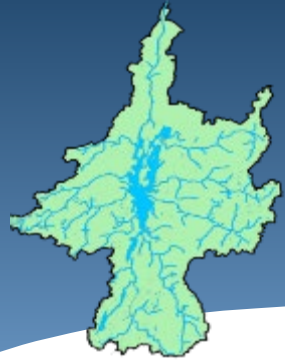


# The International Joint Commission's Lake Champlain – Richelieu River Flood Study

Outreach on Key Findings and Draft Recommendations

Date: 1/6/2022

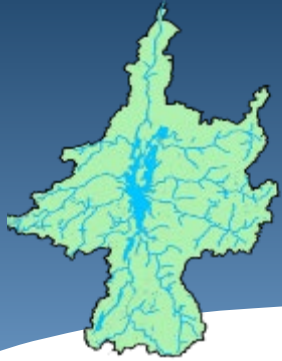




# IJC Overview

- The IJC, is an independent, science-based, binational organization, funded equally by the federal governments of the US and Canada
- Guided by the Canada-US *Boundary Waters Treaty* of 1909
- The Commission conducts studies across our shared boundary at the request of the governments
- The Lake Champlain – Richelieu River Study Board was convened by the IJC in response to a request from the governments following the 2011 flood

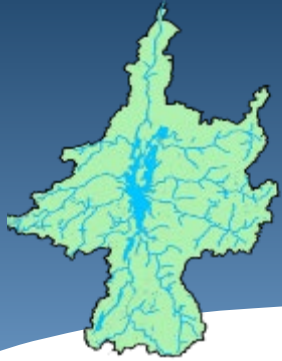




# Outline

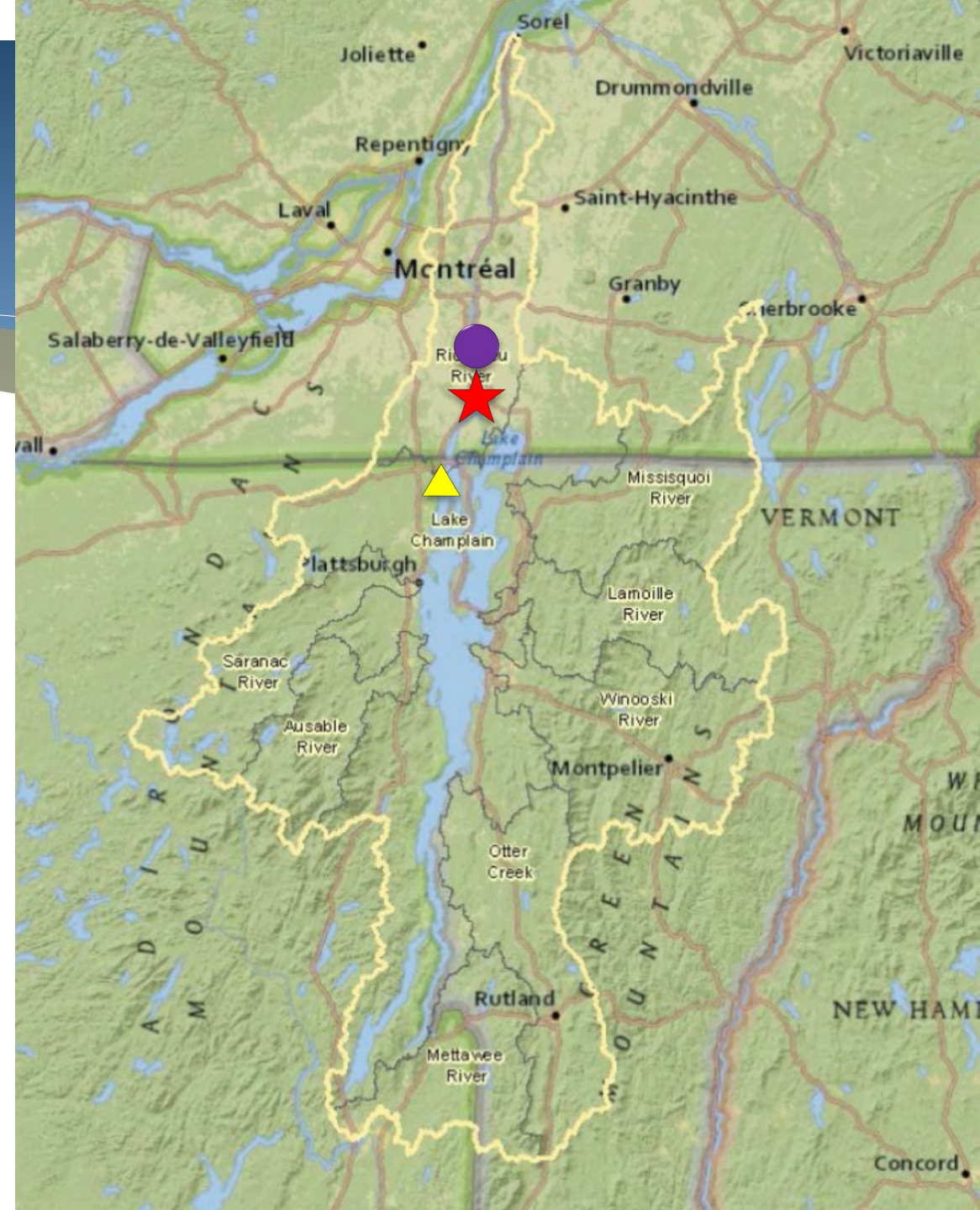
- Overview of the Lake Champlain – Richelieu River (LCRR) Study’s mandate, decision criteria, themes of Study
- Information sharing by theme:
  - Key findings
  - Draft recommendations
- Discussion/questions following each theme



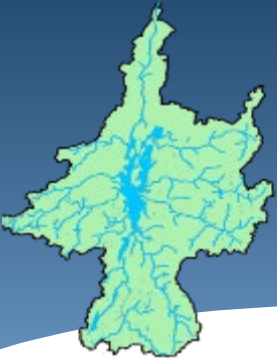


# Overview of the LCRR Basin

- 9,227 mi<sup>2</sup> (23,899 km<sup>2</sup> )
  - 84% in the United States
  - 16% in Canada
- The Saint-Jean Shoal (red star) is the hydraulic control for Lake Champlain and the upper Richelieu River and determines water levels upstream.
- The Chambly Canal (purple circle)
- Rouses Point, NY (yellow triangle)



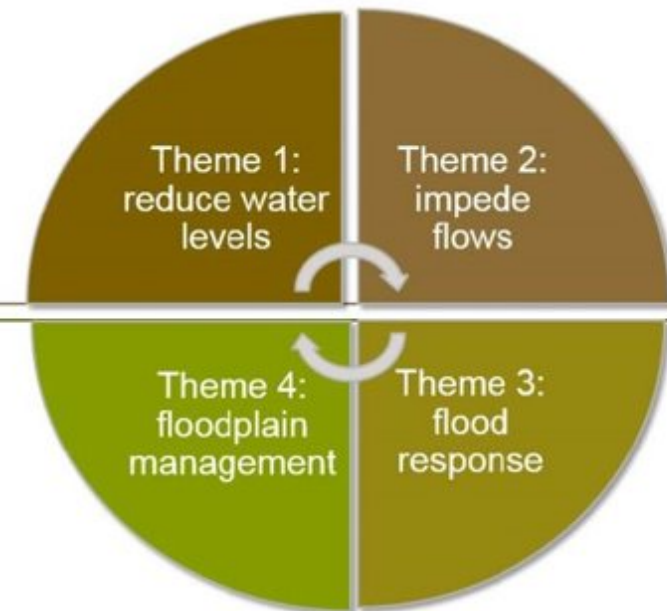




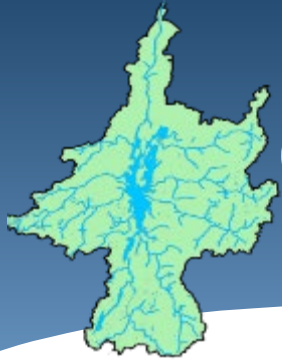
# Study's Focus

- Understanding causes and impacts of past floods
- Identifying floodplain best management practices
- Developing flood adaptation strategies
- Evaluating a binational flood forecasting system
- Exploring potential flood management and mitigation measures
- Analyzing social and political perception to measures

