Alberta's River Forecast Centre: Innovations and Upgrades

Floodplain Mapping Workshop

March 6, 2018

Evan Friesenhan, M.Eng., P.Eng.

Alberta Environment and Parks

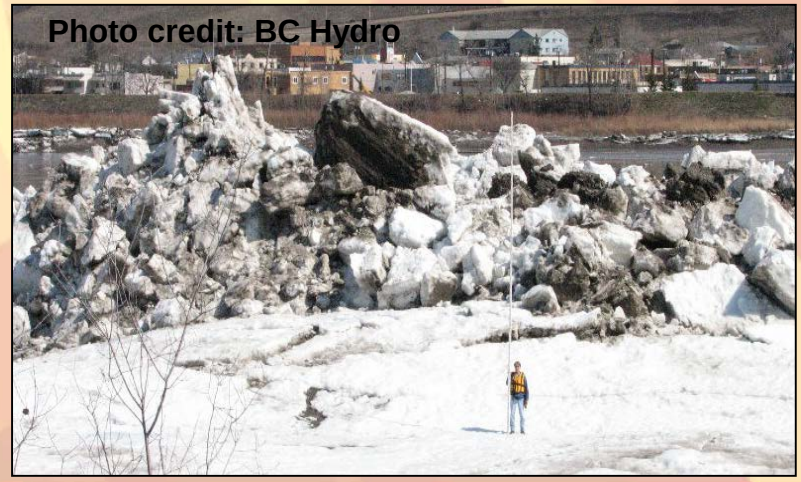
Outline:

- Upgrades
  - Tech Upgrades
  - Water Supply Forecasting
  - PMF's and Creager's Plot
- Innovations
  - Clipping Weather Model Data (WMAT, NOAA)
  - Alberta Basins App (new functionality)
  - New Webapp
  - Serious Gaming
- Future Upgrades
  - Forecast Model Studies
  - Platform Prototypes

Alberta

River Ice Monitoring

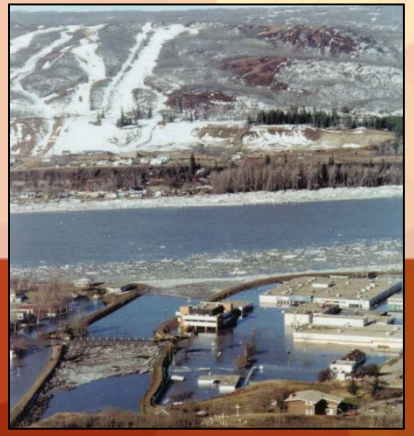
- Ice jams are natural events, and occur on many rivers in Canada
- Ice jams can form during:
  - Freeze-up
  - Mid-winter breakup
  - Spring breakup
- The location and occurrence of ice jams, and possible associated flooding, are unpredictable
- No operational models capable of forecasting specific ice jam events
- The River Forecast Center monitors ice conditions throughout the province
  - Water levels and flow
  - Weather forecasts
  - Satellite images
  - Aerial and ground observations
  - Remote cameras
  - Modelling



Alberta

Hazard Mapping for Ice Affected Rivers

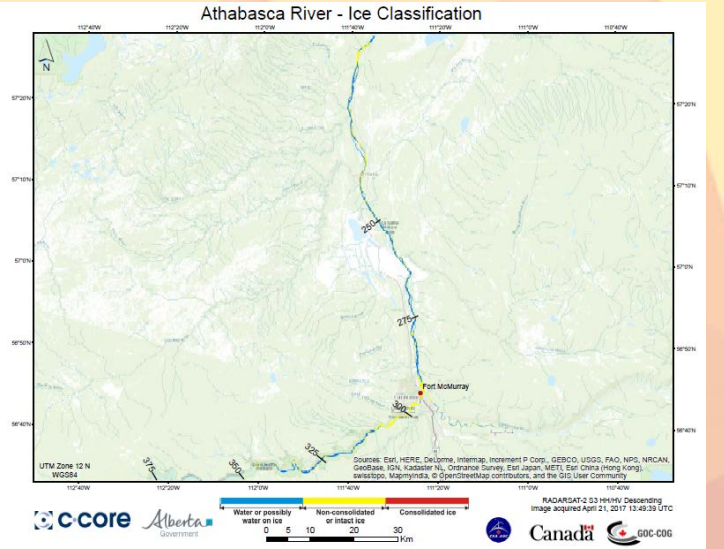
- The GOA produces flood hazard maps
- Most focus on open-water flood events, but ice jam floods are considered in areas with known ice jam flood history
- Ongoing studies in Peace River, Fort McMurray and Cochrane
- Need to reflect the relevant river flood hazard in communities
- Ice jam hazard studies look at:
  - Historical events
  - Statistical approach to determine recurrence intervals (based on water levels, not flows)
  - Hydraulic (and other) models used to generate flood profiles
  - Mapping products can be used for :
    - emergency management (inundation maps)
    - land use planning purposes (flood hazard maps)



Alberta

Upgrades: Technology (Ice)

- Satellite images to classify ice cover types
- New modelling efforts (fuzzy logic, CRHM)
- Remote cameras for ice observation
- GPS enabled tablets for aerial observation flights
- Partnered on project to test real-time inundation mapping using satellite-derived ice condition model inputs



Alberta

Upgrades: Technology (Open Water)

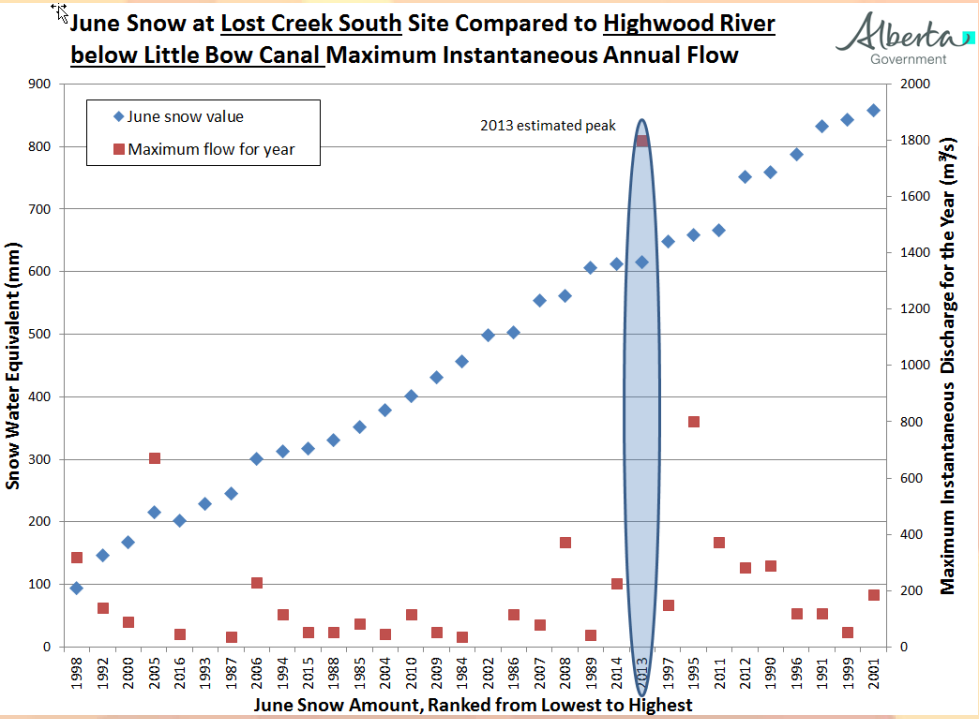
- 8 multi configurable screens in the ops room
- 4 multi configurable screens in the planning room
- 1 interactive projection screen in the planning room
- Used to show:
  - Radar
  - Weather Channel (2 cable boxes)
  - Dam Outflows
  - Model Runs
  - Precipitation Maps
  - Twice daily AAF Weather Briefings
  - General Data

Alberta

Upgrades: Water Supply Forecasting

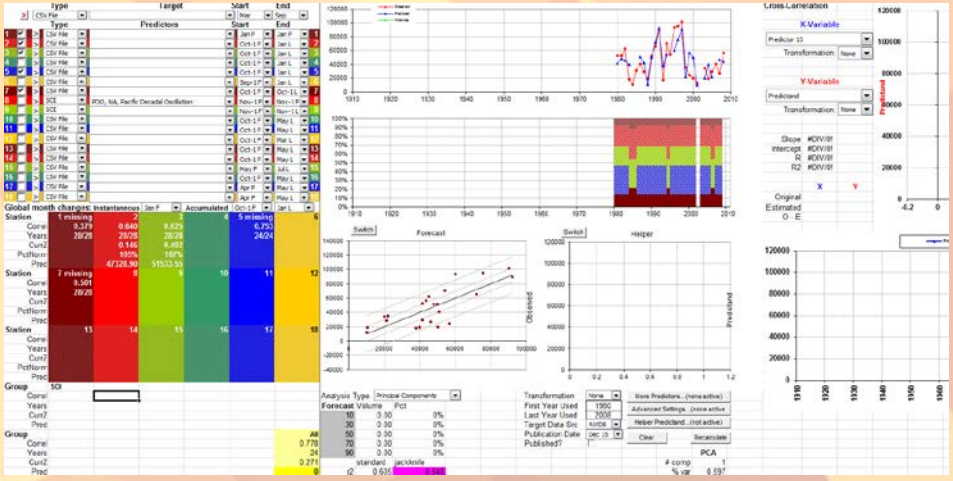
Goal: Forecast the March to September flow volume for 20 locations in the province, starting in February

- A more robust and defensible method was required
- Choosing a method is complicated by two issues
  - Long range quantitative forecasts are hard to come by (used in Hydrological process models)
  - In Alberta the snow pack is only a contributing factor to an annual flow volume – summer precipitation (too much or too little) can ruin a good forecast (Statistical Regressions)



Upgrades: Water Supply Forecasting

- Principle Component Regression Models were developed using the **VIPER** (Visual Interactive Prediction and Estimation Routines) Model developed by the US Natural Resources Conservation Service
- Five models were created for each forecast point giving the forecasters flexibility in the forecast chosen depending on none regression components such as soil moisture
  - Excluding high years
  - Including high years
  - Including an estimate for summer precipitation
  - Best Z score (alt test method)
  - No month to month consistency in predictor selection



Alberta

Upgrades: Water Supply Forecasting

- Model uncertainty is expressed by presenting the ‘probable range’ and ‘potential minimum’ as % of average

