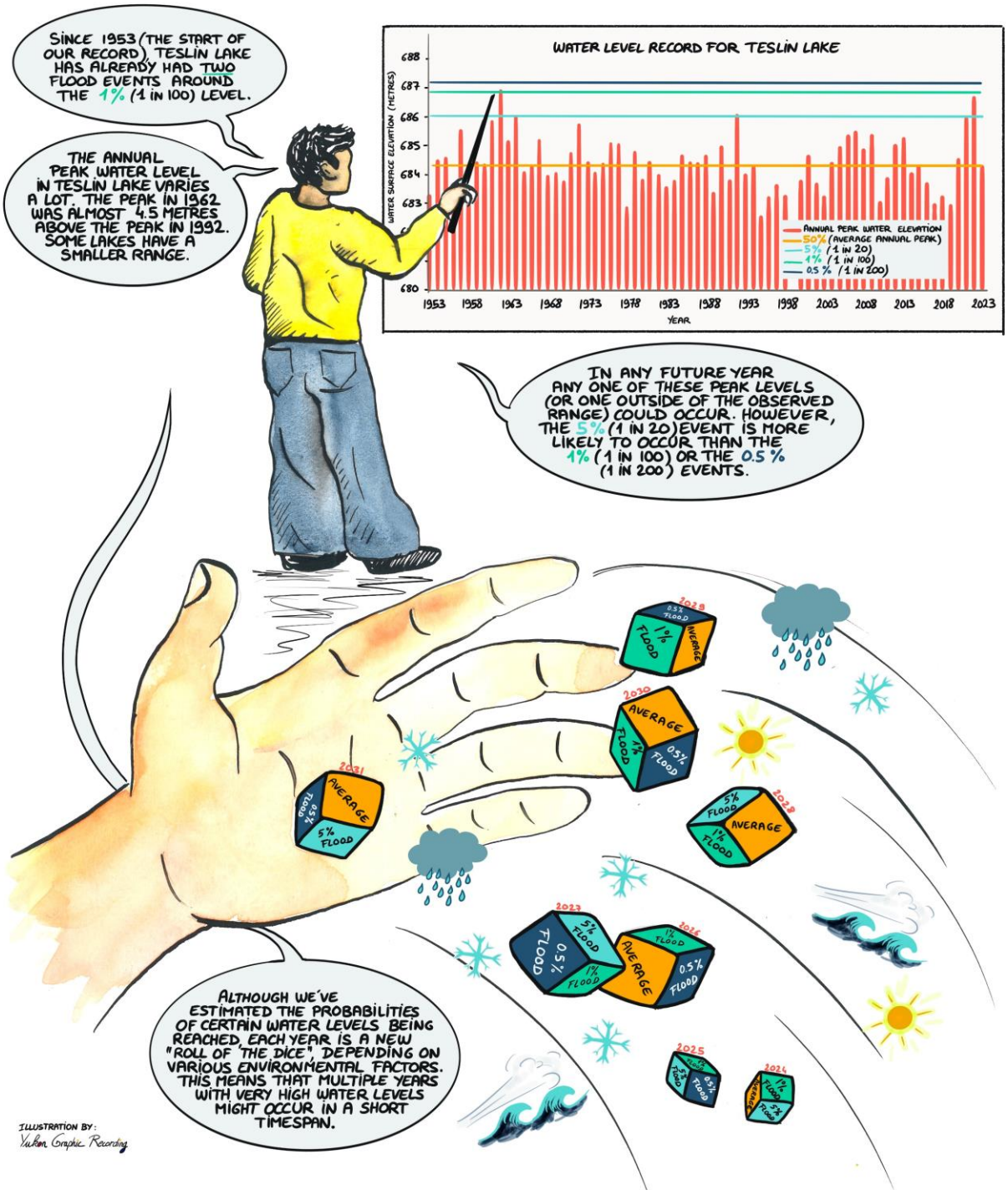
An annual exceedance probability (AEP) describes how likely a given flow is to occur or be exceeded within a single year. A return period is a different way of expressing the same thing. For example, the 1% AEP has a 1-in-100 chance of occurring or being exceeded in any given year – the same as a 1:100-year event.

The process for determining the river flows associated with the AEPs for each river is described in the following pages.