**Goal 1: Reduce High Water Levels and Thereby Flooding Impacts**  
**(Moderate Structural Solutions)**



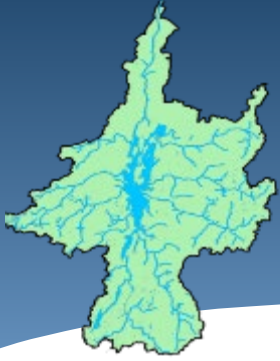
**Goal 2: Reduce Vulnerability to High Water and Build Flood Resiliency**  
**(Non-Structural Solutions)**



# Outreach/Stakeholder Engagement

- PAG – (Public Advisory Group)
- Website ([www.ijc.org/lcrr](http://www.ijc.org/lcrr))
- Videos, fact sheets and white papers on key aspects of the study
- Bimonthly study newsletter “The Current”
- Multiple stakeholder and public meetings during the course of the study
- Outreach to indigenous people across the basin



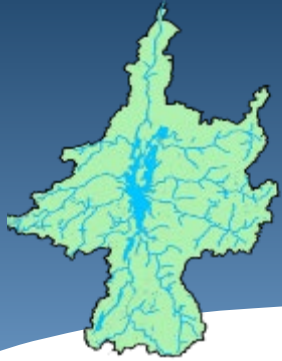


# Evaluating Solutions to Flooding

## Criteria

- |   |  |
|---|--|
| <ul style="list-style-type: none"><li>• Included in the study's scope and mandate</li></ul> | <ul style="list-style-type: none"><li>• Fair and equitable</li></ul>         |
| <ul style="list-style-type: none"><li>• Achievable/feasible</li></ul>                       | <ul style="list-style-type: none"><li>• Environmentally acceptable</li></ul> |
| <ul style="list-style-type: none"><li>• Technically viable</li></ul>                        | <ul style="list-style-type: none"><li>• Climate change resilience</li></ul>  |
| <ul style="list-style-type: none"><li>• Economically viable</li></ul>                       |  |



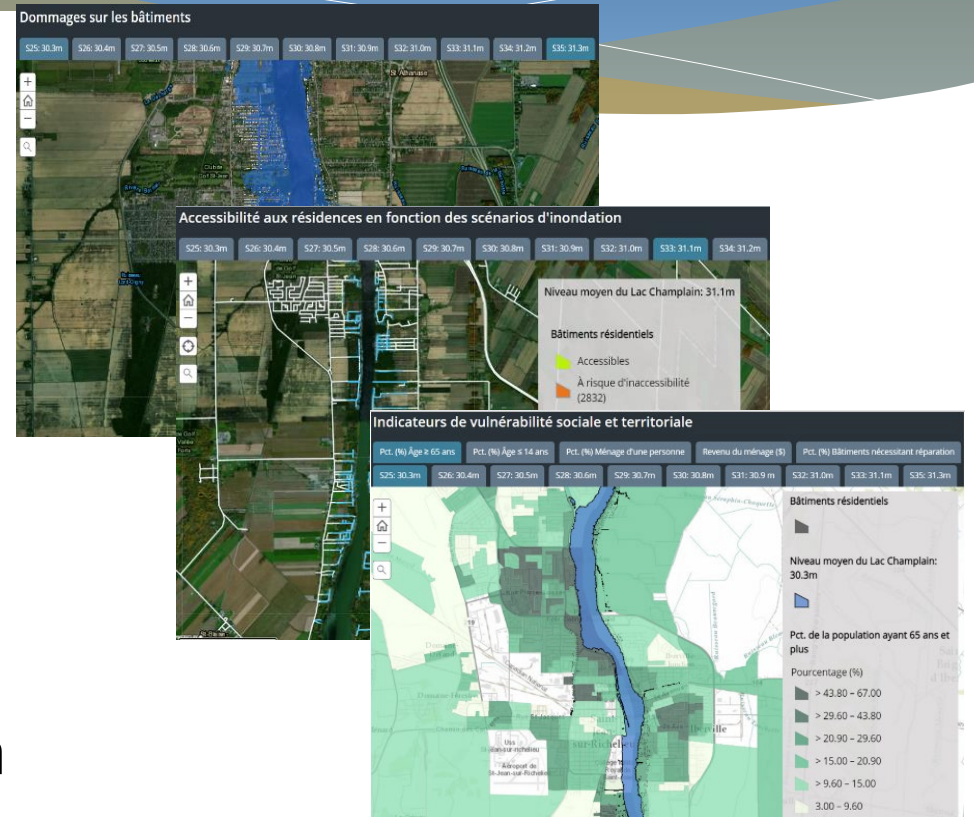


# Assessing Flood Risk:

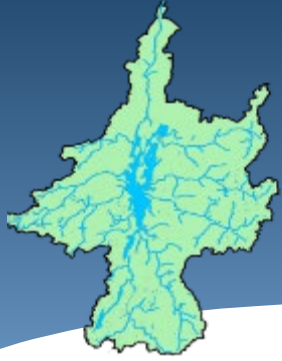
## A new approach was used to identify and communicate flood risk

The Integrated Social, Economic and Environmental System (ISEE) is a state-of-the-science system for assessing flood risk beyond the hazard:

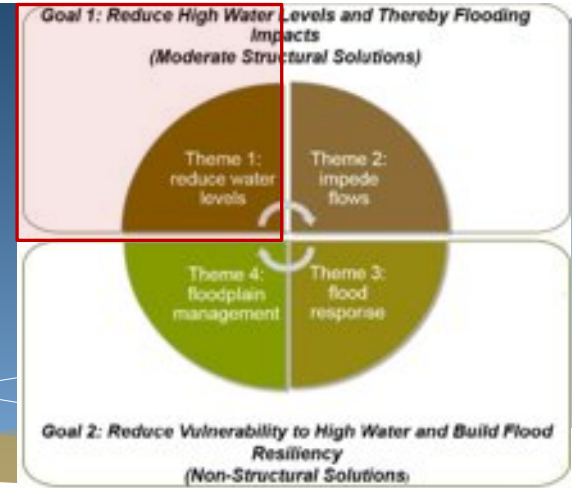
- A fully integrated system.
- Incorporates social risk such as vulnerability.
- Based on high quality data.
- Thorough verification of data and information.
- The system provides data and maps on several aspects, for example the water level in the streets, damage to property and infrastructure, vulnerable population areas.