Water Supply Outlook for Alberta
February 2018

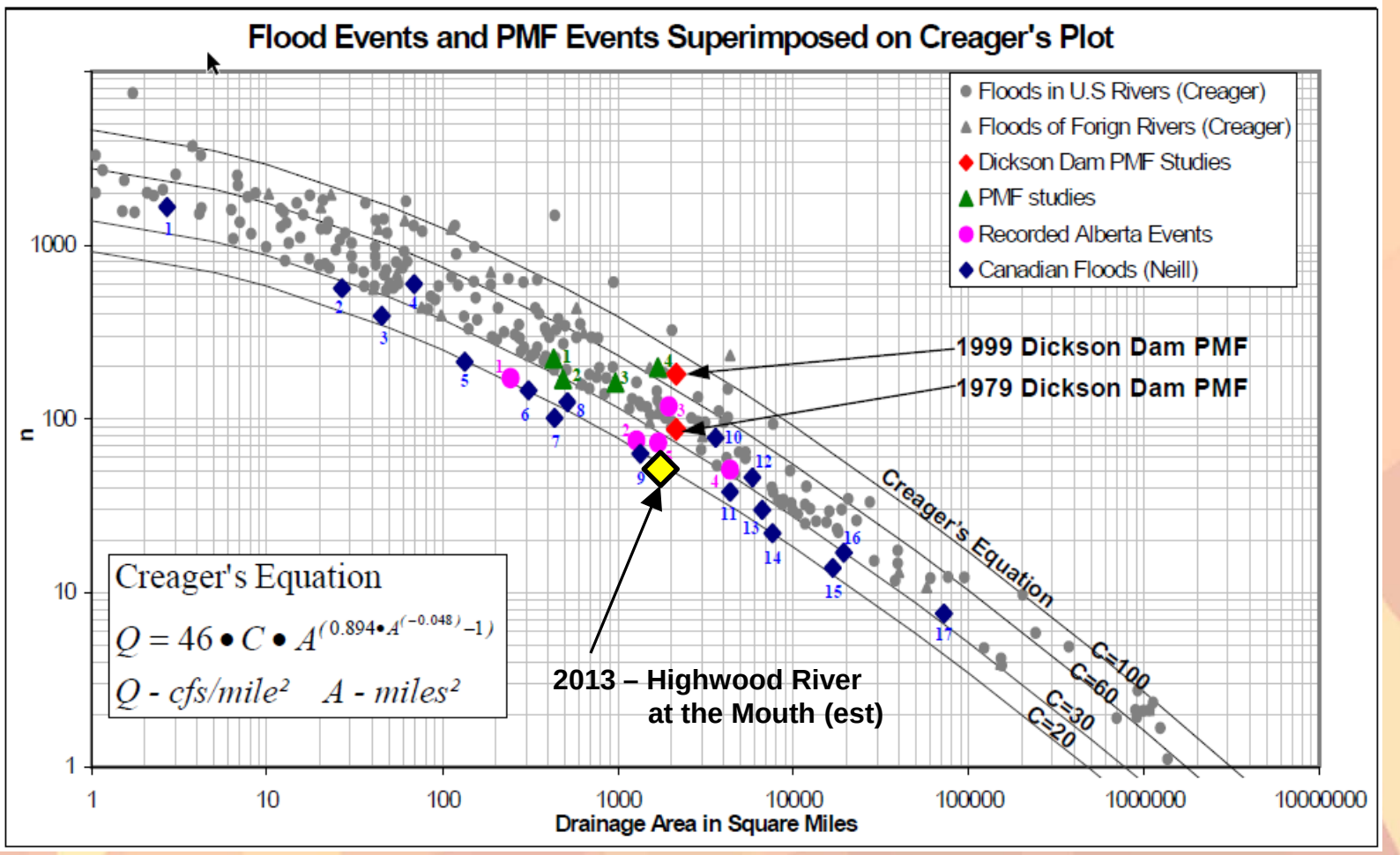
Water Supply Forecast as of February 1, 2018 - Bow River Basin (Natural Flows)

	Volume Forecast for March 1 to September 30, 2018					
Locations	**Volume in dam^3**	**Volume as a % of Average**	**Probable Range as a % of Average**	**Potential Minimum as % of Average**	**Forecast Ranking (lowest to highest)**	**Recorded March-September 2017 Volume as a % of Average**
Bow River at Banff	1,055,000	105	99-111	94	49/99	116
Lake Minnewanka Inflow	193,000	109	98-123	87	55/99	101
Spray River near Banff	402,000	112	105-119	99	70/99	92
Kananaskis River	392,000	102	92-113	82	44/99	95
Bow River at Calgary	2,470,000	107	102-112	98	56/99	104
Elbow River	189,000	94	84-116	76	42/99	84
Highwood River	572,000	103	86-130	70	47/99	82

Average is calculated for the March 1 to September 30 period from 1981 to 2009

Alberta

Upgrades: PMF's and Creager's Plot

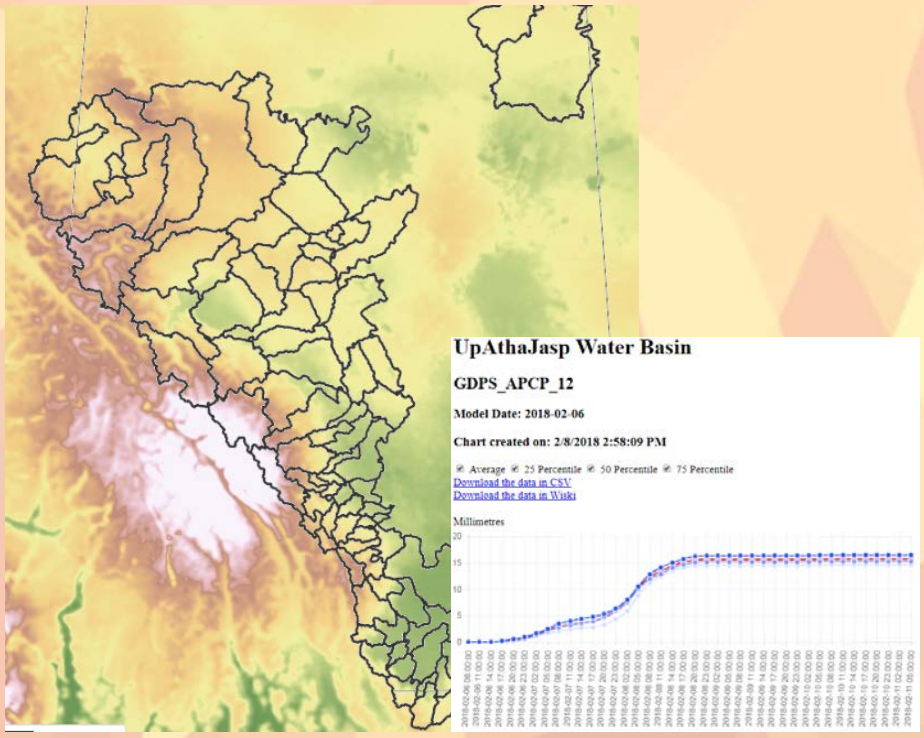


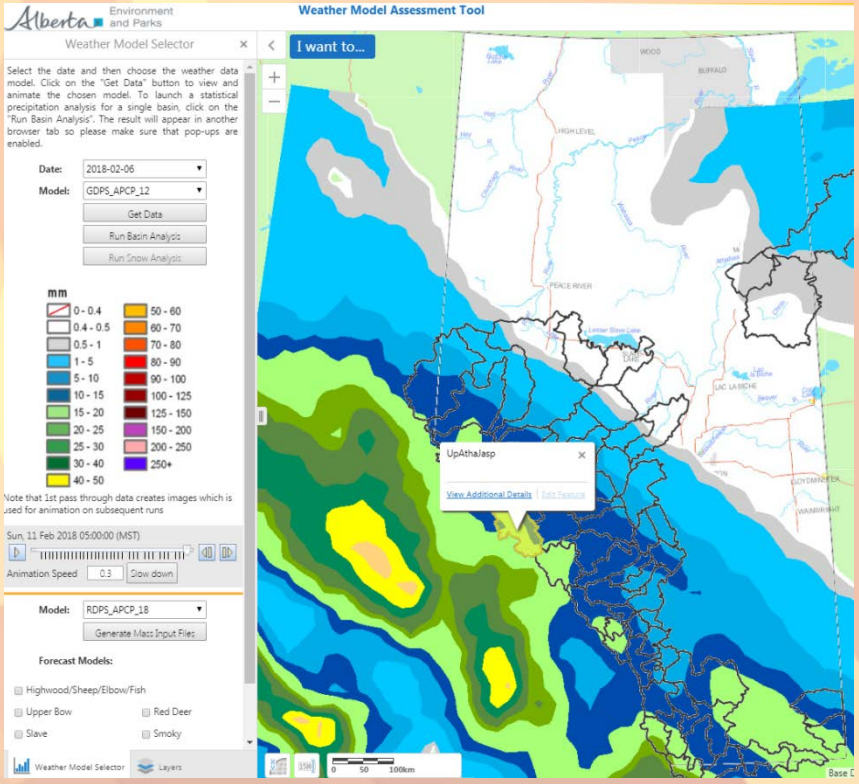
Source: 'Probable Maximum Flood Red Deer River at Dickson Dam' - 2002

Alberta

Innovations: Clipping Weather Model Data (when you don't have a platform)

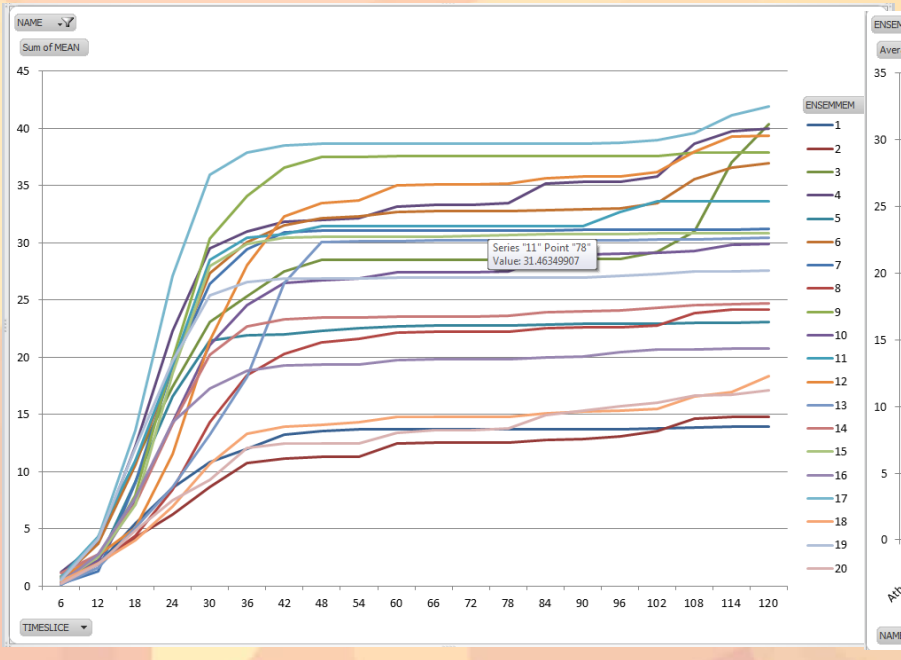
- Weather Model Assessment Tool (WMAT) ECCC – GDPS, RDPS, HRDPS,

