Flood Hazard Mapping of the Red River Valley

Andrew Weiss, M.Sc., P.Eng.
KGS Group

Kibreab Assefa, Ph.D., P.Eng.
Manitoba Transportation and Infrastructure

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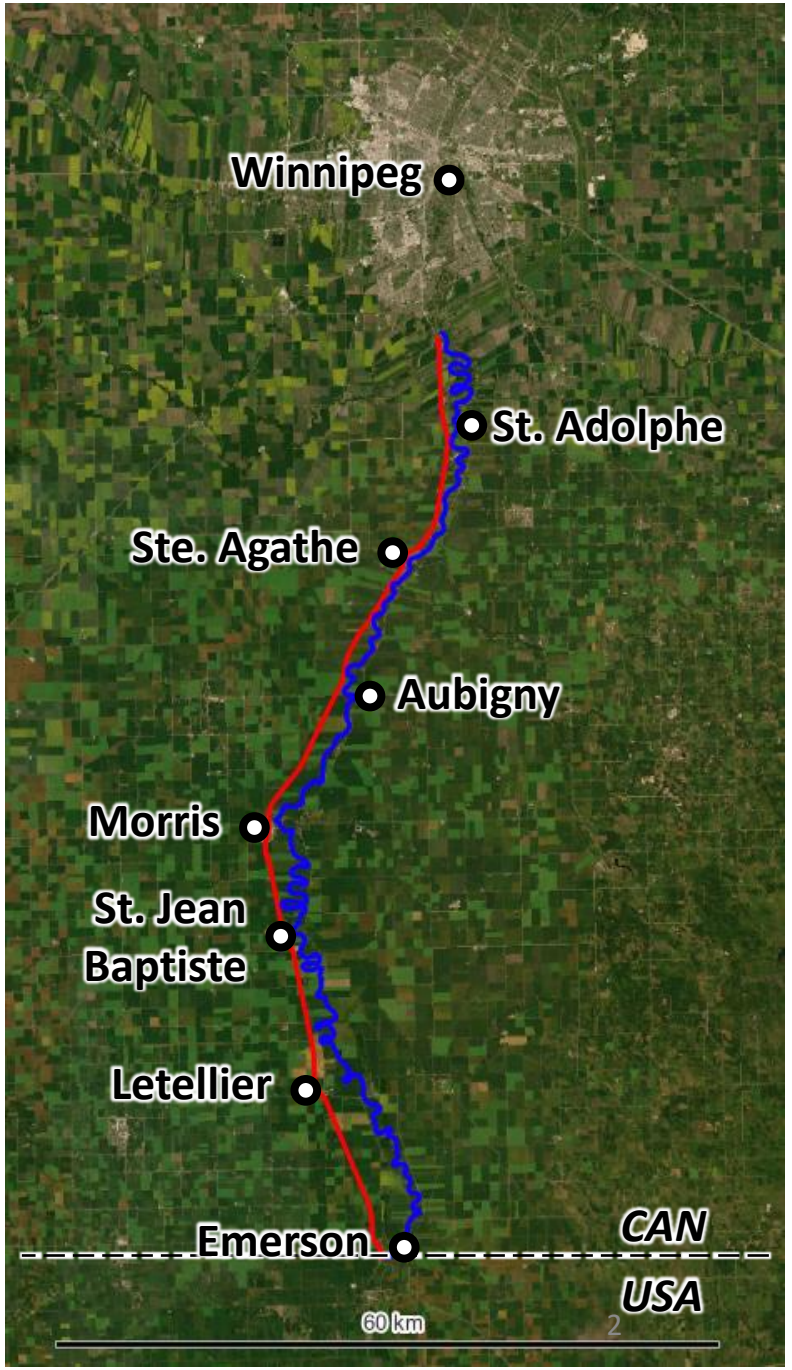
Background

- Flooding in the Red River Valley is a frequent occurrence resulting in impacts from nuisance flooding to significant damage and economic impacts to the Province
- Moderate to severe flooding can result in closures to PTH 75, which serves as a critical transportation link connecting Winnipeg to the United States, including most recently during the 2022 flood