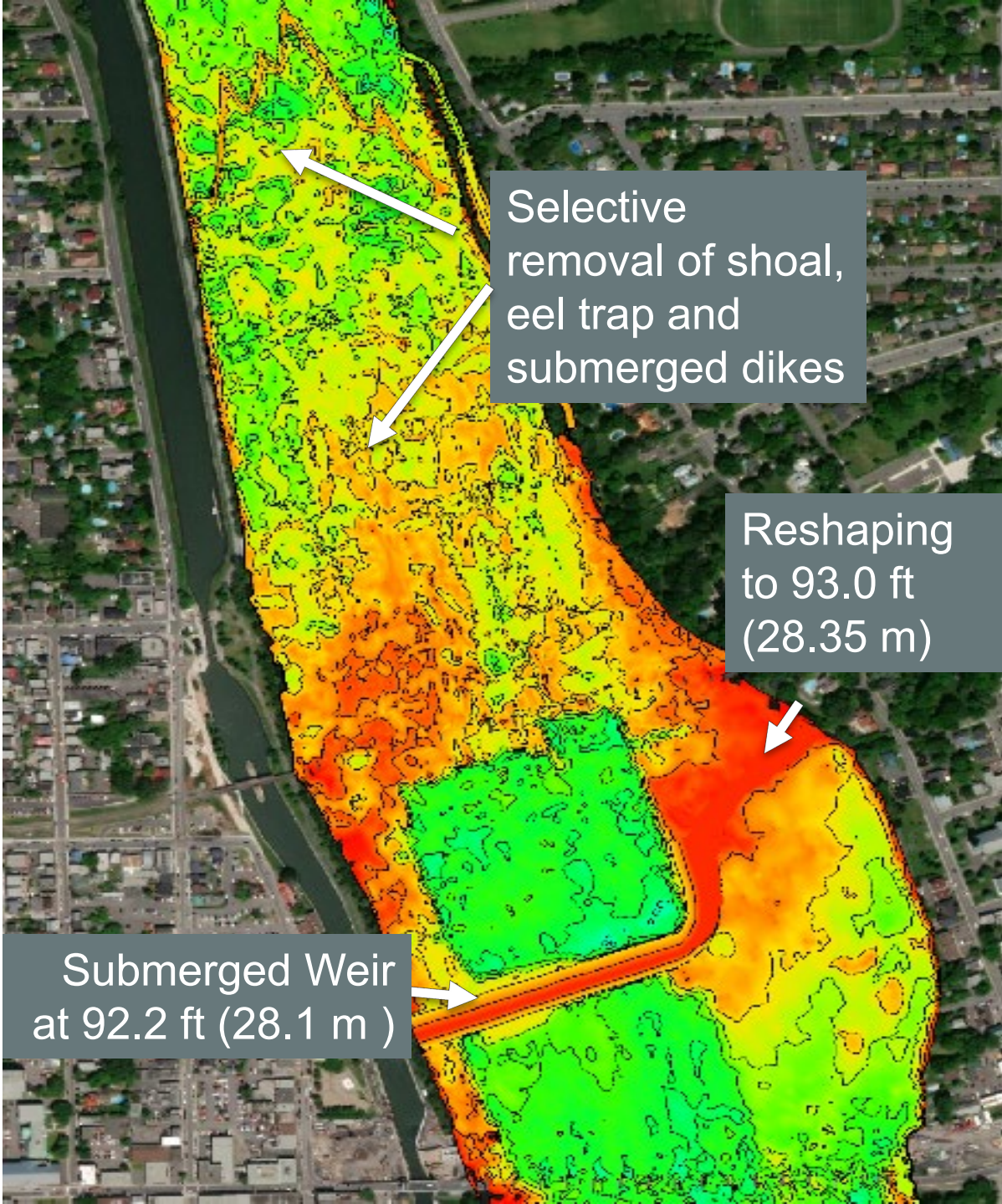


# Theme 1: Structural Solutions Key Findings

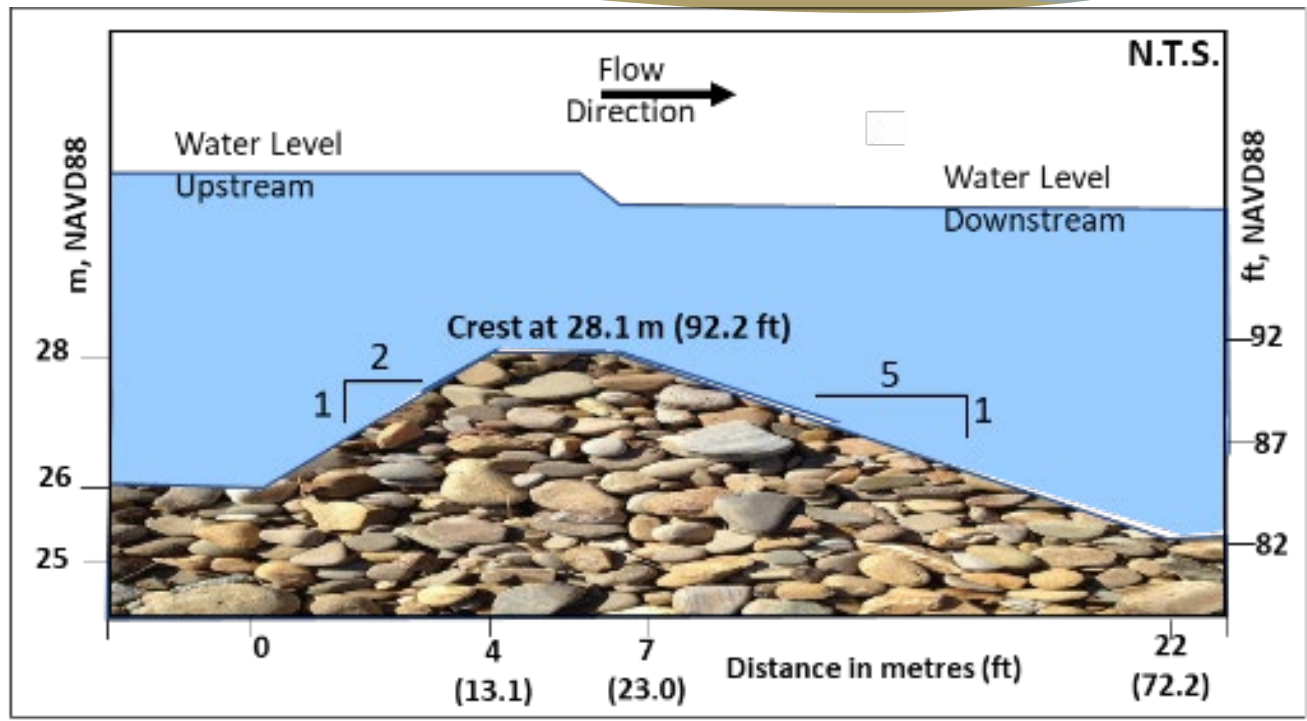


- The Study has identified two structural solutions that meet the Board's evaluation criteria
- The two alternatives are modest, but would lower water levels during floods, resulting in reduced damages in both the US and Canada
- The potential options have the added benefit of raising water levels during low-flow periods as well
- The structural solutions under consideration help return the Richelieu River to a more naturalized state





# Submerged Weir: Selective excavation of the Richelieu River and implementation of a submerged weir

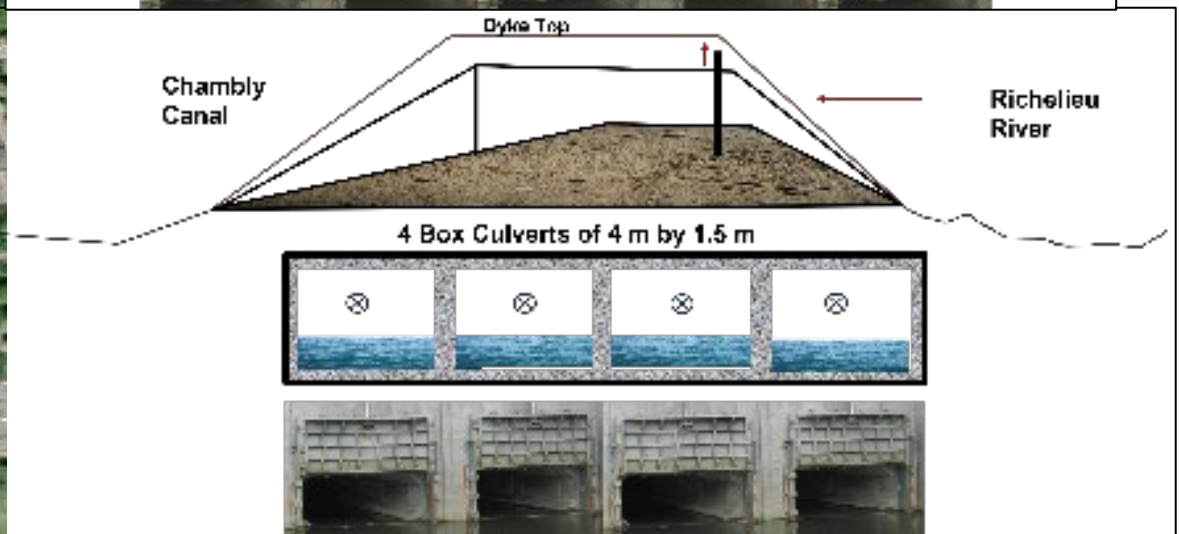
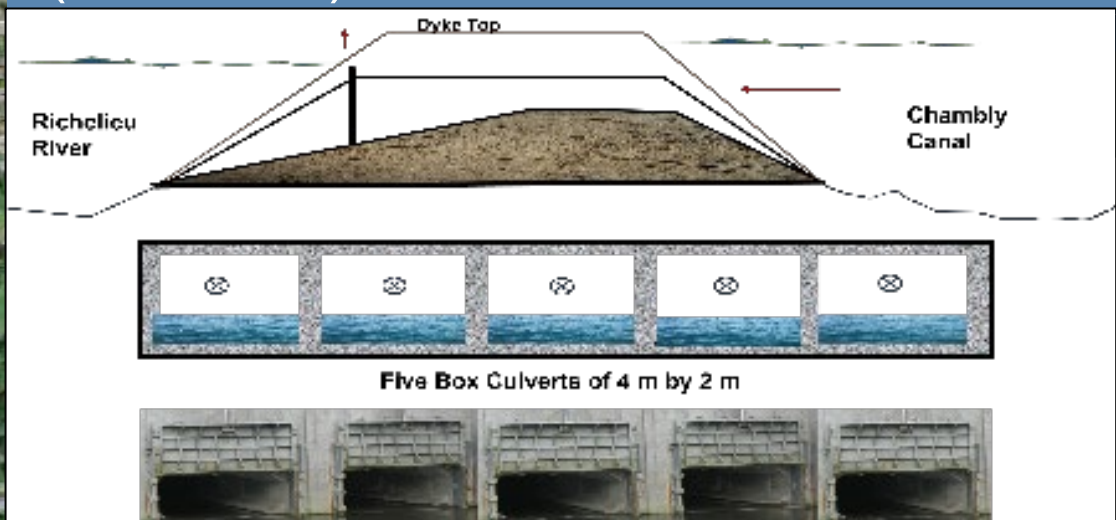