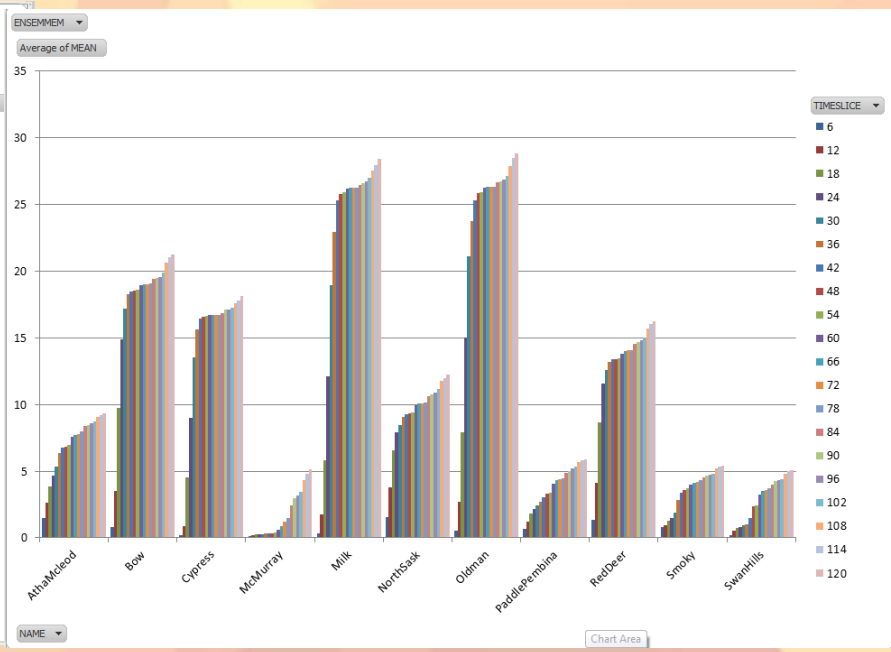




Innovations: Clipping Weather Model Data (when you don't have a platform)

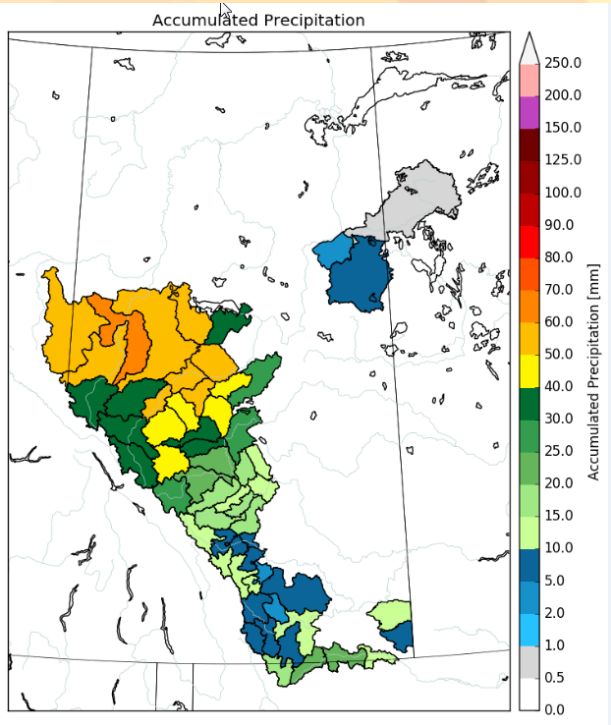
- Weather Model Assessment Tool (WMAT) North American Ensemble Data
  - 1 degree resolution results in only the major (ie large) basins being analyzed





Innovations: Clipping Weather Model Data

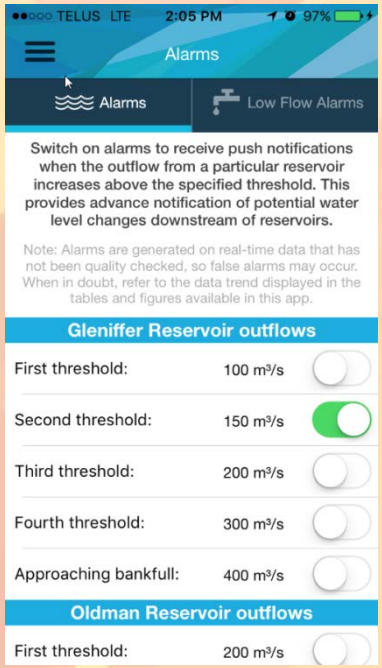
- RWDI Contract (WRF, NOAA – GFS, NAM5, NAM12, SREF)
  - Posts tables and figure of pre clipped data
  - Provides comparison to ECCC data
  - Provides context as AAF Meteorologists often reference NOAA models

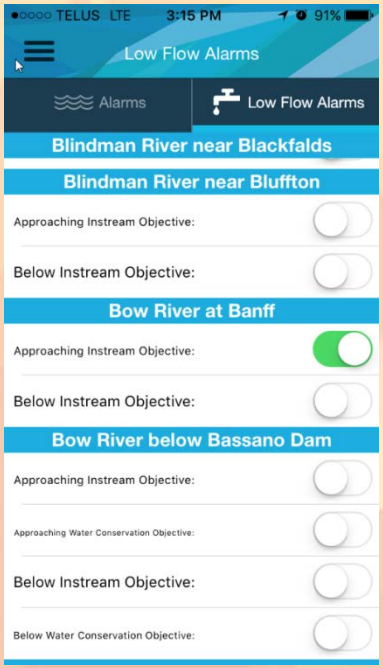


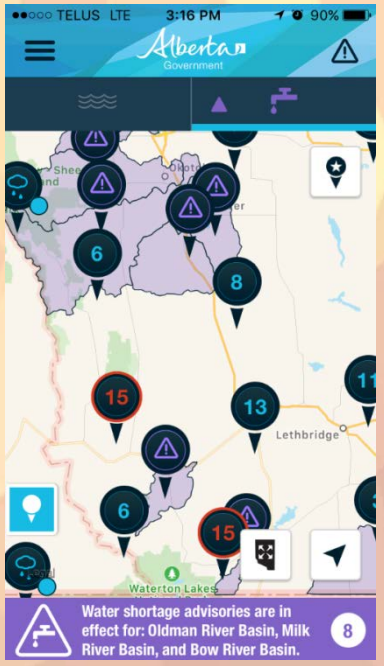
GFS 5 day accumulation

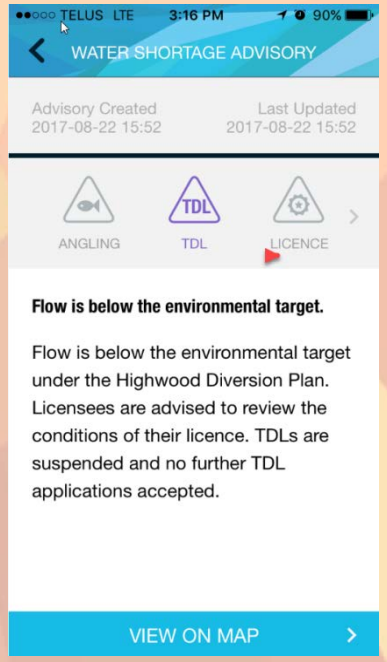
Innovations: Alberta Data and Advisories Mobile App

- Recently added functionality
  - User enabled **Discharge Alarms** for operations of AEP managed structures
  - **Low Flow Alarms** – part of the Water Shortage aspect of the app



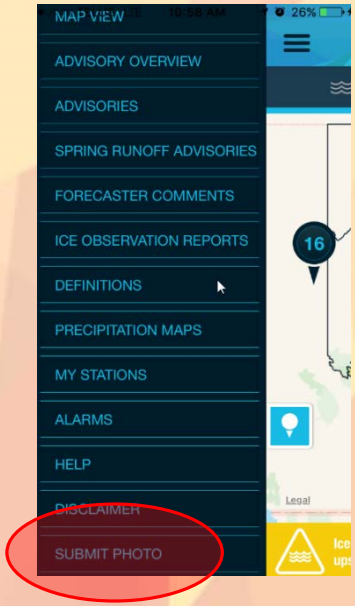


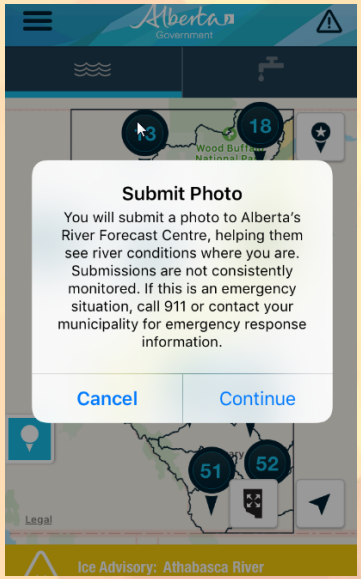


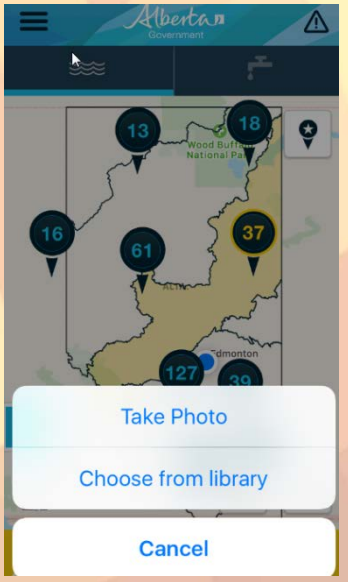


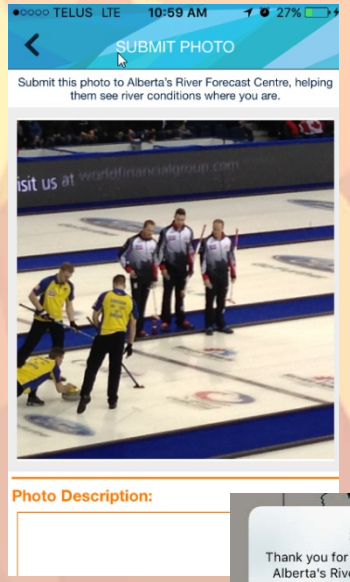
Innovations: Alberta Data and Advisories Mobile App