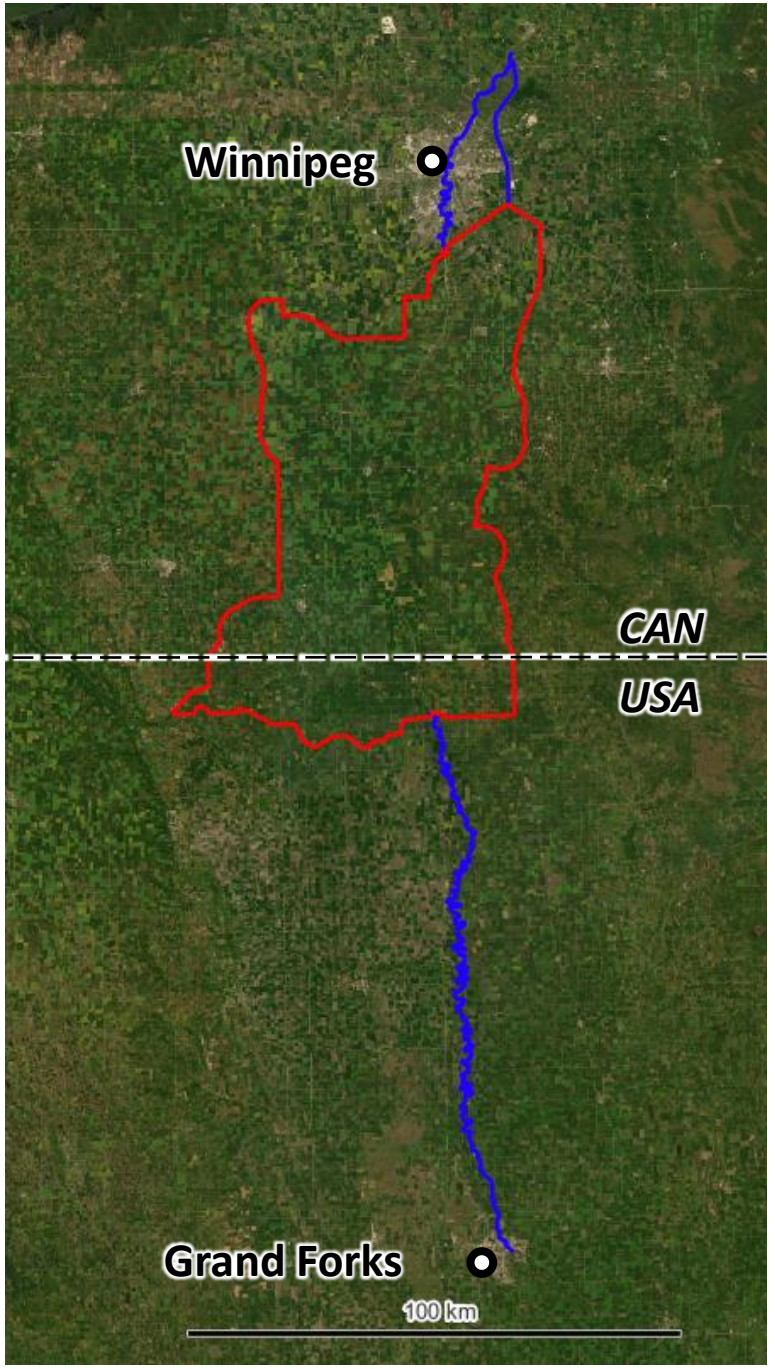


Background

- Given the frequent occurrence of flooding in the Red River Valley, as well as the extreme flooding that occurred in 1997, flood protection is well developed
- To better understand the performance of the flood protection infrastructure, as well as flood risk for more severe events, flood hazard modelling and mapping was completed