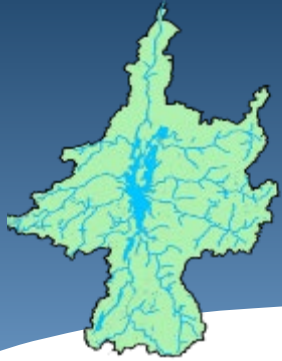
**Submerged weir cross-section**





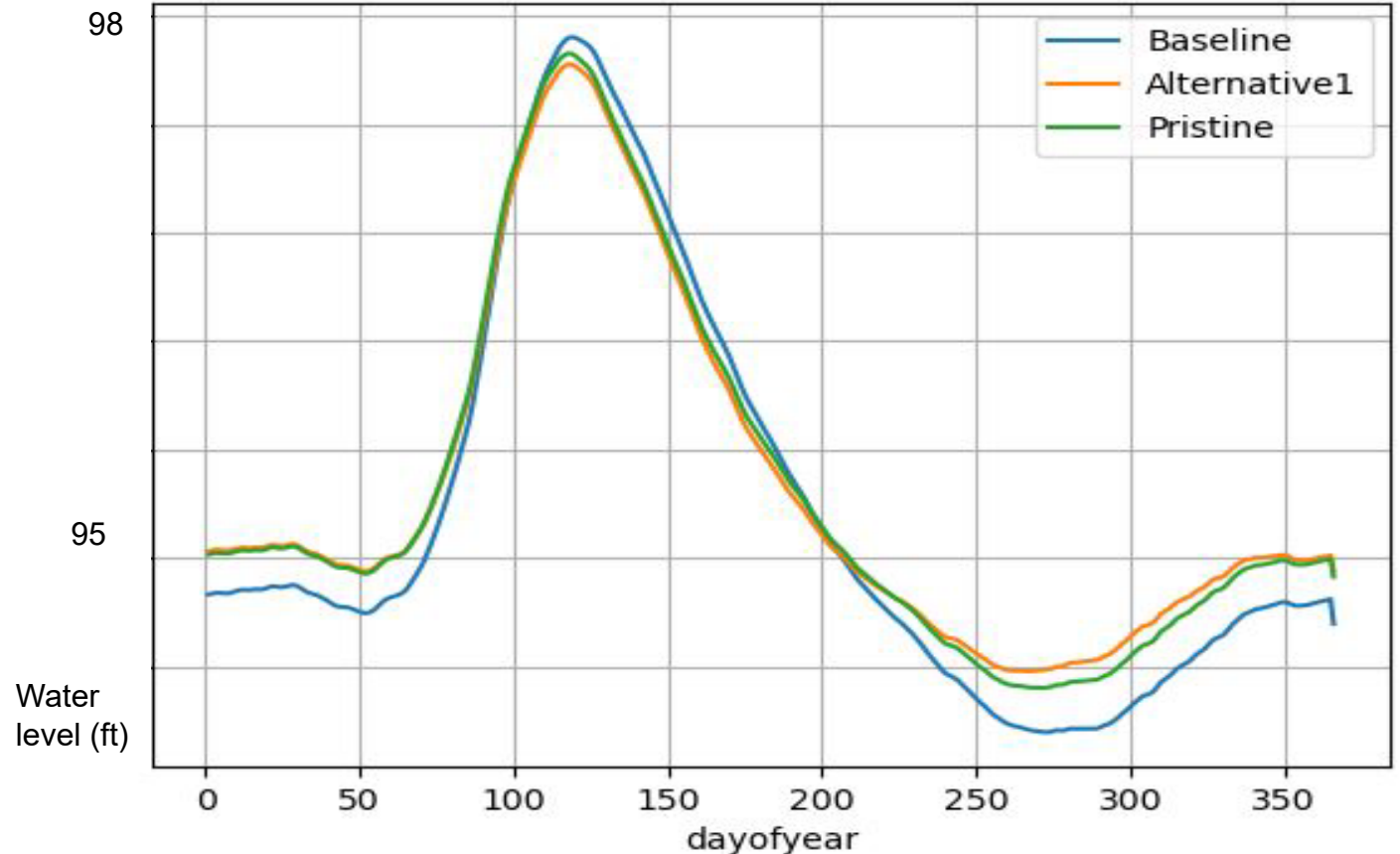
**Weir + Diversion: Submerged Weir/Selective Excavation with Limited Flow Diversion – Capacity 80 m<sup>3</sup>/s (2,825 cfs)**





# General Impacts of the Structural Solutions

- Decrease of lake level (upstream of St-Jean-sur-Richelieu) during the spring flood
- Increase in lake level in summer, fall and winter
- Overall hydraulic behavior closer to the behavior observed before the widening of the canal

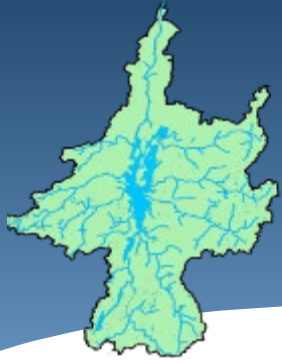




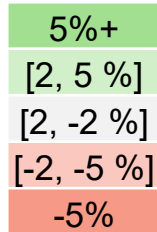
# Structural Solutions

Economic Assessment	Submerged Weir	Submerged Weir + Diversion
Cost of the Structure	\$6 M US (\$8.0 M CAD)	\$15.75 M US (\$21.0 M CAD)
Benefit – Cost Ratio (not including US benefits)	3.4 to 3.9	0.92 to 1.24
Relief for 2011 Flood Event	Submerged Weir	Submerged Weir + Diversion
Water level reduction: • Saint-Jean-sur-Richelieu	6.0 in (15.2 cm)	8.8 in (22.4 cm)
• Lake Champlain at Rouses Point	4.2 in (10.7 cm)	5.6 in (14.2 cm)
Relief for 1965 Low Water Event	Submerged Weir	Submerged Weir + Diversion
Water level improvements (Spring, Fall)	2.8 to 10.9 in (7 to 28 cm)	2.8 to 10.9 in (7 to 28 cm)



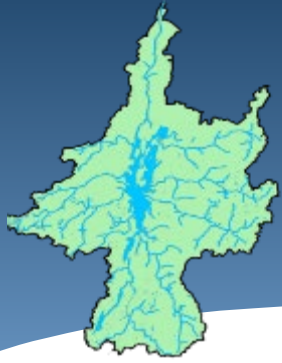


# Environmental Performance Indicators



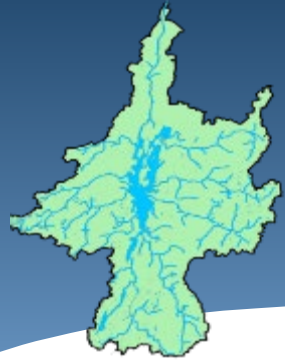
	Submerged weir			Submerged weir + diversion		
	Lake	RR Up	RR down	Lake	RR Up	RR down
Wetlands (marshes and swamps)						
Wetlands (all types)						
Submerged vegetation						
Northern pike spawning area						
Copper redhorse spawning area						
Waterfowl migration habitat						
Least bittern nesting habitat						
Muskrat survival						
Spiny softshell turtle nesting						