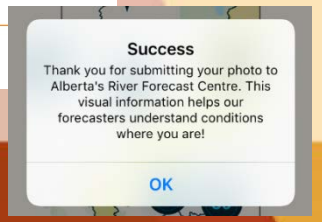
- Recently added functionality
  - **Submit Photo –** allows field staff and the public to take pictures of flooded rivers and creeks and submit them with comments to the River Forecast Centre dashboard of the Website User Portal (to be discussed next)





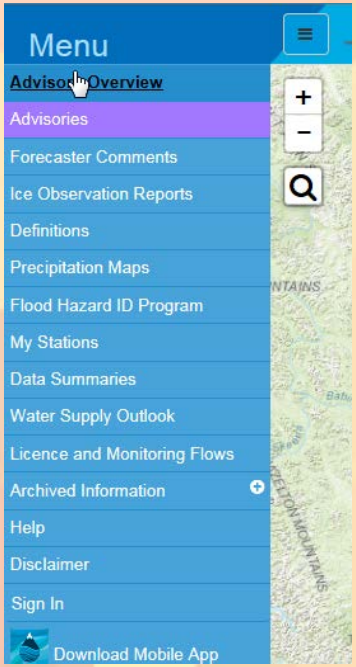


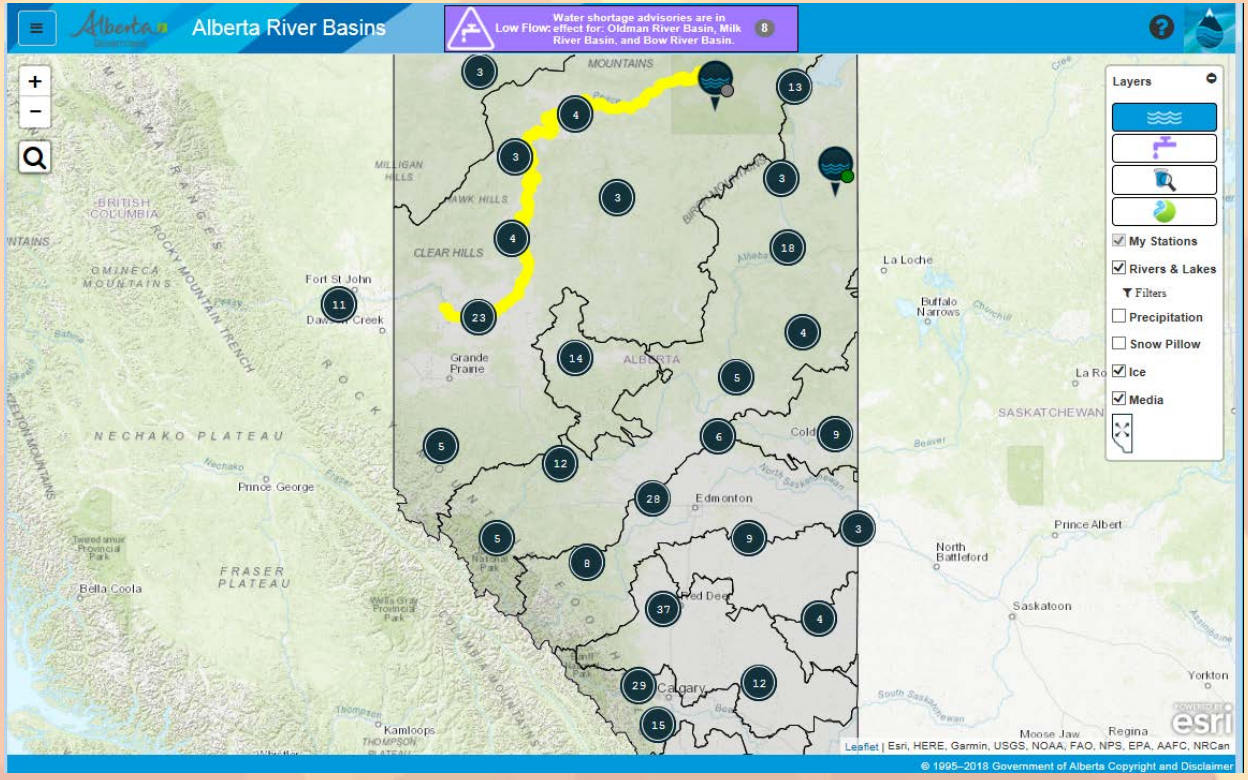




Innovations: rivers.alberta.ca Webapp

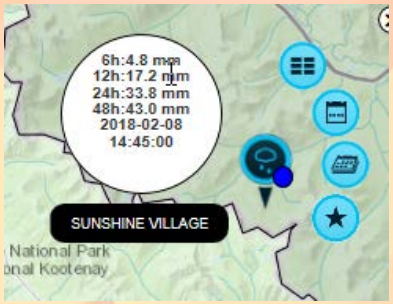
- AEP is currently in the process of decommissioning the old website where we previously posted data and advisories
- The look and feel of the new site mirrors that of the App

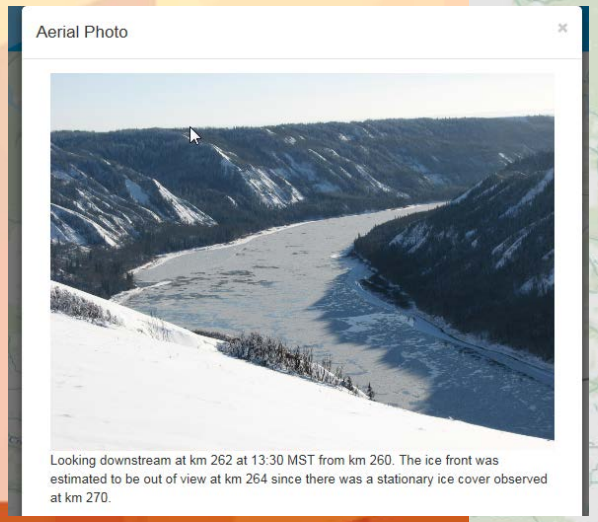


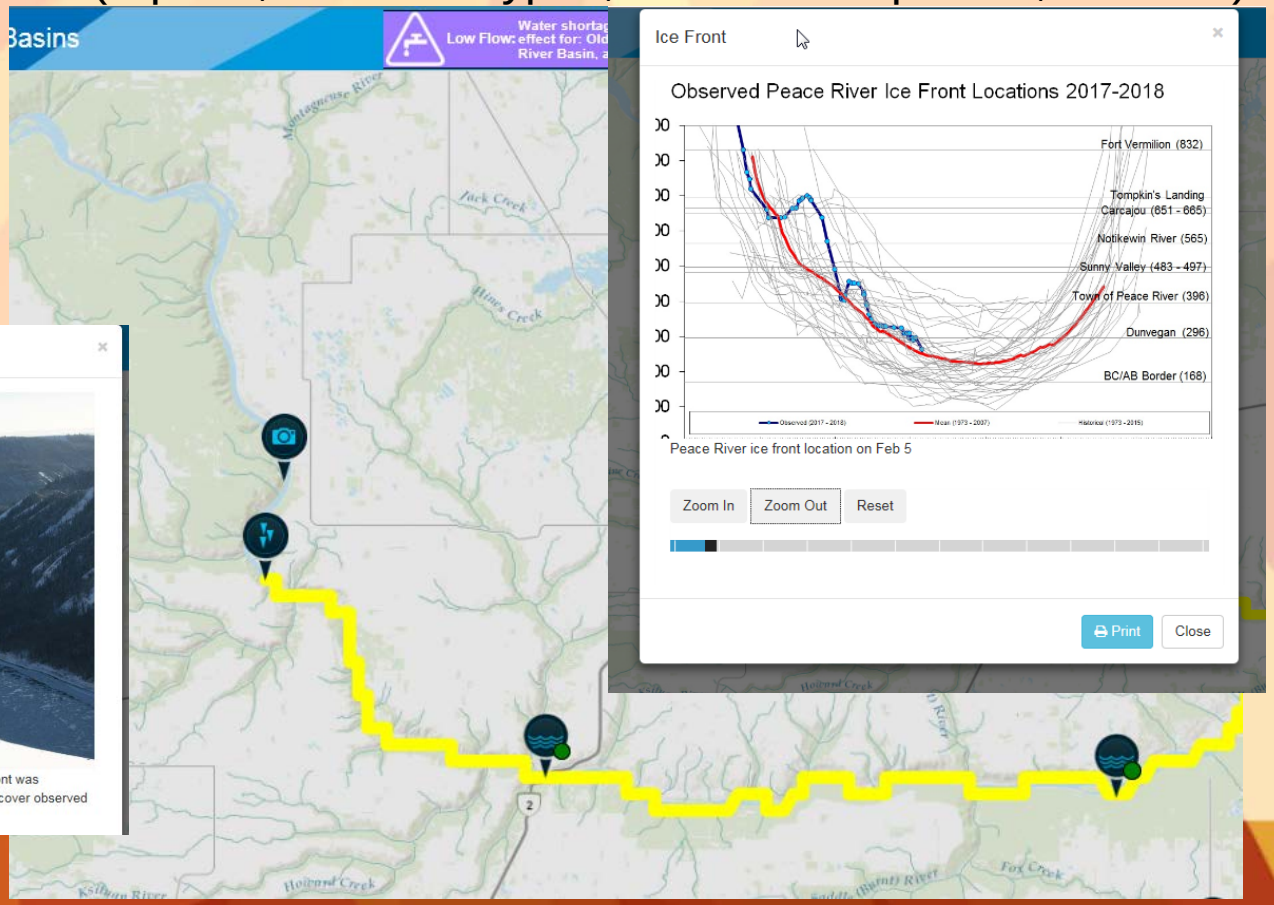


Innovations: rivers.alberta.ca Webapp

- Precipitation is presented in increments rather than showing the last hours total
- Ice observation data (reports, ice cover types, observation photos, ice front)