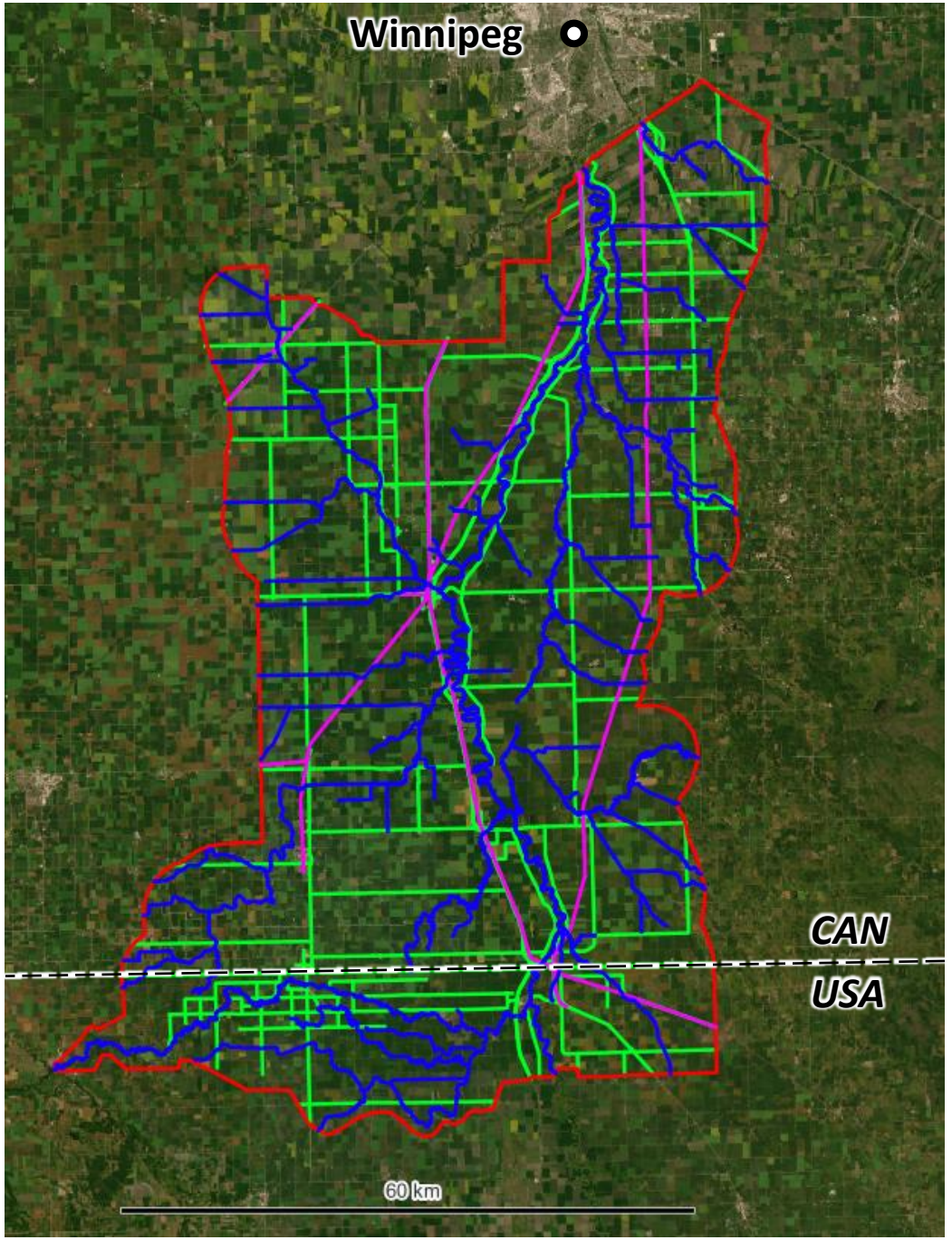
Model Domain

- Coupled 1D-2D-1D hydrodynamic model developed using DHI's MIKE FLOOD modelling software
  - 225 km of 1D Red River between Grand Forks and Pembina, ND
  - 65 km of 1D Red River in the City of Winnipeg
  - 30 km of 1D Red River Floodway
  - 4,700 km^2 of 2D Red River Valley between Pembina, ND and Winnipeg
- 2D model domain based on initial simulations of the 700-year flood



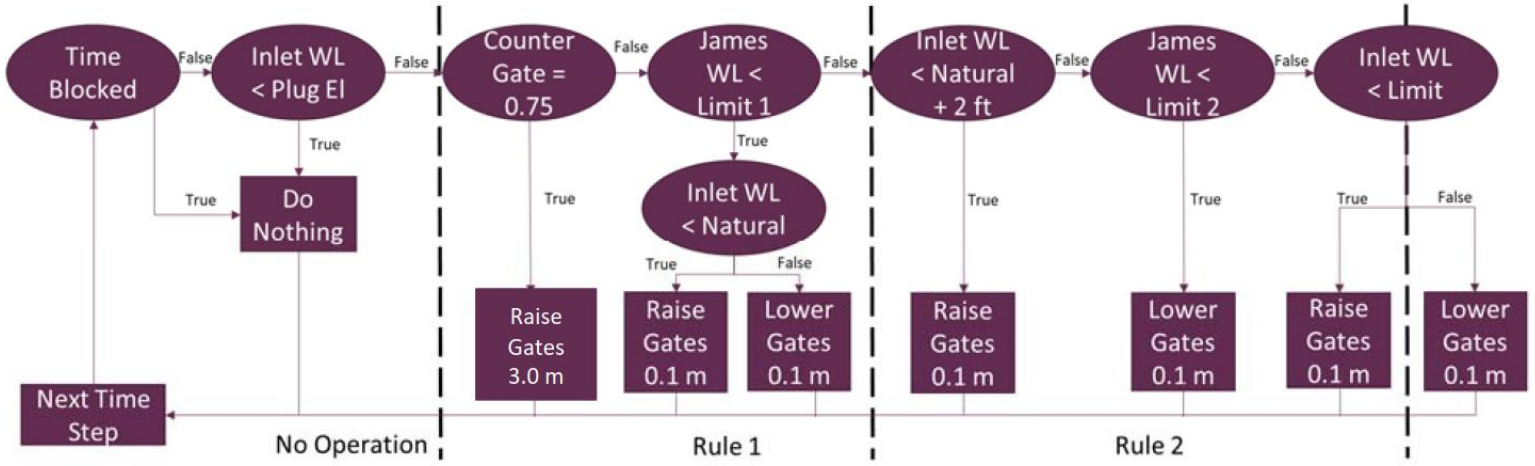
Model Development

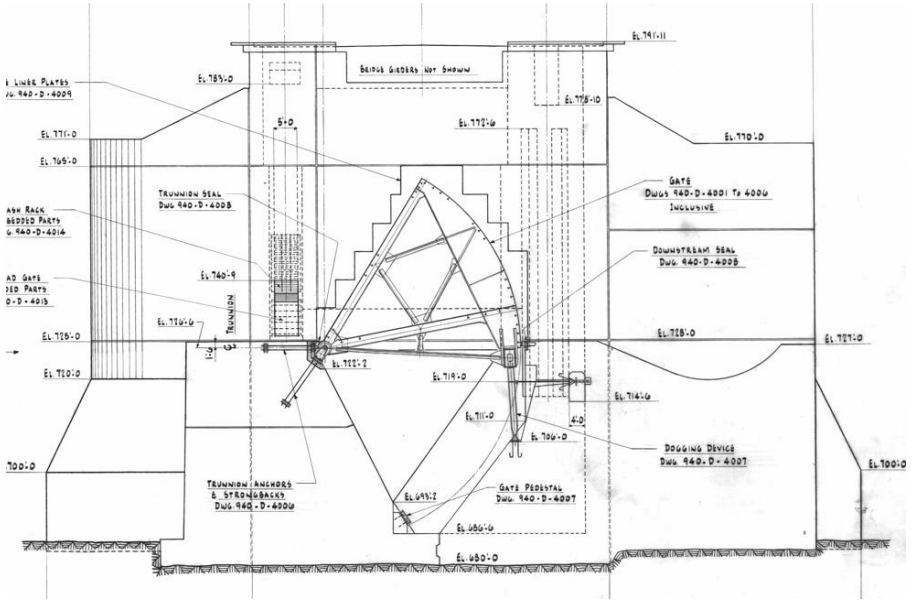
- Study was able to leverage previous model development completed by KGS Group for MTI
- Model development was largely focussed on the 2D domain
  - 285 km of rails
  - 580 km of roads
  - 1,865 km of waterways
  - 480 bridge and culvert crossings
  - 125 km of community dikes