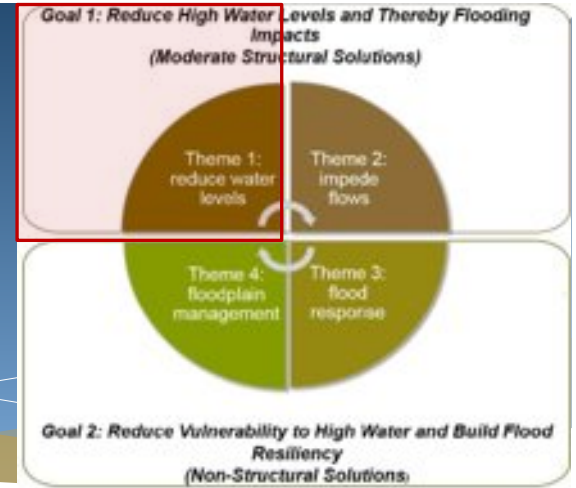


# Evaluation of Structural Alternatives

Criteria #	1	2	3	4	5	6	7
Study Board Decision Criteria	Within study scope and mandate	Technically viable	Economically viable	Environmentally sound	Equitable and fair	Climate change resilient	Implementable
Submerged weir	✓	✓	✓	✓	✓	✓	Pending further jurisdictional discussions
Large Chambly Canal diversion	✓	✗	✗	Not evaluated	Not evaluated	Not evaluated	Not evaluated
Submerged weir + low volume diversion	✓	✓	✓	✓	✓	✓	Pending further jurisdictional discussions



# Draft Recommendation on Theme 1: Structural Solutions

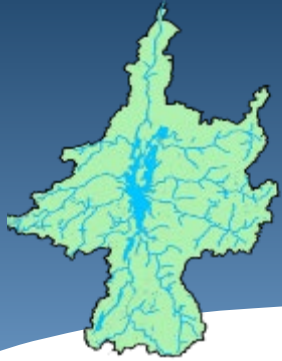


The Study Board recommends the IJC advise governments that a modest level of flood and drought relief can be achieved by returning the Saint-Jean-sur-Richelieu shoal and the hydraulic regime to a more naturalized state, through the removal of some flow-impeding human artifacts and the installation of a submerged weir (Alternative 1).

Additional flood relief can be gained through combining this with a modest diversion through the Chambly Canal (Alternative 3).

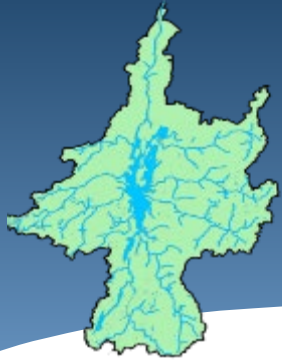
The Study Board has determined that both these alternatives present a viable, moderate structural solution.



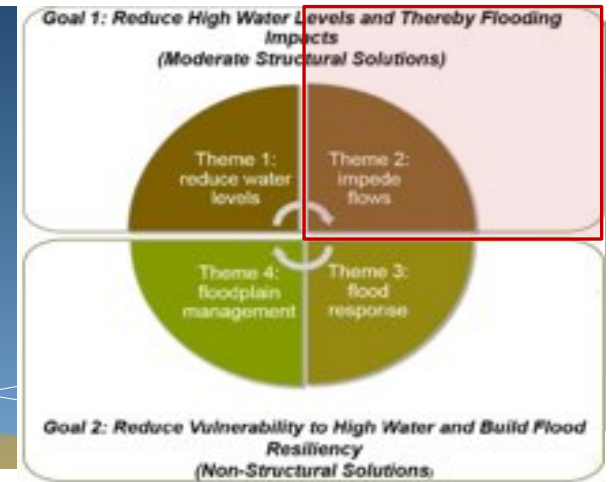


# Discussion: Structural Solutions

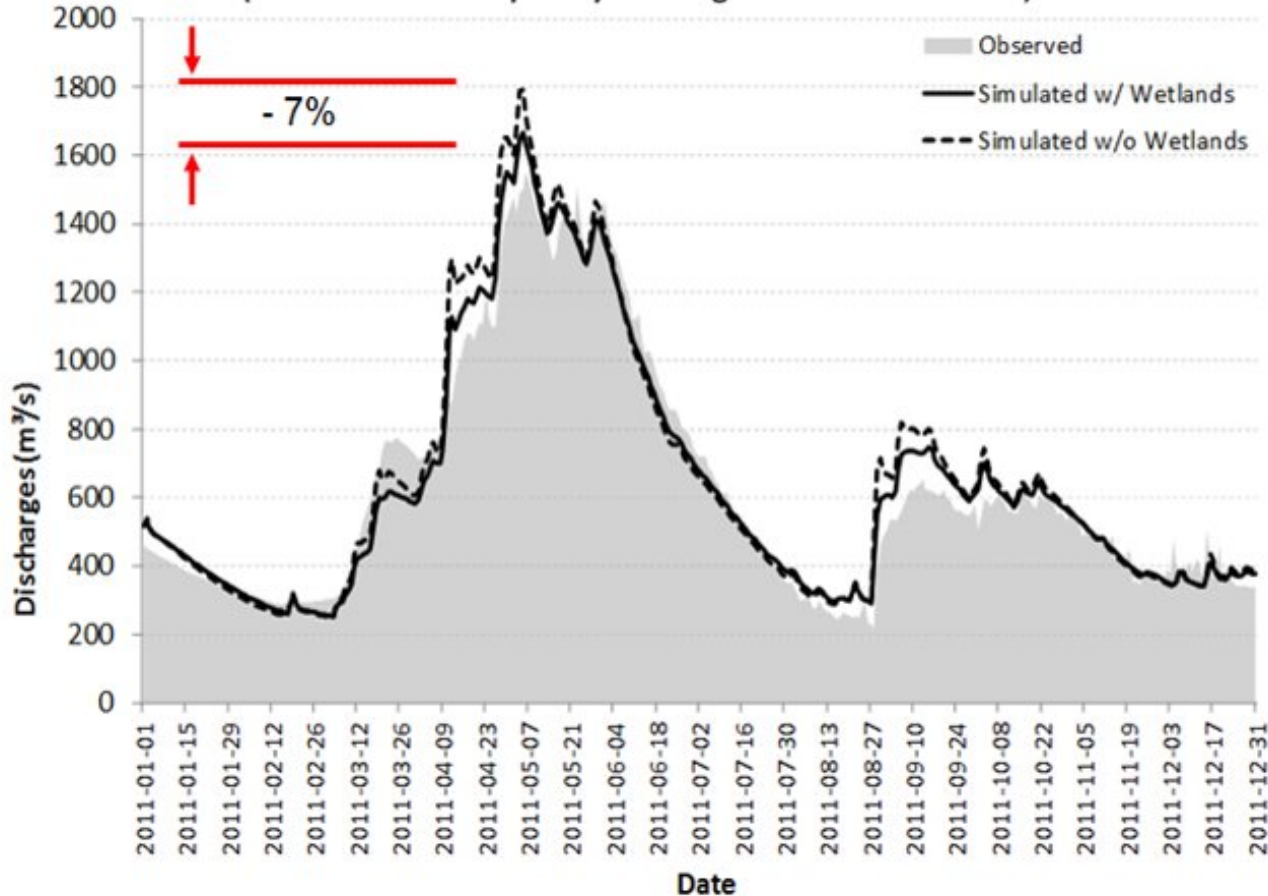
1. Do you think that this recommendation is (will be) acceptable to (residents, lake-related businesses, recreationalists and environmentalists, local/state governments) in the basin? Why or why not?
2. Do you think that this recommendation can be feasibly implemented by local, provincial, state and federal governments and agencies? Why or why not?
3. What obstacles to implementation do you foresee?
4. What plans, programs, or communication and coordination needs to fall into place in order for implementation to occur smoothly?
5. What can federal, state and local governments do to increase the potential for successful implementation of this recommendation?



# Theme 2: Watershed Storage Key Findings

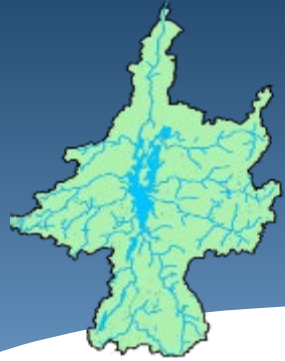


2011 annual hydrograph  
(Richelieu River Rapid Fryers Carignan Station 02OJ007)



- Existing wetlands have a positive impact on reducing flood levels in the basin
- However, expanding wetlands for flood relief at the basin scale would require a large land area (about the size of Lake Champlain). This solution is therefore cost prohibitive (Benefit/Cost  $\sim 0.01$ ) and not practical to implement.