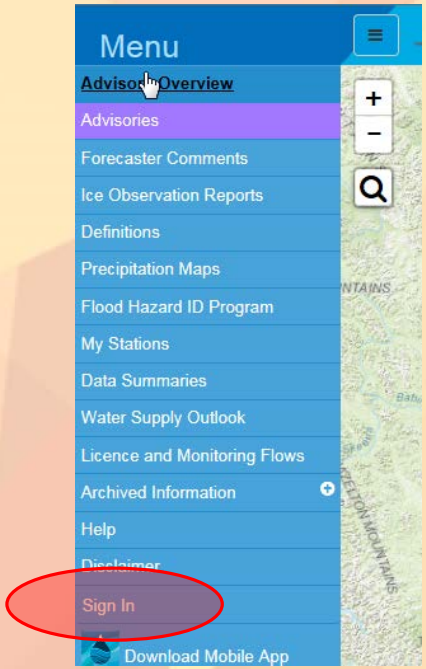


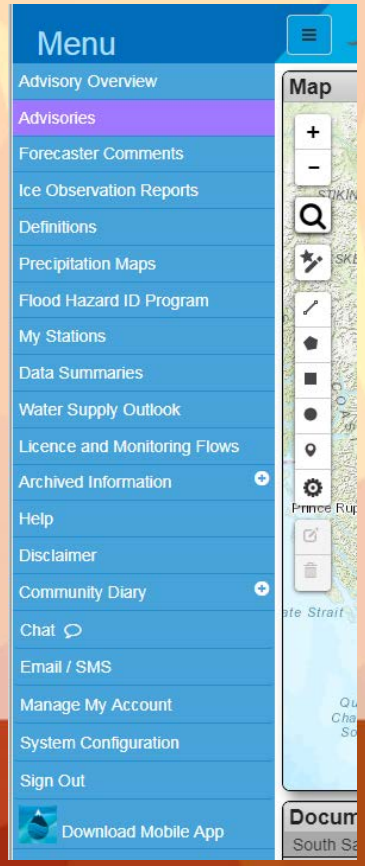


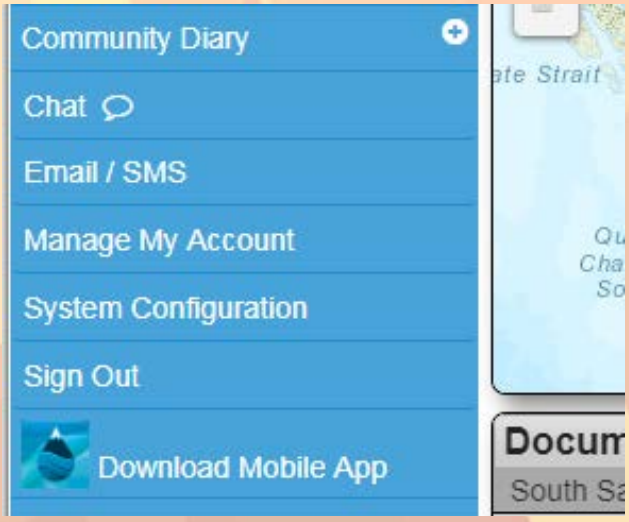
Innovations: rivers.alberta.ca Webapp

Authenticated User Portal

- Signing in from the main web page enables additional functionality and improved data currency only available to River forecast centre staff and community/provincial emergency managers.



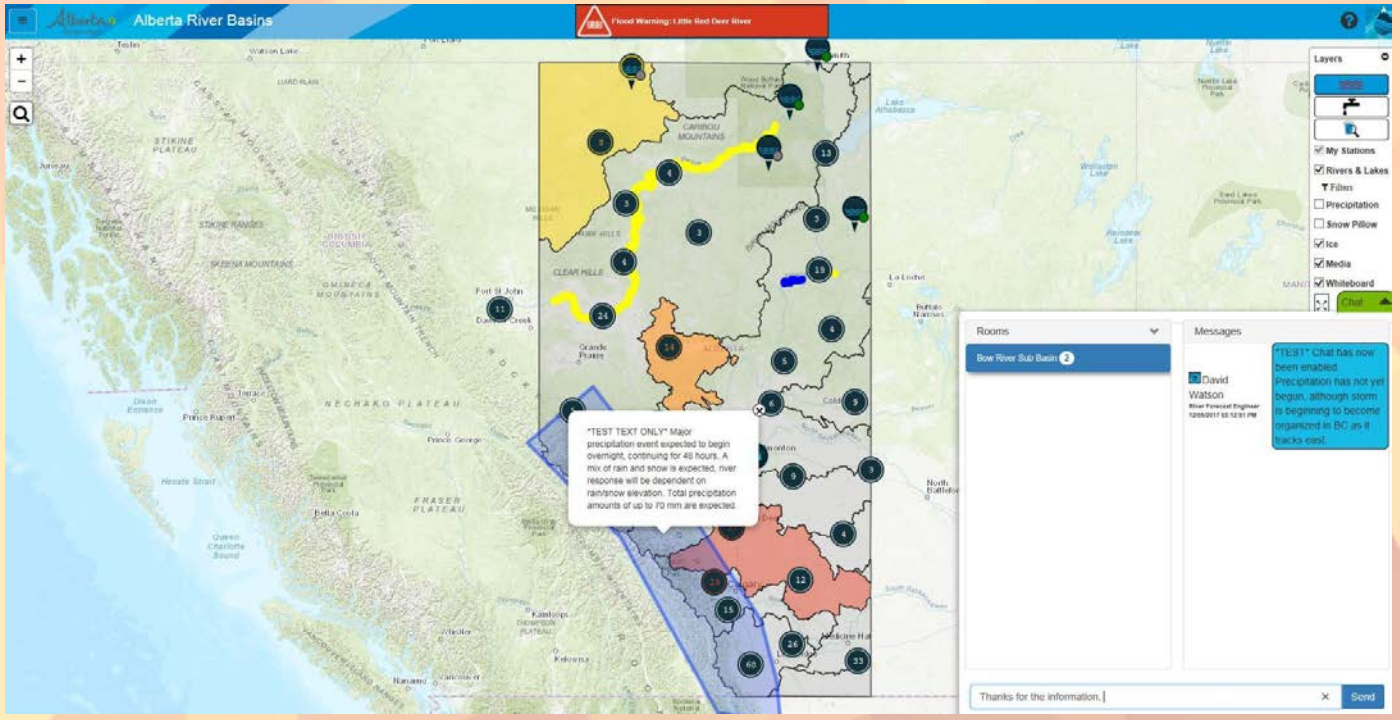




Innovations: rivers.alberta.ca Webapp

Authenticated User Portal

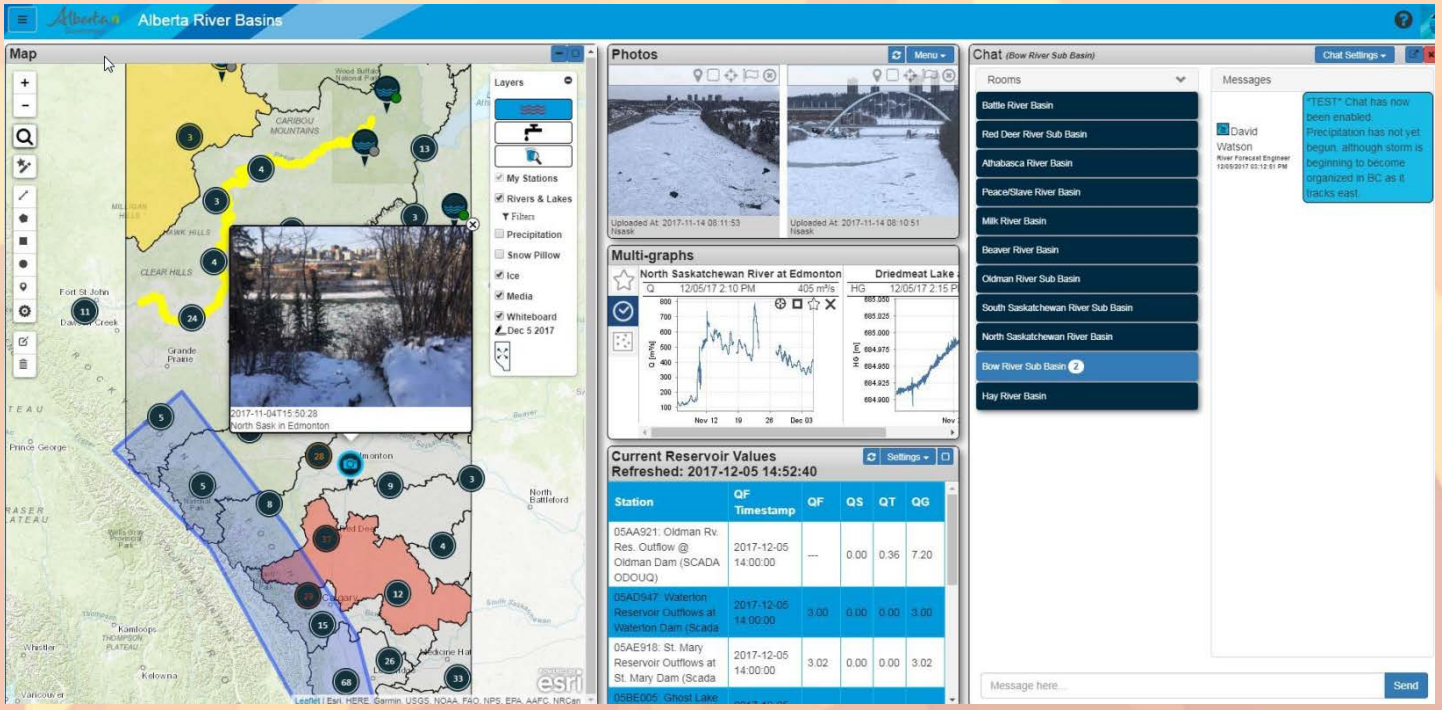
- Emergency managers view



Innovations: rivers.alberta.ca Webapp

Authenticated User Portal

- Forecaster View – Whiteboard, user submitted photos, reservoir outflow table, all chat windows, canned multi-graphs



Innovations: Serious Gaming

The central philosophy of Serious Gaming is to bring together elements of simulations and games for learning purposes

Successful serious games typically have one particular end-user persona in mind, and are geared towards satisfying the needs of that user (i.e. people involved in water resources management)

Alberta

Innovations: Serious Gaming

The overall objective is to develop a standalone desktop prototype Serious Gaming tool as a proof of concept, the Bow River Sim.