Model Development

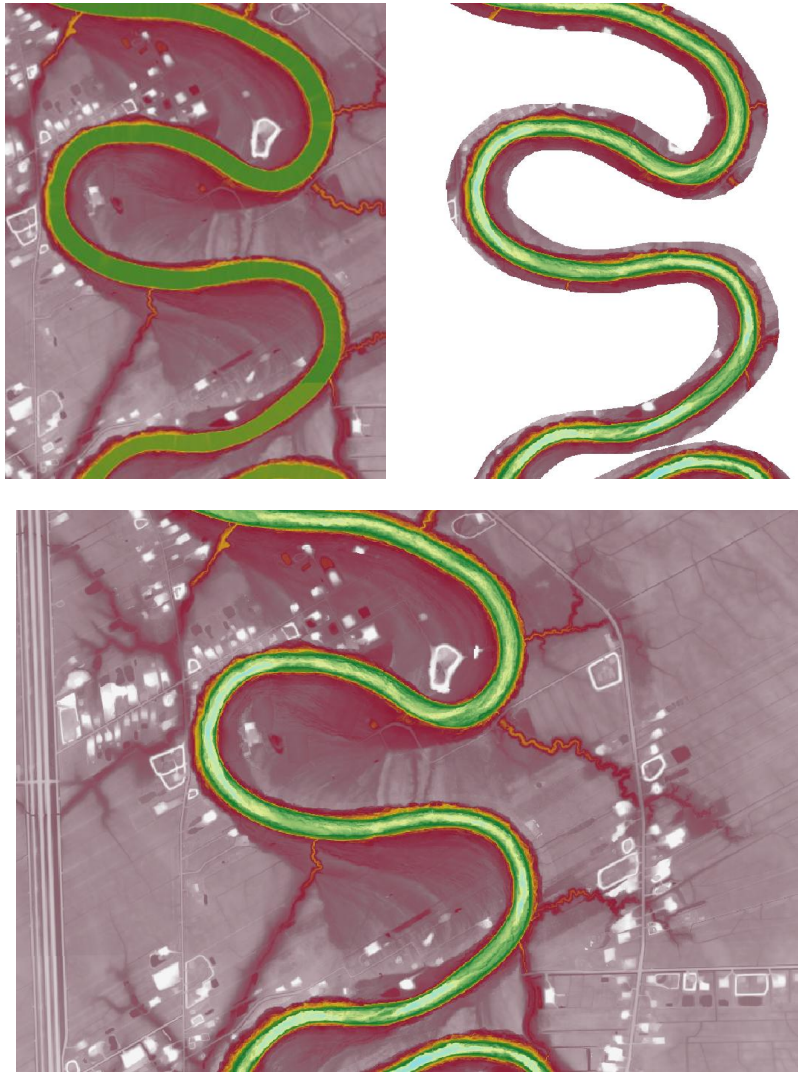
- Model also included an automated representation of the operation of the Red River Floodway Inlet Control Structure
- Considers defined natural and actual flows on the Assiniboine River in concert with simulated Red River flows and water levels to meet operating rules