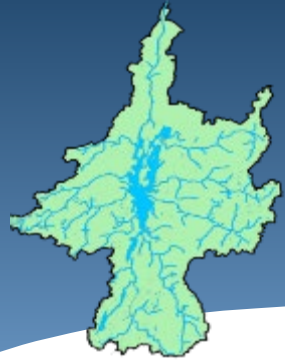




# Effects of Increasing Watershed Storage

- **Significant additional land area** would need to be converted to wetland to have further impacts on water levels during floods

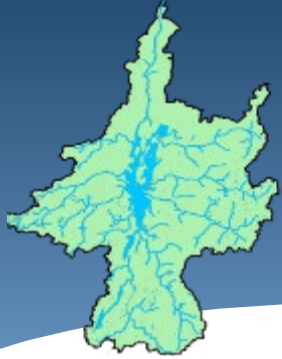
Scenario	Land area converted to wetland (km <sup>2</sup> )	Equivalent land area	Reduction in water levels in a 2011-sized flood (cm)
1. Use farmland (Scenario 1)	2,256	1.8 times Lake Champlain, 5 times the area of Montreal	5
2. GIS designed wetlands (Scenario 2)	647	Half of Lake Champlain, area about equal to New York City	6
3. US EPA wetland (Scenario 3)	865	70% of Lake Champlain	8
4. Combined GIS + EPA (Scenario 4)	1,488 (some overlap)	120% of Lake Champlain	12



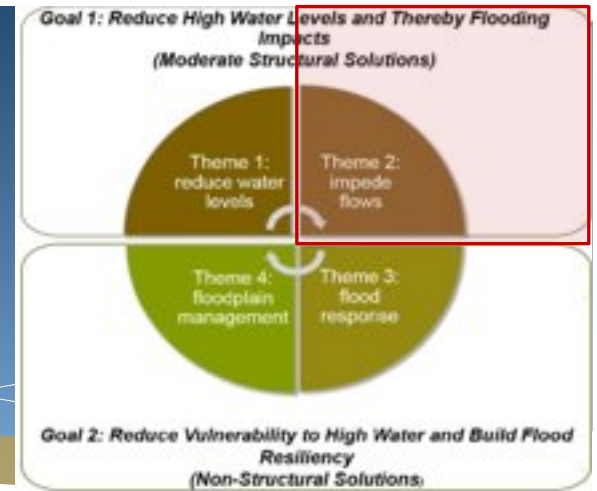
# Evaluation of Watershed Storage Options

Criteria #	1	2	3	4	5	6	7
Study Board Decision Criteria	Within study scope and mandate	Technically viable	Economically viable	Environmentally sound	Equitable and fair	Climate change resilient	Implementable
For Lake Champlain and Richelieu River	✓	✗	✗	Not evaluated	Not evaluated	Not evaluated	Not evaluated



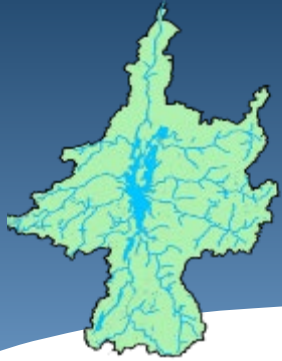


# Draft Recommendation on Theme 2 : Watershed Storage



The Nature Conservancy

The Study Board recommends that the IJC encourage the governments to continue protection of existing wetlands as they provide some level of flood relief at the basin scale.



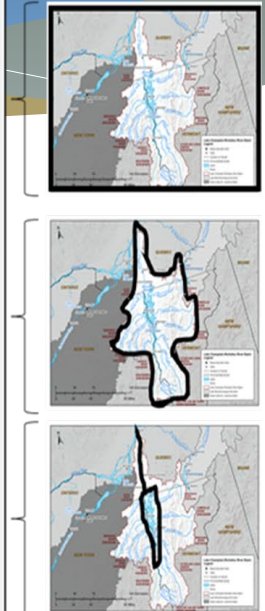
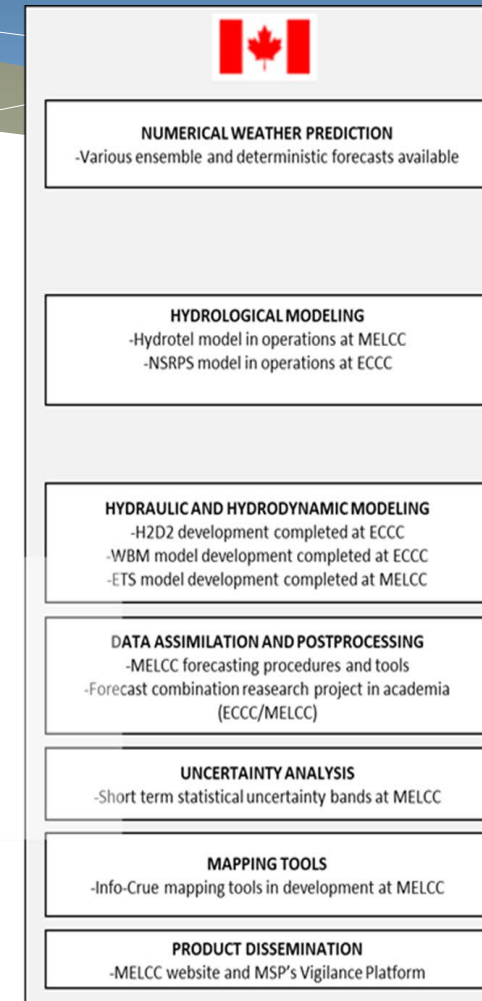
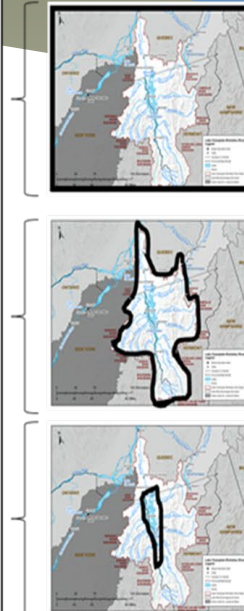
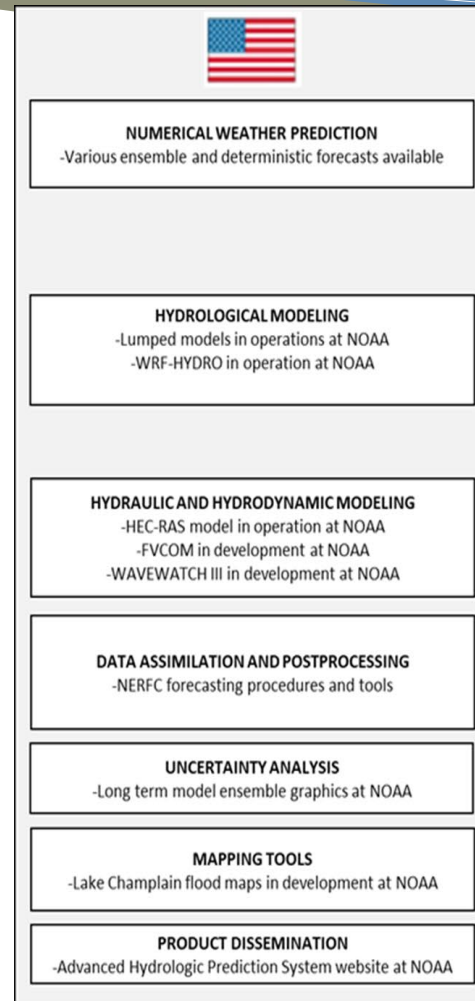
# Discussion: Watershed Storage

1. Do you think that this recommendation is (will be) acceptable to (residents, lake-related businesses, recreationalists and environmentalists, local/state governments) in the basin? Why or why not?
2. What obstacles to implementation do you foresee?
3. What plans, programs, or communication and coordination needs to fall into place in order for implementation to occur smoothly?
4. What can federal, state and local governments do to increase the potential for successful implementation of this recommendation?