Specific objectives:

- Develop an educational tool to increase awareness on water resources management
- Facilitate workshops which bring stakeholders together to expedite discussion
- Present data in a communicative and interactive way to explore the behavior of the river basin under different scenarios
- Create an understanding of the roles and responsibilities of stakeholders in the basin

Alberta

Future Work: Forecast Model Studies

Phase 1:

Northwest Hydraulic Consultants/RTI were awarded the contract to complete a review of different Modelling Tools that would work best for forecasting in Alberta

The objectives of this study were:

- To provide a comprehensive assessment of hydrological models suitable for the open water season operation of the RFC,
- To develop criteria and a tool/application for hydrological model performance evaluation.

Final Deliverables:

- A preliminary selection of 21 candidate models was shortlisted to 8 models based on 9 critical criteria
- An application developed in 'R' that provides calculations for a suite of model performance metrics, including a group of general metrics to assess overall goodness of fit for long-term calibrations, a group of seasonal metrics and a group of "peak over threshold"

Alberta

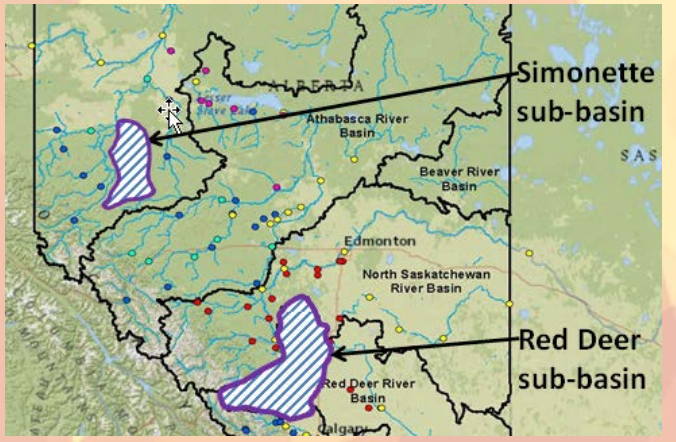
Future Work: Forecast Model Studies

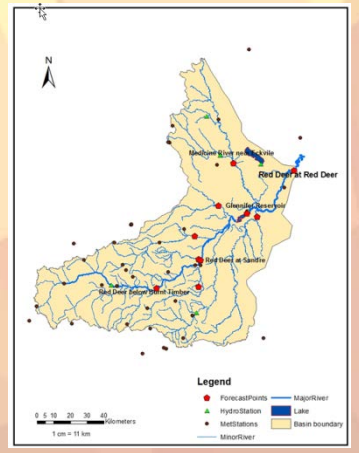
Phase 2:

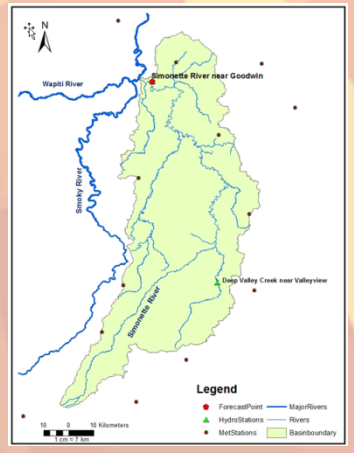
Currently Underway – studies ending in late summer 2018

Two forecast basin models will be built in 5 of the 8 shortlisted models

- Red Deer River basin to the City of Red Deer – must include snow processes, dam operations, and high elevation and plains runoff, multiple headwater basins
- Simonette River basin (part of the Smoky River basin) – must include snow processes, must deal well with limited meteorological gauges, must deal with complex soil types, few streamflow gauges with very large DA







Future Work: Forecast Model Studies

Phase 2:

Models applications being tested

- NWS Suite
- HEC-HMS
- HFAM
- Raven
- MIKE-Hydro

Phase 3-4:

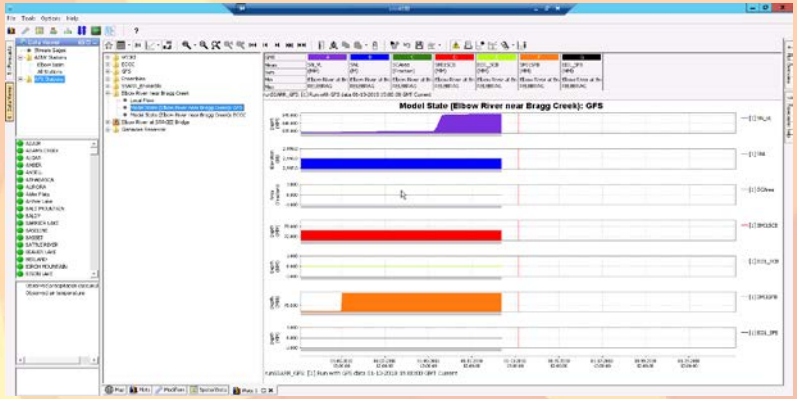
- Prepare remaining forecast models, decision, initiate model change process if required (5-10 years)

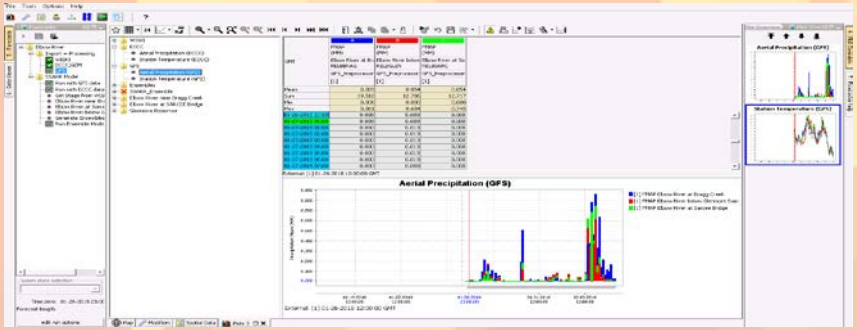
Alberta

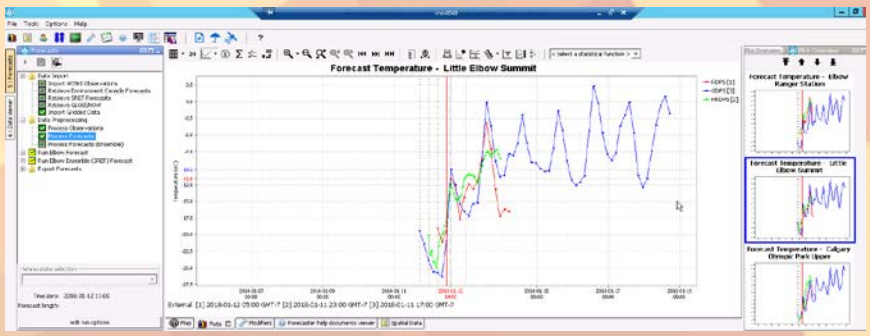
Future Work: Platform Implementation

In the winter of 2016-2017 an RFP was posted with the objective of providing the information required to determine which data integration, management and model control platform would be the most appropriate for use within Alberta's RFC.

Three prototypes, built to the RFC specifications, were submitted by DHI, Deltares and RTI (previously Riverside).

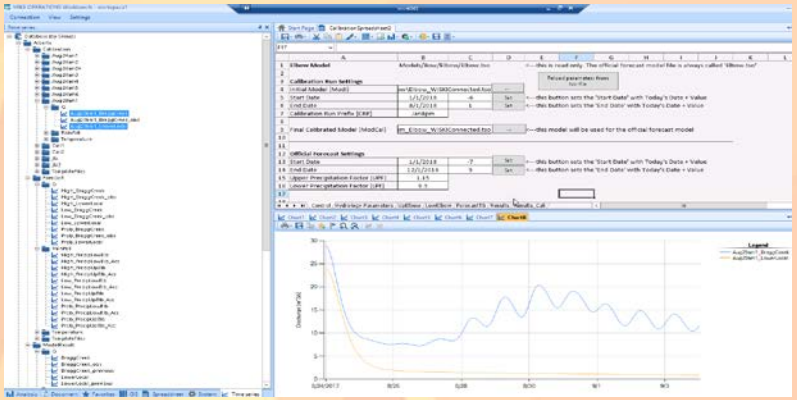




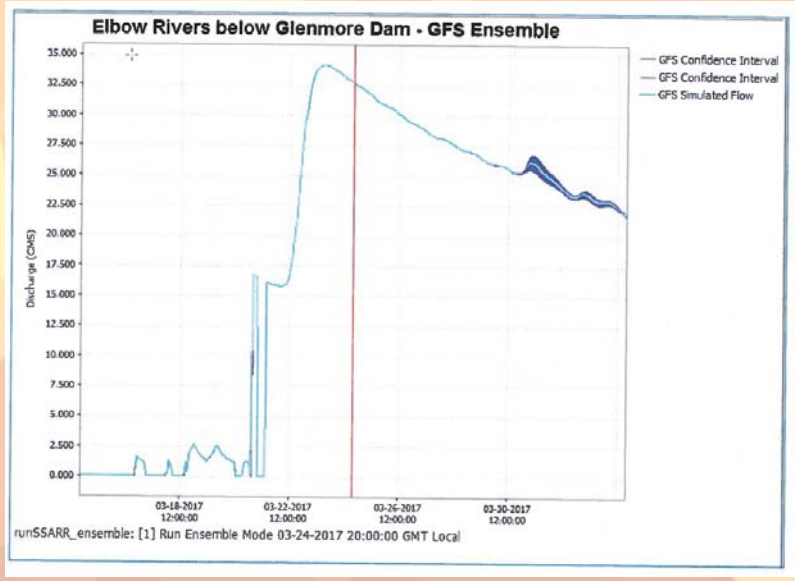


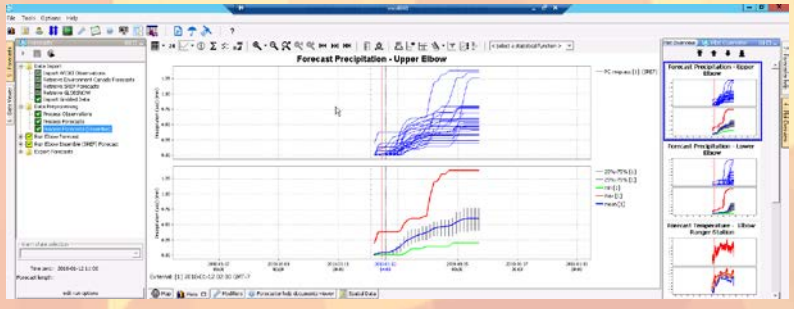
Future Work: Platform Implementation

These prototypes are currently being evaluated and a decision is expected by March 31, 2018.



Decision must be made within the context of the model review and change process – regardless of the final model selected the current SSARR model will need to be kept running during any transitional period.