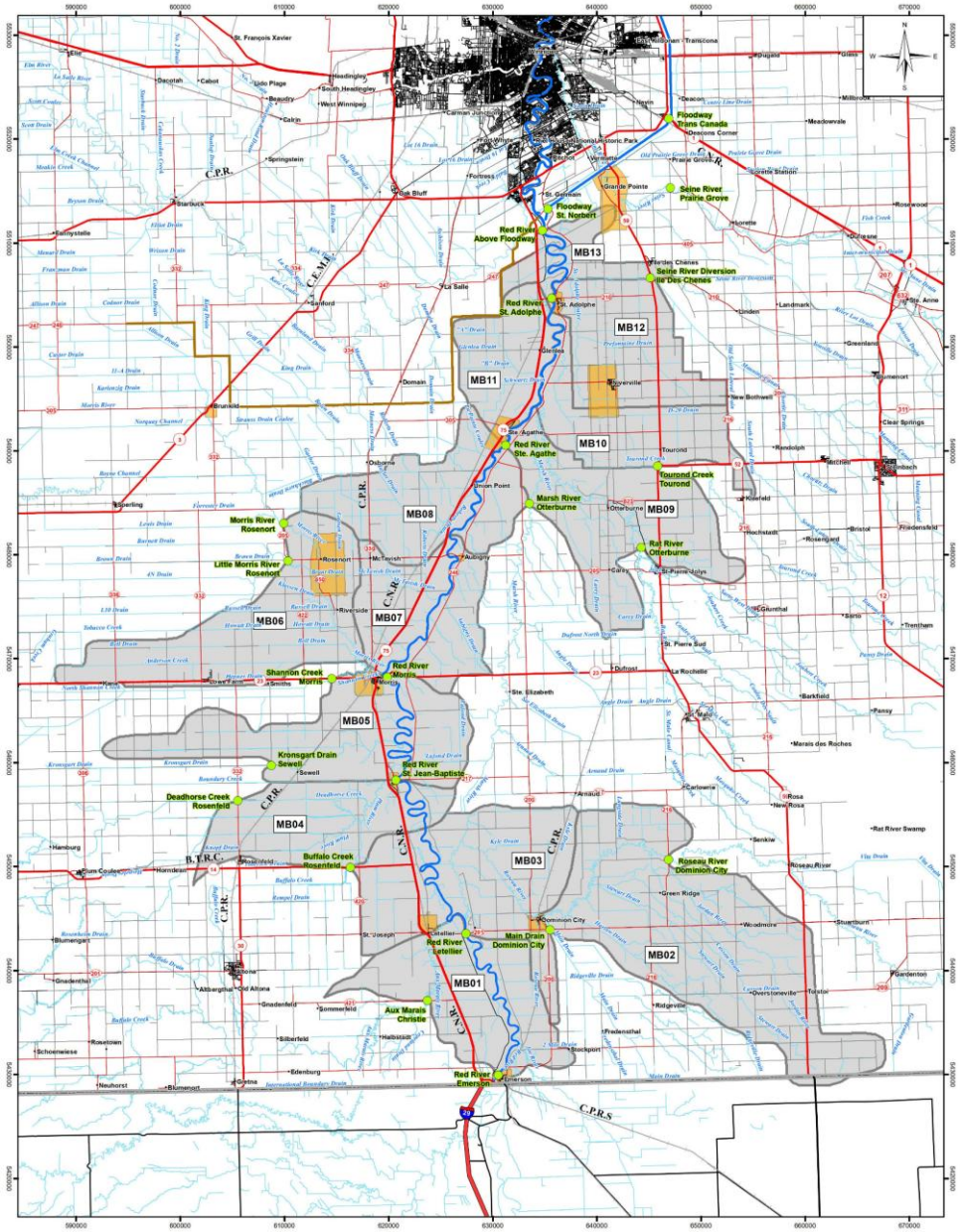
Digital Elevation Model Development

- LiDAR coverage throughout the 2D model domain collected by the Government of Manitoba
- Continuous bathymetric surface collected by MTI along the Red River from Emerson to Winnipeg
- Additional bathymetric data available on select tributaries
- All topographic and bathymetric data merged into a continuous, seamless DEM that was integrated into the MIKE model

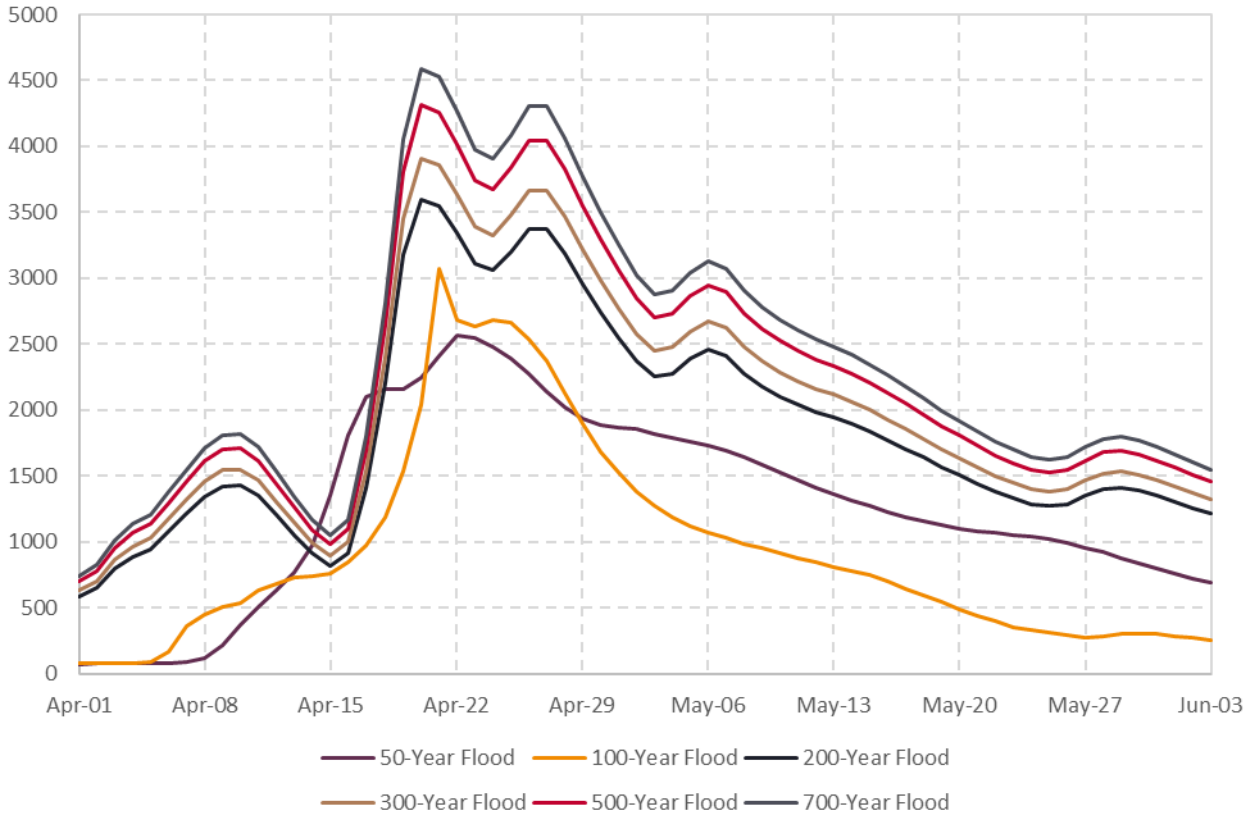


Hydrologic Analyses

- Inflows to the model defined by:
  - 19 inflow hydrographs in the 1D domain
  - 80 inflow hydrographs in the 2D domain
- Gauged inflows available on a relatively small number of waterways for calibration floods
- Calibration inflows on ungauged tributaries defined by proration
- Local inflows for calibration floods defined by regional unit hydrographs