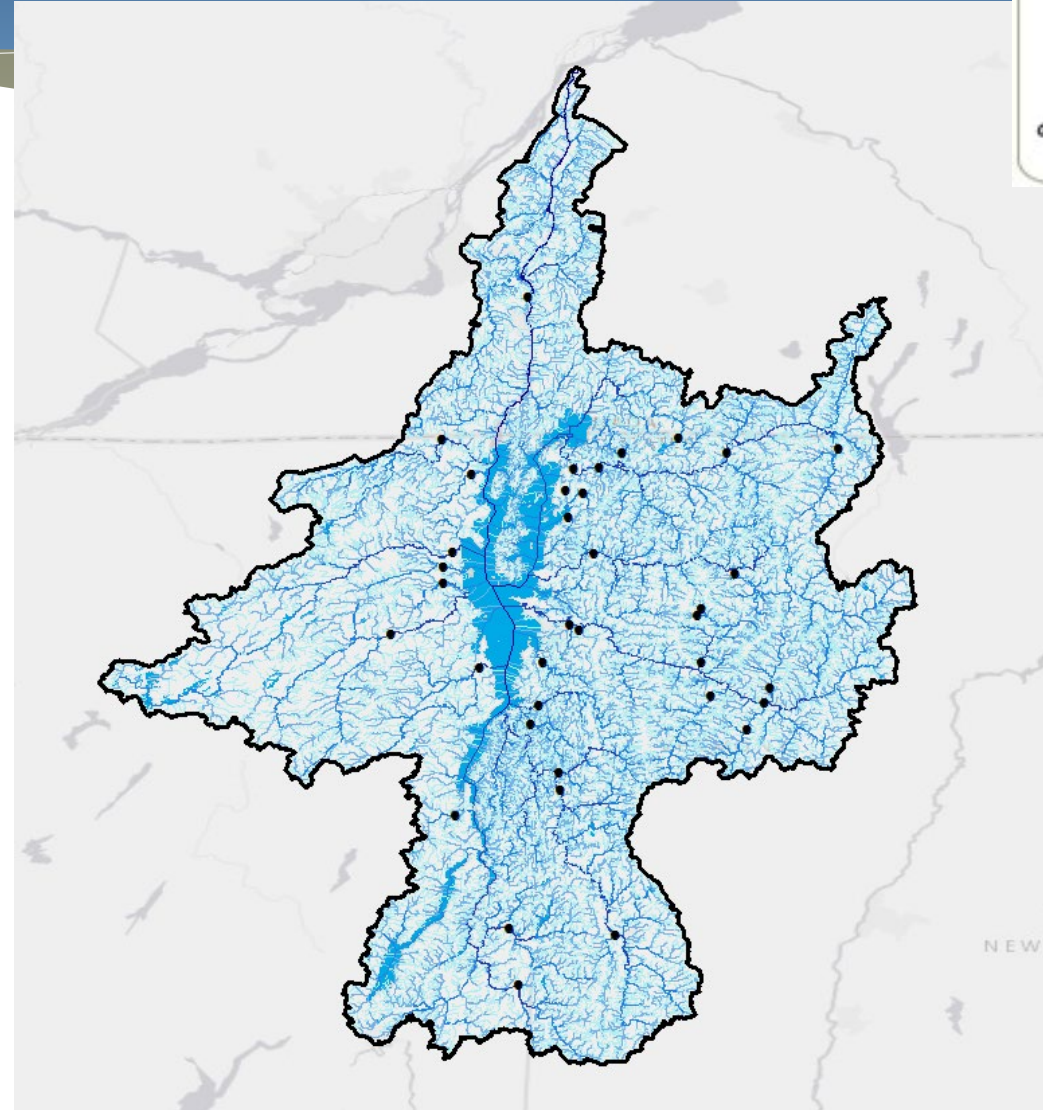
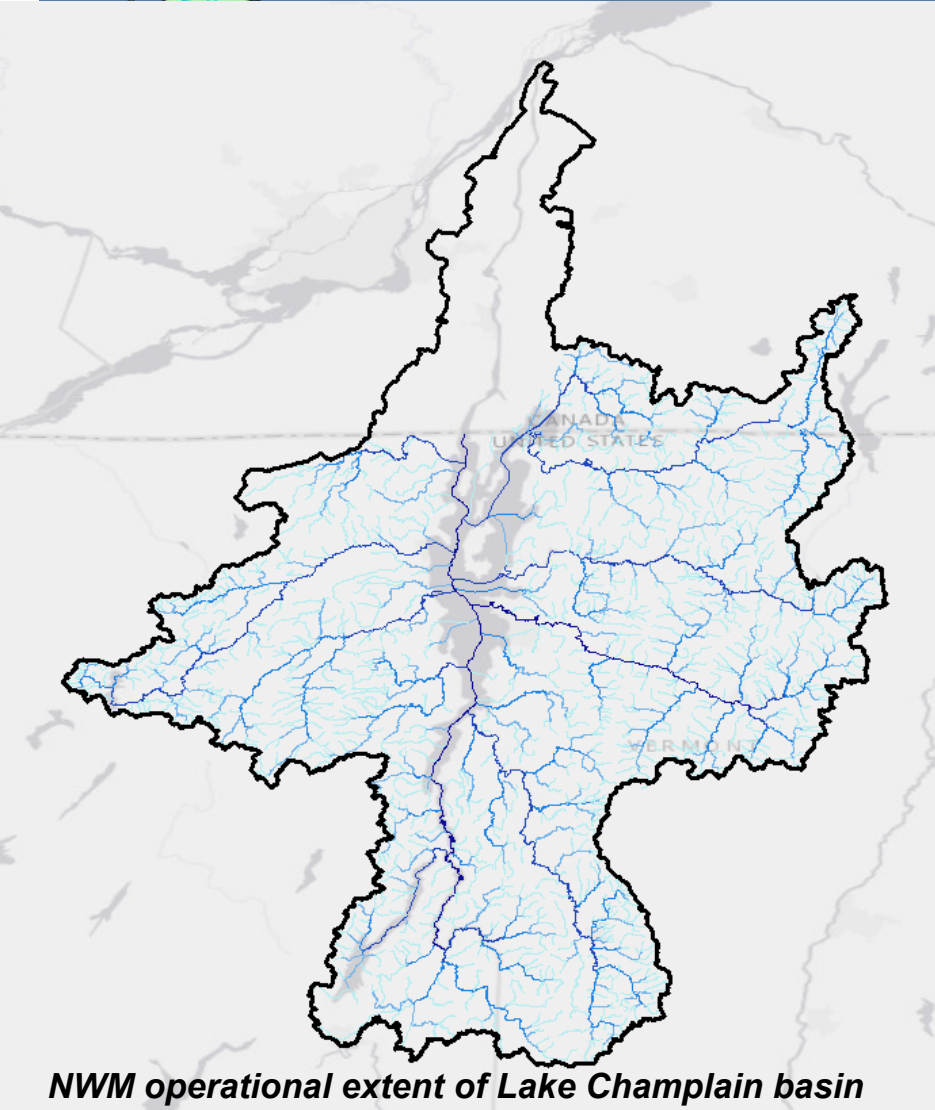
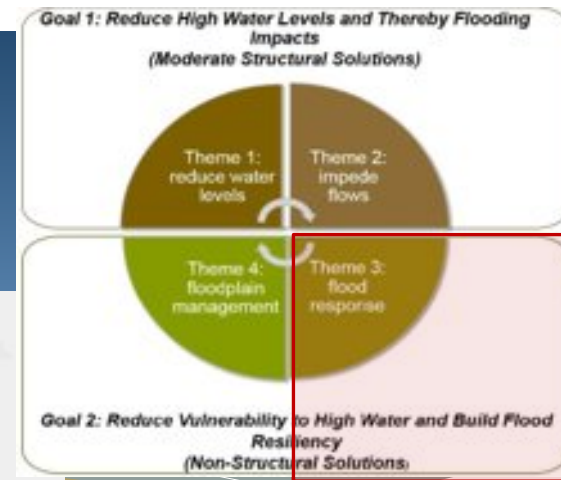
# Theme 3: Reduce flood vulnerability and build flood resilience through improved preparedness

- The Quebec / Canada and U.S. forecast systems have been improved and a 5-day prediction has been created.
- Although working together, forecasts are produced with the two modeling chains.
- The current coordination is working well.
- The Study wants to encourage countries to continue working together to ensure consistency.