Alberta

Future Work: Event Inundation Mapping

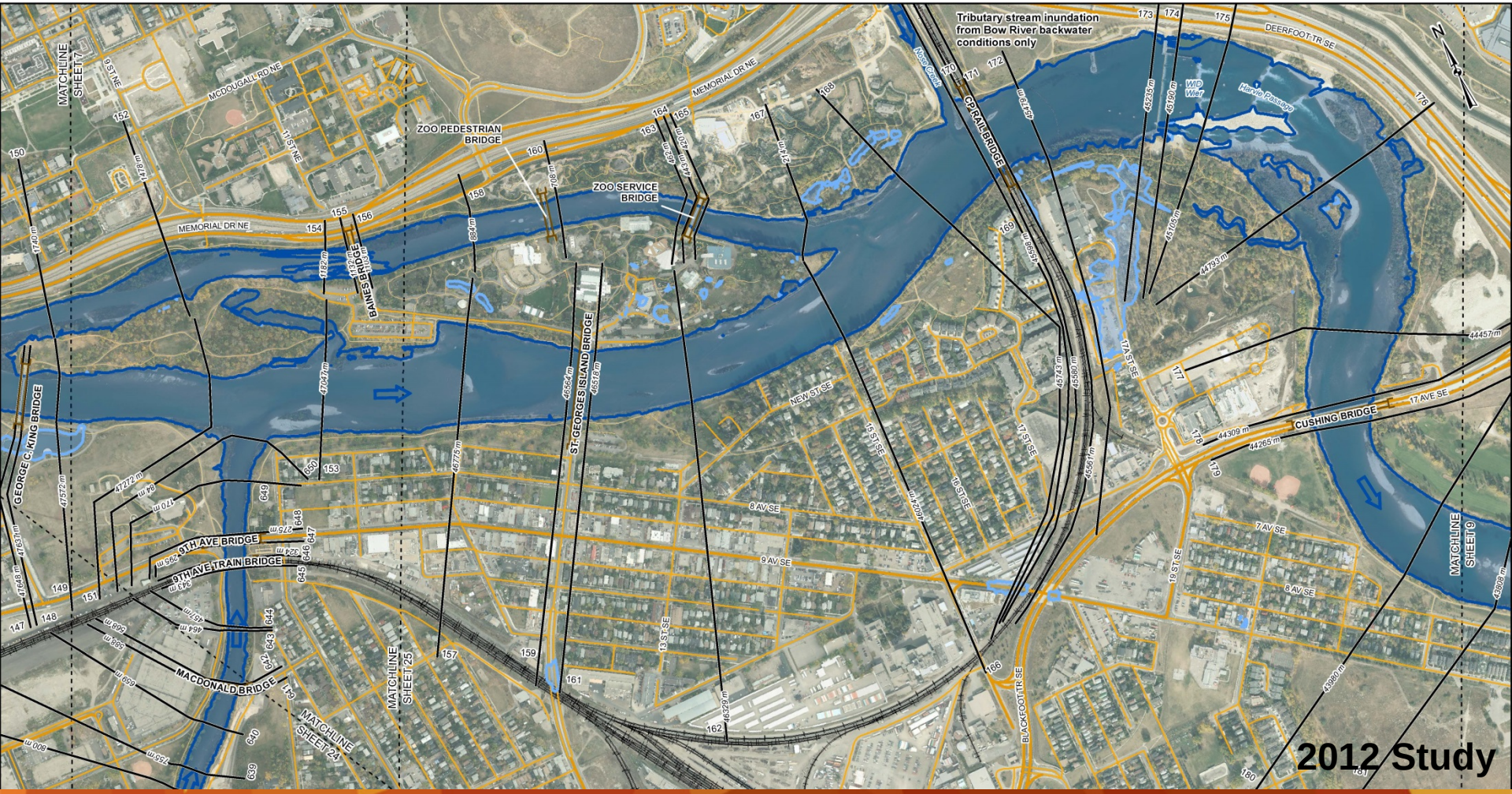
- Previous Flood Hazard Studies mapped 10-, 50-, 100-year floods
- New River Hazard Studies will map 2-, 5-, 10-, 20-, 35- 50-, 75-, 100-, 200-, 350-, 500-, 750-, and 1000-year open water floods
- Maps show the inundated extent for these flood scenarios

Alberta

FLOOD INUNDATION EXTENT

- FLOOD EXTENT
- FLOOD EXTENT (ISOLATED AREA)
- FLOOD EXTENT (FLOOD CONTROL STRUCTURE FAILURE)

Inundation – 5-Year Flood

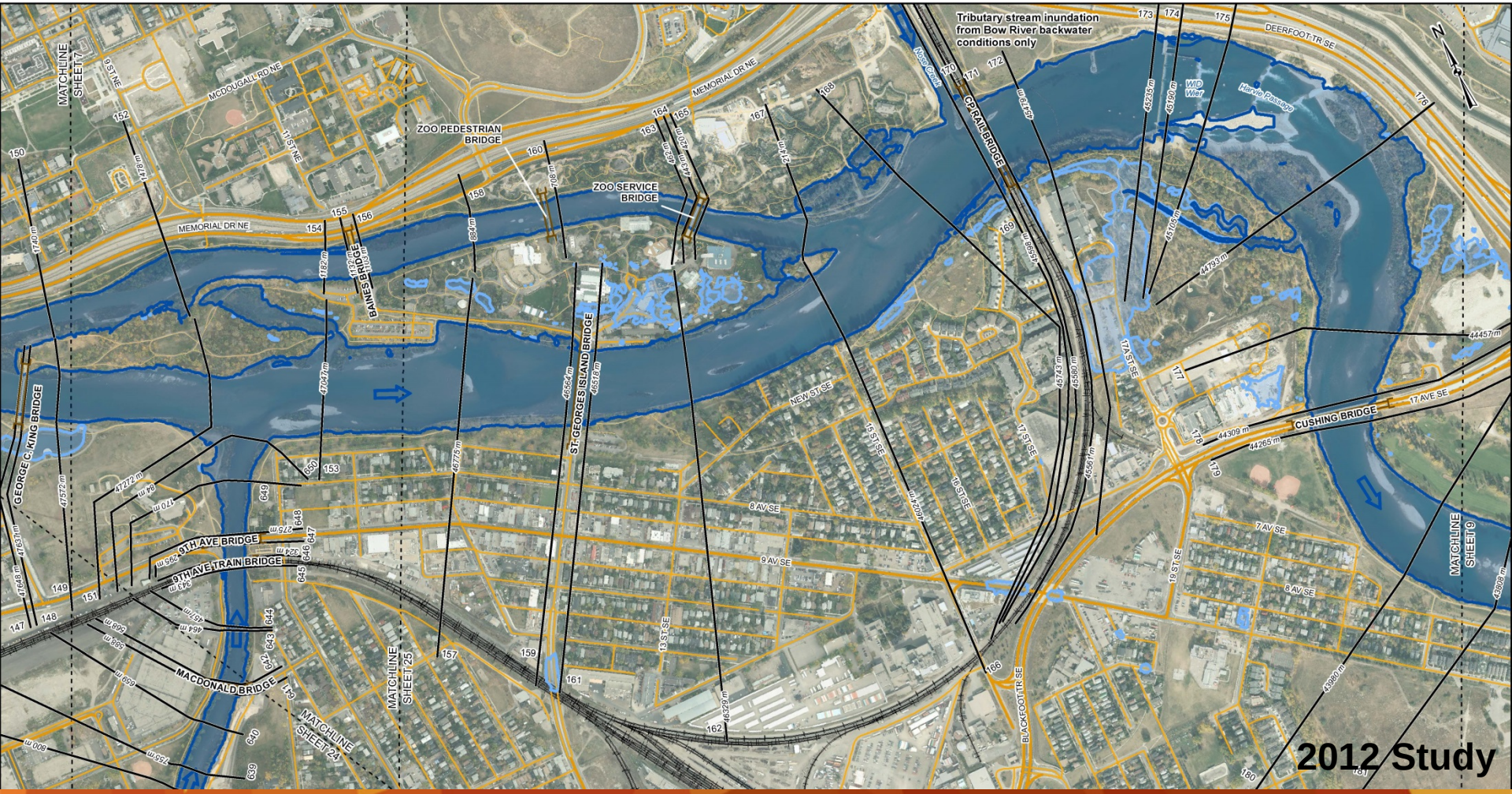


Alberta

FLOOD INUNDATION EXTENT

- FLOOD EXTENT
- FLOOD EXTENT (ISOLATED AREA)
- FLOOD EXTENT (FLOOD CONTROL STRUCTURE FAILURE)