Hydrologic Analyses

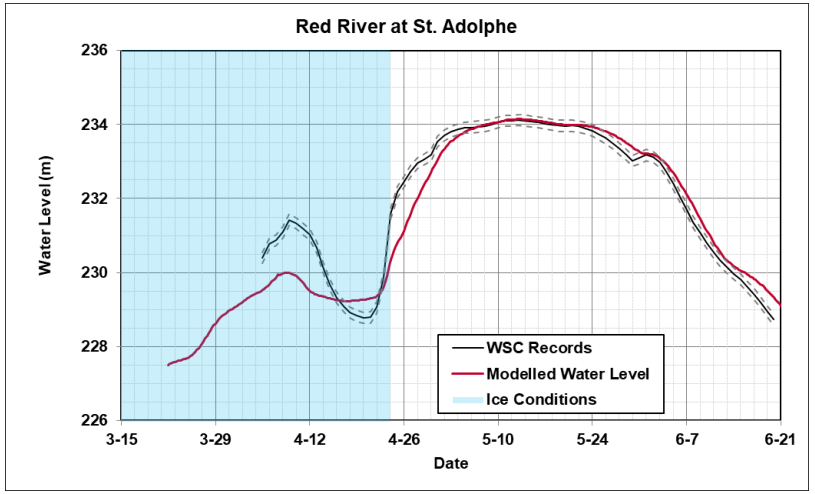


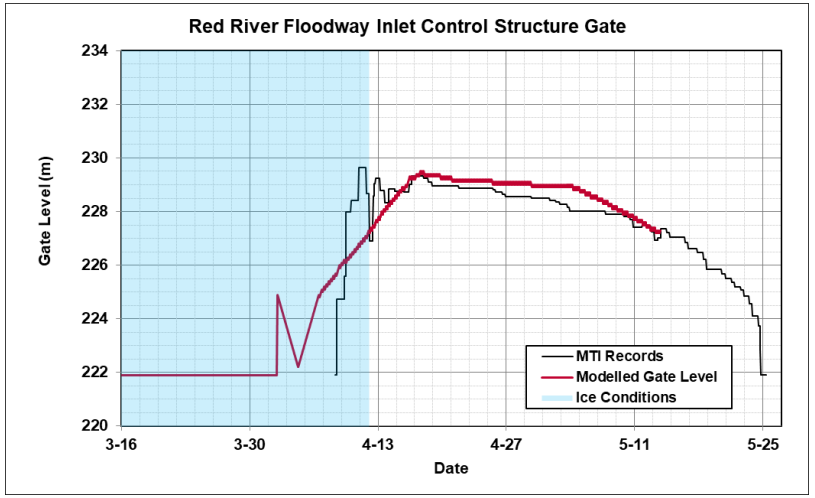
- Inflows for production runs defined by scaling historical flood events, and iteratively adjusting those inflows as necessary to meet target flows at Emerson and Winnipeg:
  - 50 and 100-year floods based on 2009 and 1997 flood events
  - 200, 300, 500 and 700 year floods based on 2022 flood event (i.e. rain-on-snow)

Model Calibration

- Model calibrated to the 2009 and 2022 flood events
- Model validated to the 2020 flood
- Model accuracy targets of +/- 0.15 m on peak water levels and +/- 5% on peak flows
- Considerable water level and flow data collected throughout the study area