FOR MORE INFORMATION:
FloodMapping@yukon.ca / https://flood-atlas.service.yukon.ca/

UNDERSTANDING FLOOD PROBABILITIES

THE LIKELIHOOD OF THE WATER REACHING OR EXCEEDING A CERTAIN LEVEL IN ANY YEAR CAN BE DESCRIBED AS A PERCENT PROBABILITY. THESE PROBABILITIES ARE CALCULATED BASED ON RECORDS OF THE PEAK LEVEL REACHED IN PAST YEARS. LEARN MORE ABOUT FLOOD PROBABILITIES BELOW THROUGH THE EXAMPLE OF PAST FLOODING IN TESLIN.



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Hydraulic modelling

How high is the water in the river when flood flows and/or ice jams occur?

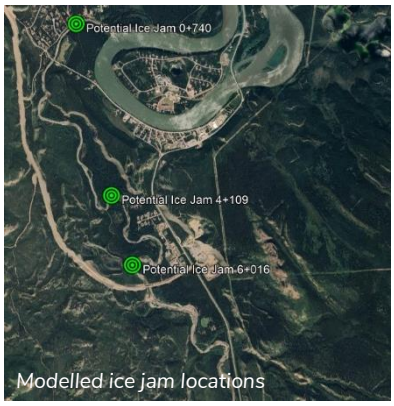
Hydraulic modelling was completed using analysis software to estimate water levels throughout the Carmacks Study Area. The hydraulic model took the terrain data and flows as inputs for the following AEP events, or flooding scenarios:

5% AEP 1% AEP 0.5% AEP

Based on historical review of flooding in Carmacks, the most extreme flooding in a given location for a given scenario could result from one of three different flooding processes: open water flooding on the Yukon River, open water flooding on the Nordenskiold River, or breakup ice jam flooding on the Nordenskiold River. The hydraulic modelling simulated all three flood processes for each scenario.

The breakup ice jam modelling on the Nordenskiold River considered ice jams at three locations in the study area where ice jams have been documented to occur:

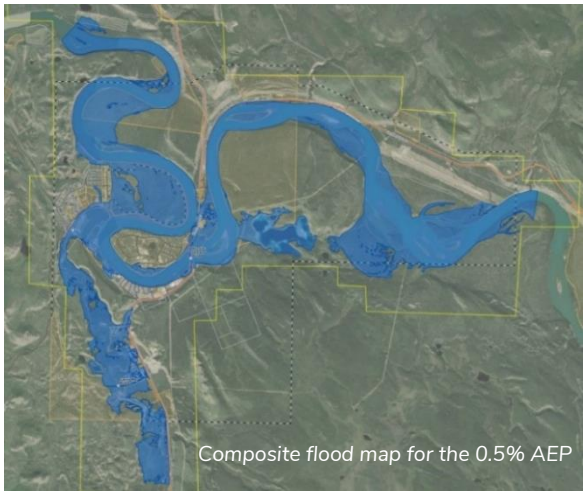
- 540 m downstream of the River Drive bridge
- 350 m downstream of Ptarmigan Road
- 420 m downstream of the Casino Way bridge



Modelled ice jam locations

Flood hazard mapping

For each AEP, or flooding scenario, a "composite flood map" adopted the outer extent of the inundations of the three flood processes that could cause flooding (open water conditions on the Yukon River, open water conditions on the Nordenskiold River, and breakup ice jam conditions on the Nordenskiold River). This approach meant that the flood maps show the overall flood extent associated with a given AEP, whether that flooding is from open water or ice jams.


Composite flood map for the 0.5% AEP

Community engagement provided opportunities for the public to review draft flood hazard maps and provide comments. Comments received regarding observed flooding extents and ease of interpreting the maps were used to finalize the maps. A What We Heard report is now available on Yukon.ca

What about changes to land & climate?

The project looked at changes to land cover – including potential future changes to vegetation type and forest fires – and determined that it was unlikely that these changes would increase flood flows.

Climate change effects forecasted in the Yukon River and Nordenskiold River catchments include warmer temperatures and increased precipitation. These effects are anticipated to increase flood flows between now and 2100. Therefore two additional sets of AEP flows were modelled to account for potential changes to flows under future climate conditions. The climate change scenarios considered a 10% increase to the Yukon River flow, and a 20% increase to the Nordenskiold River flow, for each of the 5% AEP and 0.5% AEP events. These increases were based on a review of hydrologic patterns, the projected changes to temperature, precipitation, and snowpack, and approaches to accounting for climate change used in other jurisdictions.

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