Inundation – 10-Year Flood



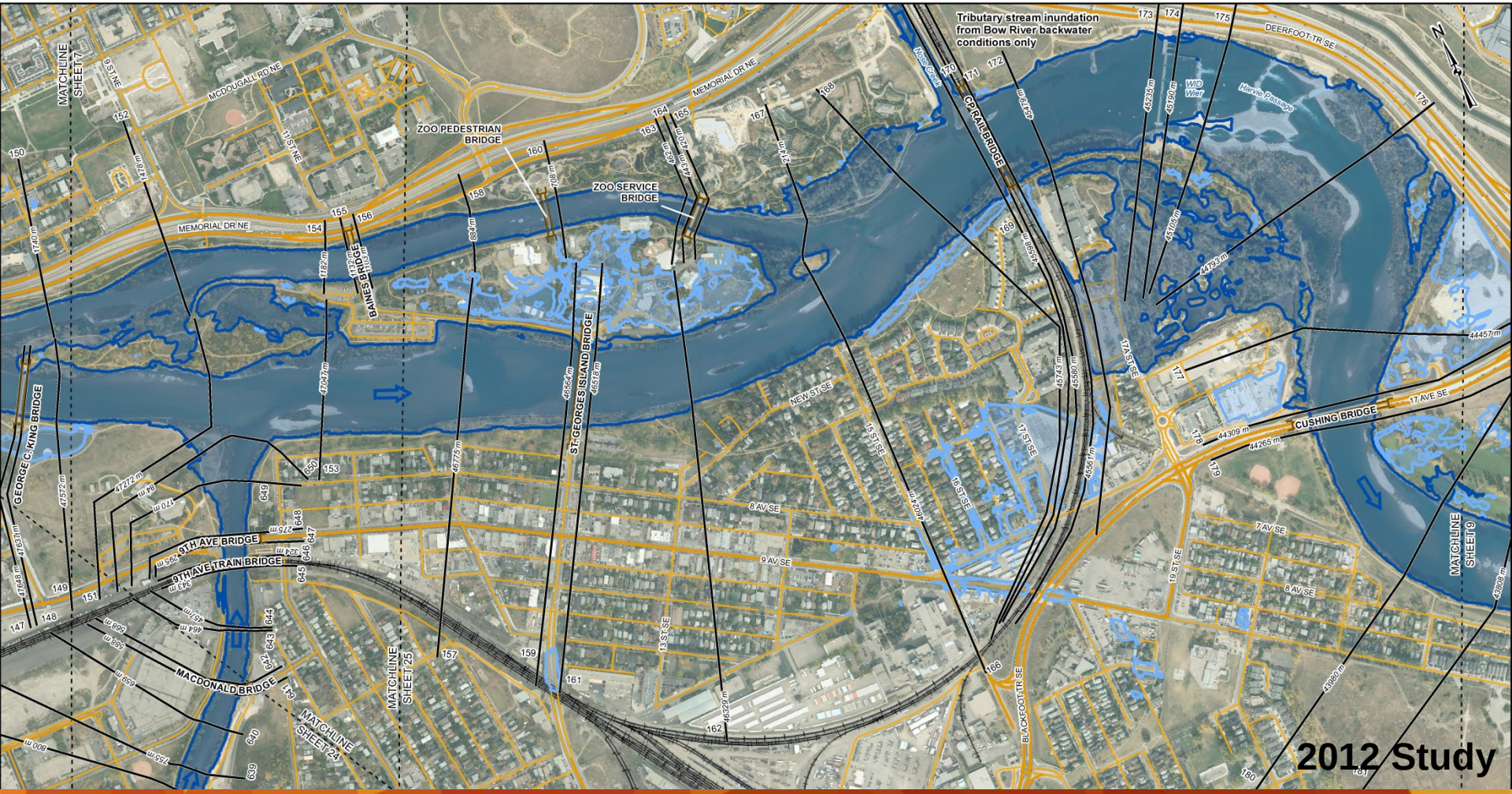
2012 Study

Alberta

FLOOD INUNDATION EXTENT

- FLOOD EXTENT
- FLOOD EXTENT (ISOLATED AREA)
- FLOOD EXTENT (FLOOD CONTROL STRUCTURE FAILURE)

Inundation – 20-Year Flood



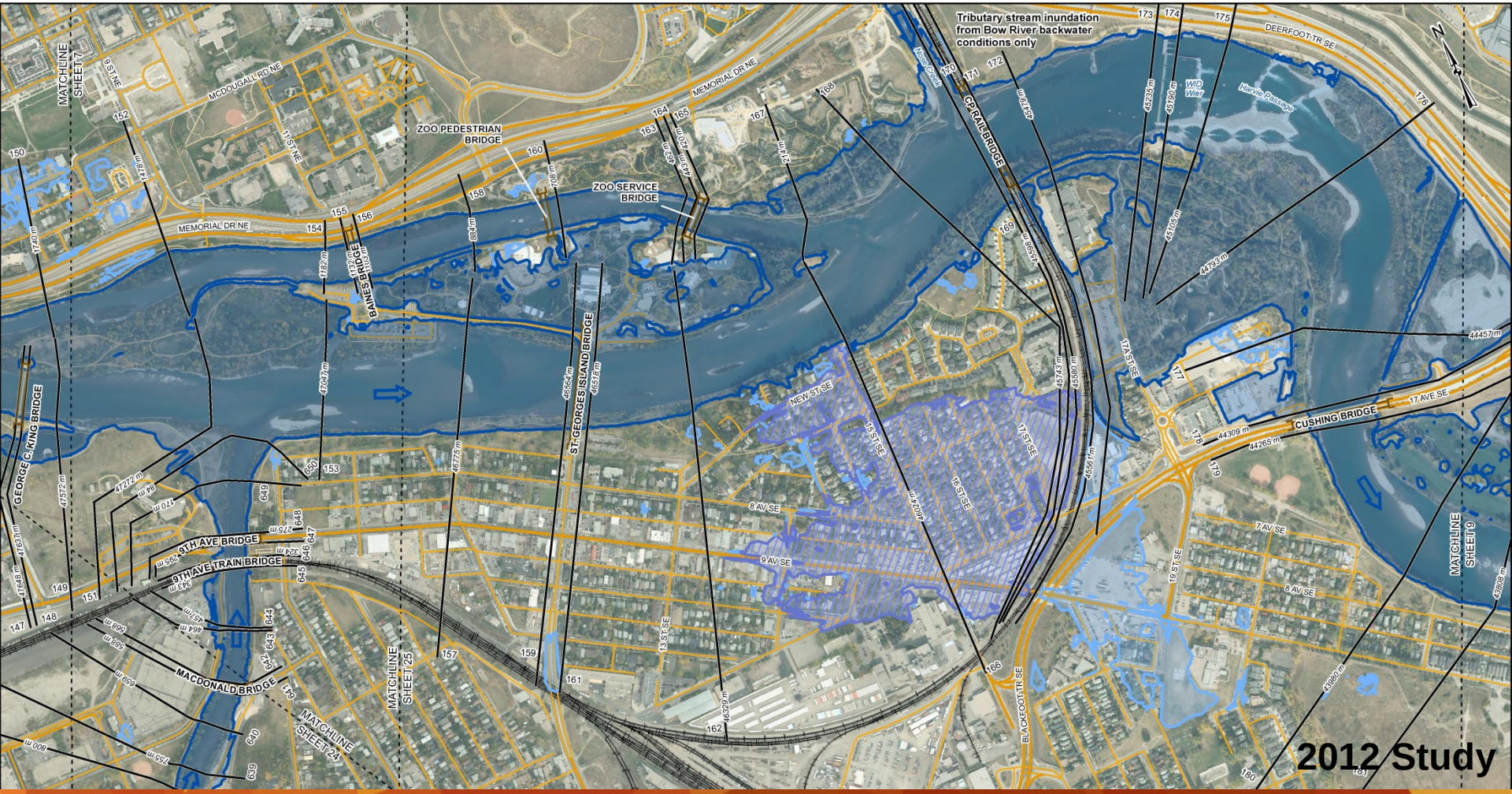
2012 Study

Alberta

FLOOD INUNDATION EXTENT

- FLOOD EXTENT
- FLOOD EXTENT (ISOLATED AREA)
- FLOOD EXTENT (FLOOD CONTROL STRUCTURE FAILURE)

Inundation – 50-Year Flood

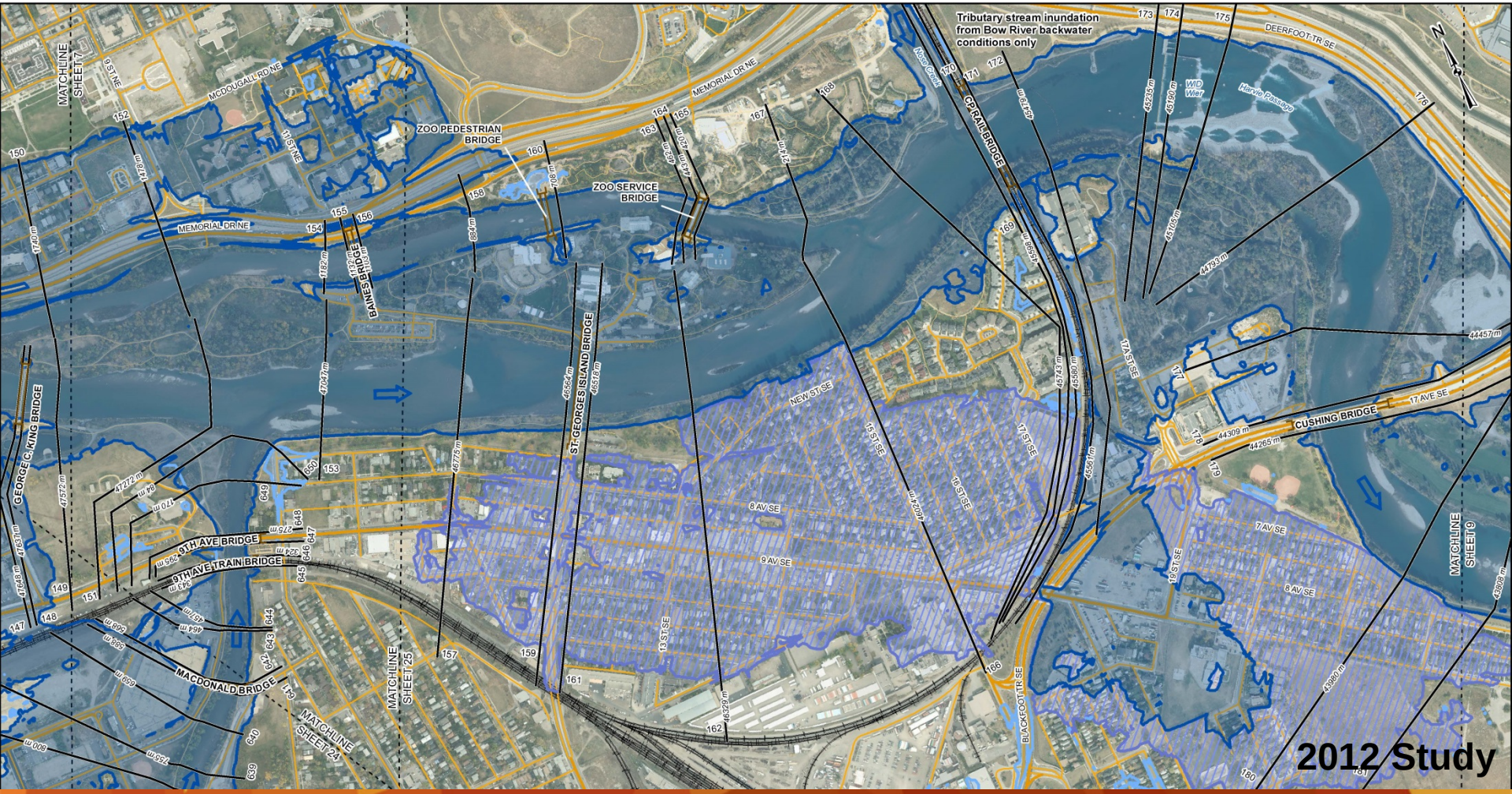


Alberta

FLOOD INUNDATION EXTENT

- FLOOD EXTENT
- FLOOD EXTENT (ISOLATED AREA)
- FLOOD EXTENT (FLOOD CONTROL STRUCTURE FAILURE)

Inundation – 100-Year Flood



Alberta

Questions?

Alberta