Model Calibration

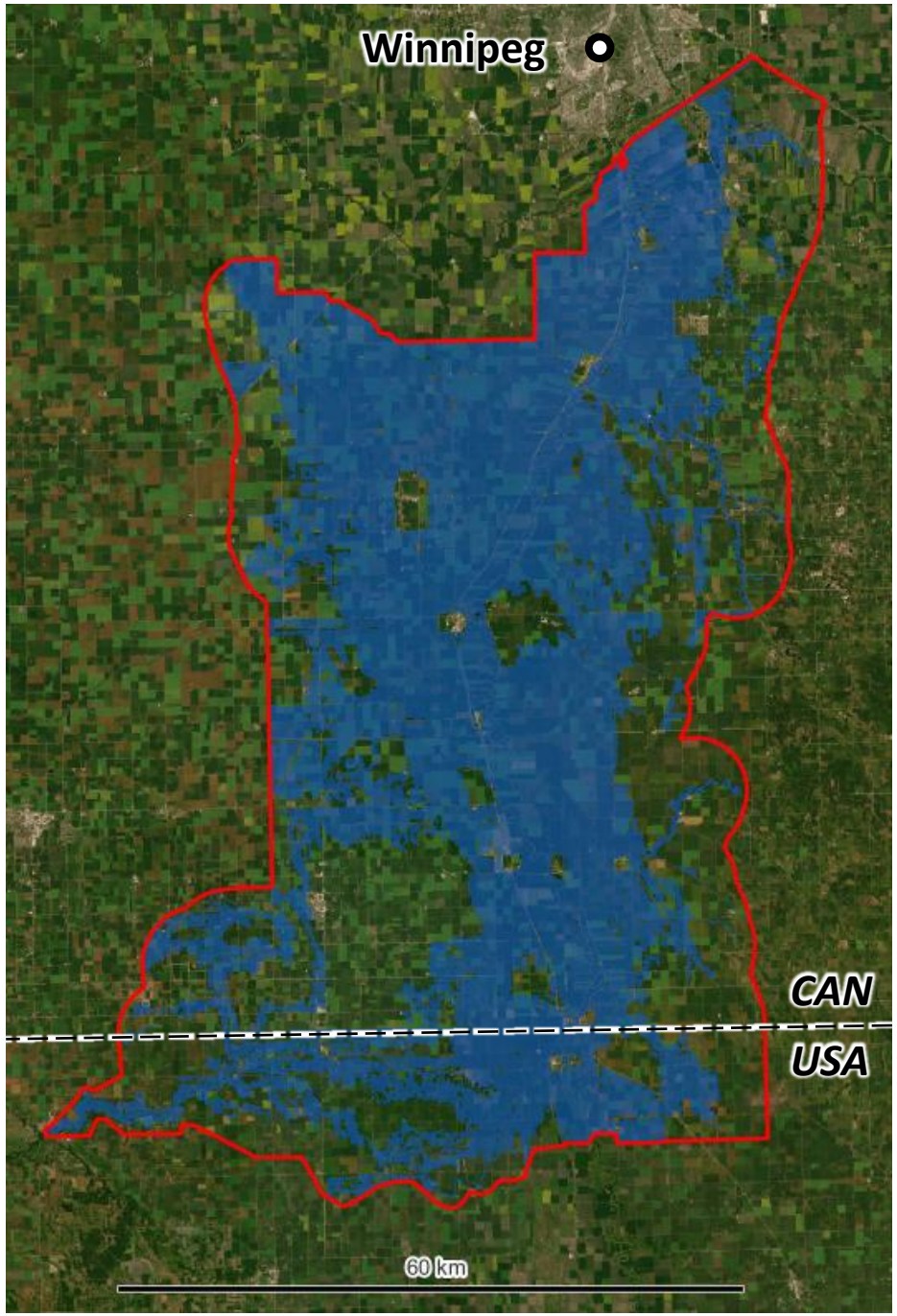




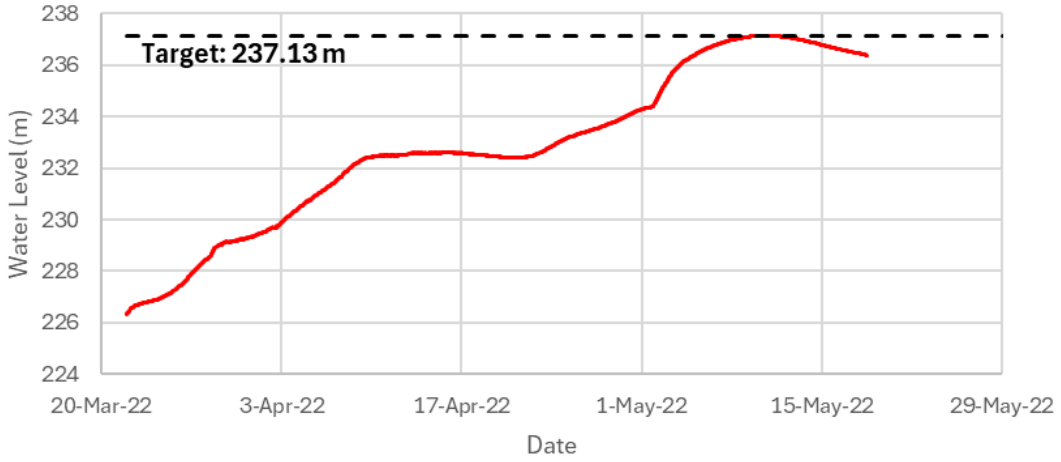
- Very good model representation of water levels and flows on the Red River main stem
- Acceptable model representation of water levels and flows on tributaries
- Good representation of surveyed floodplain water levels
- Very good representation of Red River Floodway operations, although slight bias to conveying more flow through Winnipeg than in reality

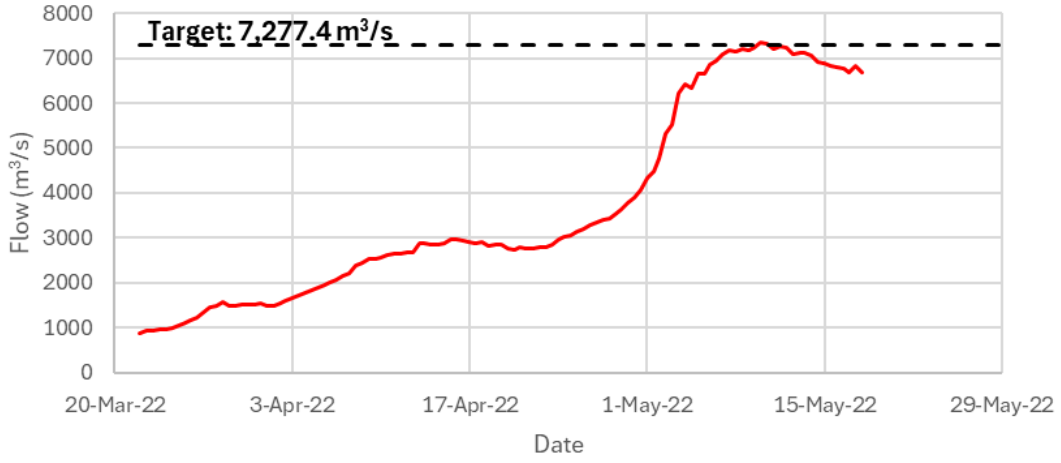
Production Run Simulations

- Production run simulations were completed for flood events ranging from the 50-year flood to the 700-year flood
- Some iterative adjustments required to inflows to match anticipated flood levels at key locations through the study domain



Production Run Simulations

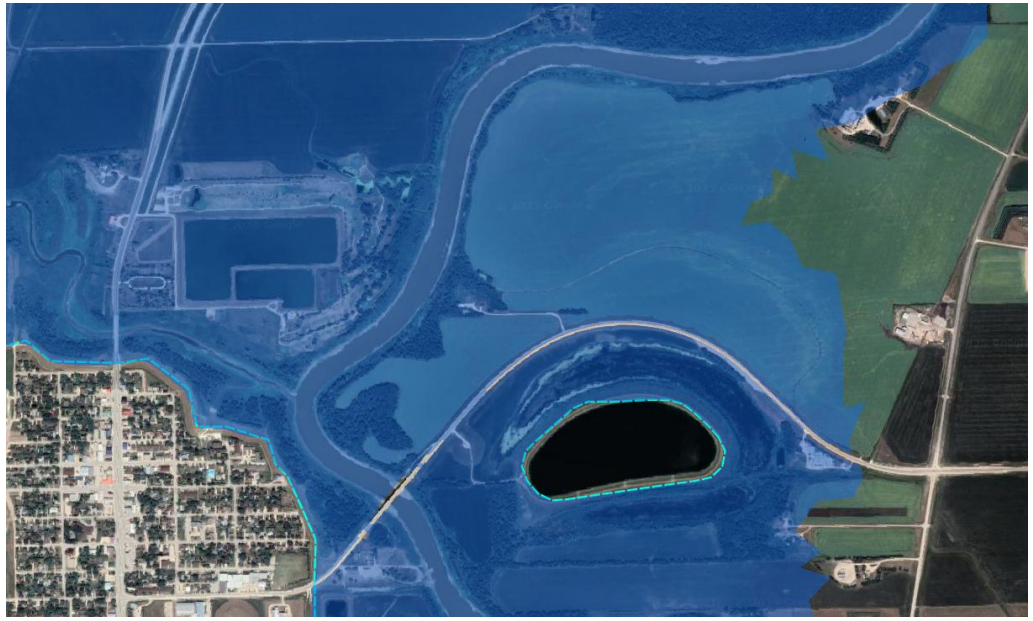


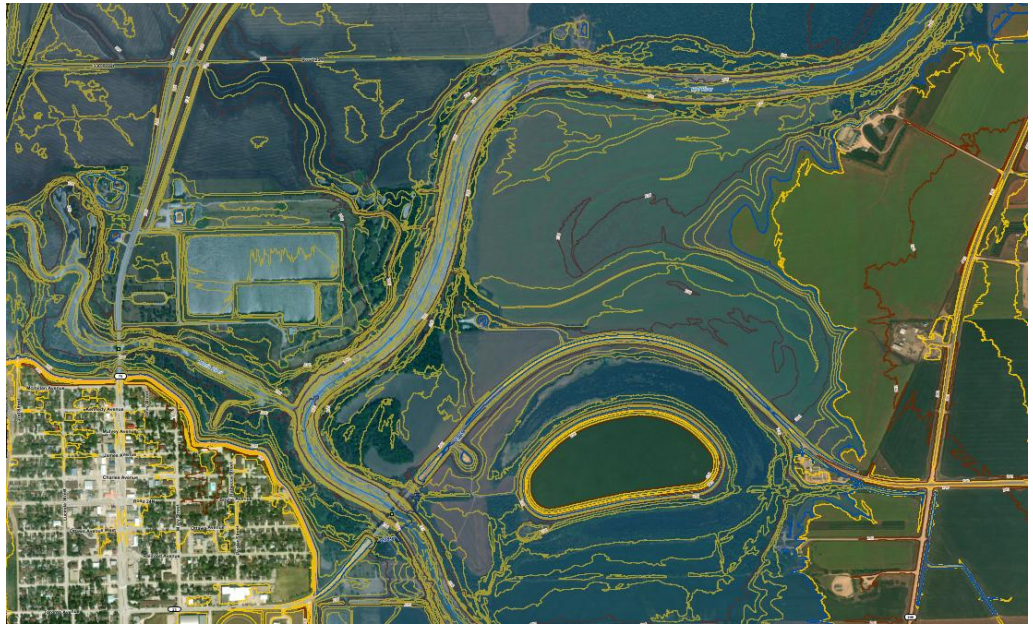


- MTI completed a Monte Carlo analysis to understand the range of water levels at the Red River Floodway Inlet given a range of inflow conditions
- Target water levels and flows were defined at the Red River Floodway Inlet, while target flows were defined at Emerson
- Simulated water levels were within 0.05 m of targets, while simulated flows were within 3% of targets

Flood Hazard Maps

- 250 flood hazard maps prepared for the Red River Valley for the 200-year flood event
- Considerable challenges converting flood extents defined by the MIKE FLOOD model mesh to flooding defined by the intersection of flood levels and the DEM





Next Steps

- Flood mapping data will inform flood hazard across a broad range of flood events
- Flood infrastructure to be reviewed against simulated flood levels to evaluate adequacy for severe flood events
- Flood hazard data will enhance Manitoba's flood mitigation and emergency response

Questions?

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Thank you!

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