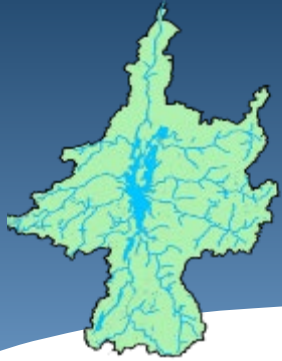




# Hydrologic Modeling



- Improved hydrologic models for the LCRR basin have been created for forecasting
- In the US, these modeling improvements increase our ability to produce flooding forecasts for the tributaries to Lake Champlain



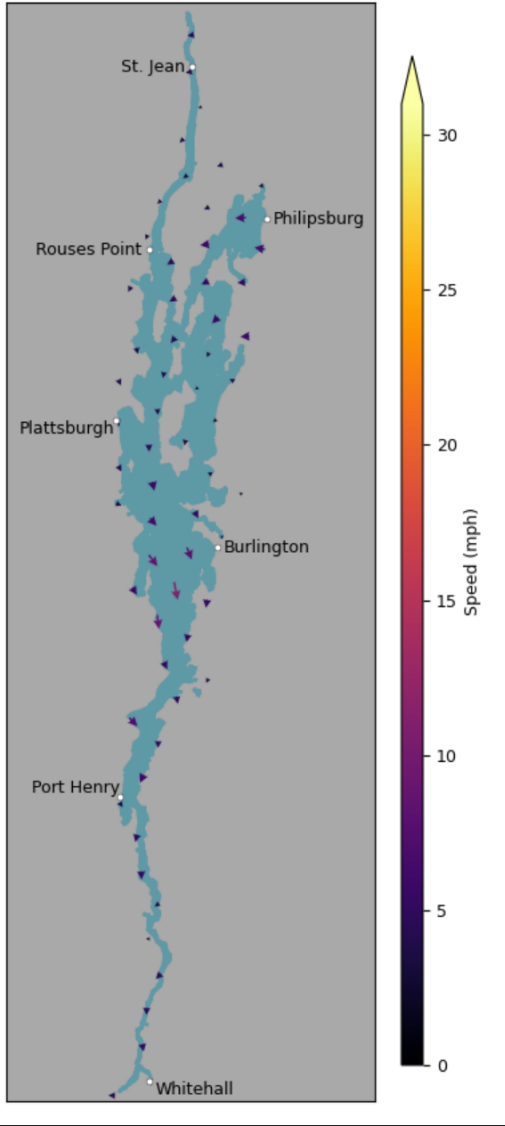
# Transition to Operations

- The study upgraded U.S. operational hydrologic predictions for the Lake Champlain basin to (1) improve forecasting, and (2) increase the quality and quantity of inflow to lake models
  - NOAA National Water Model v2.1 upgrade occurred in Spring 2021
- The National Weather Service currently operates a 1D hydraulic model for Lake Champlain water level predictions, but it cannot account for wind and wave conditions
  - NOAA is now running an experimental lake hydrodynamic model driven by river inflow and wind conditions is planned for operations in several years
- The study developed the first ever wave prediction model of the lake
  - Planned for transition to operations by 2023



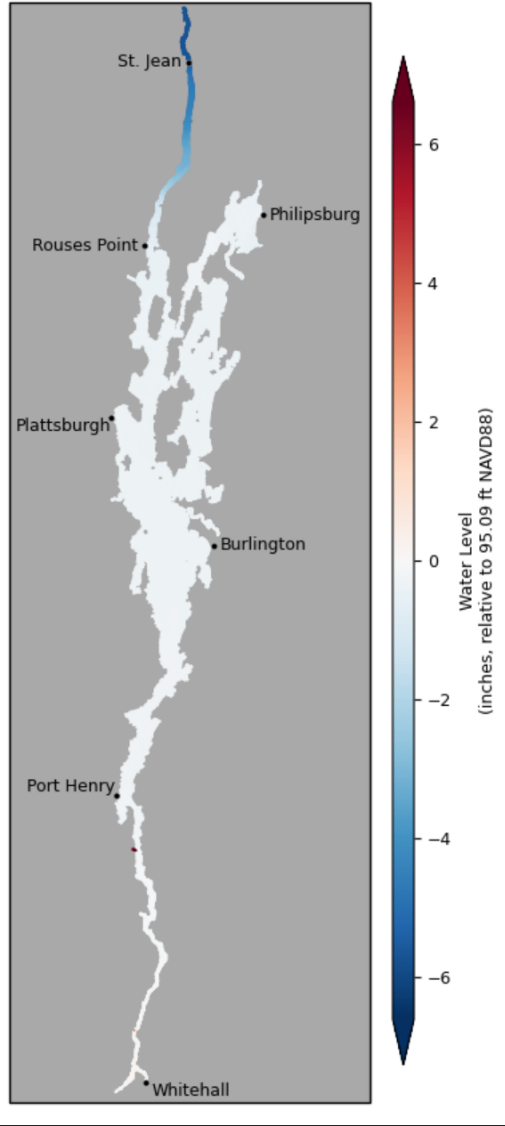
### Wind Velocity ⓘ

Lake Champlain Wind  
June 11, 2021 06:00 UTC (Nowcast)



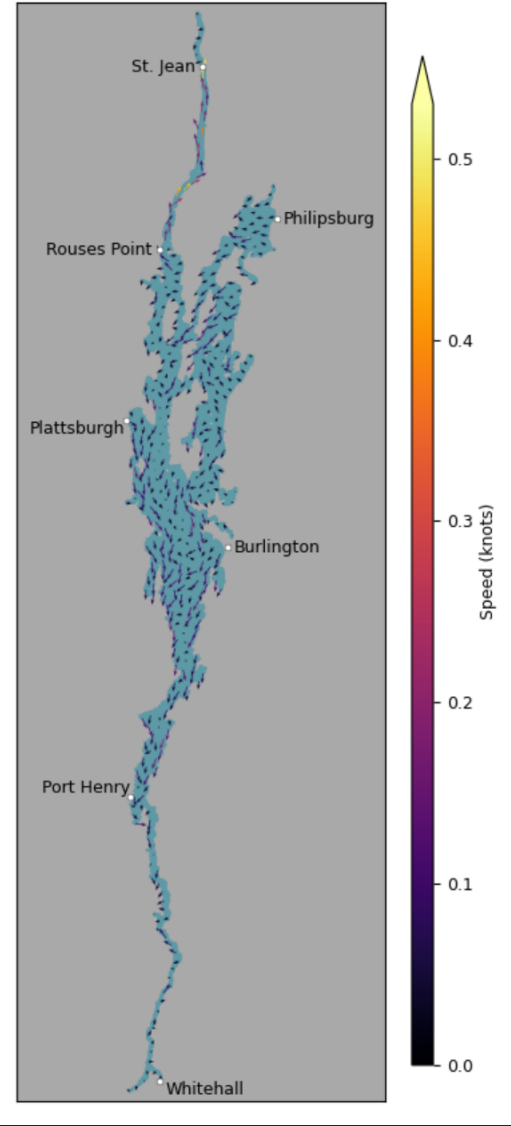
### Water Level Change ⓘ

Lake Champlain Water Level  
June 11, 2021 06:00 UTC (Nowcast)



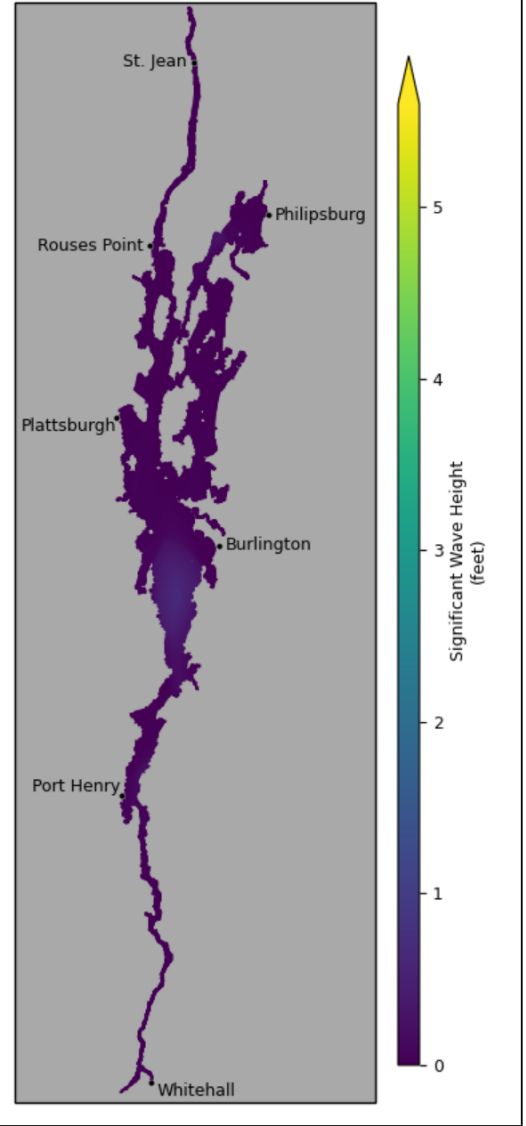
### Surface Currents ⓘ

Lake Champlain Surface Currents  
June 11, 2021 06:00 UTC (Nowcast)



### Waves ⓘ

Lake Champlain Wave Height  
June 11, 2021 06:00 UTC (Nowcast)



▶  Interactive Current Conditions

▶  Interactive Current Conditions

▶  Interactive Current Conditions

▶  Interactive Current Conditions

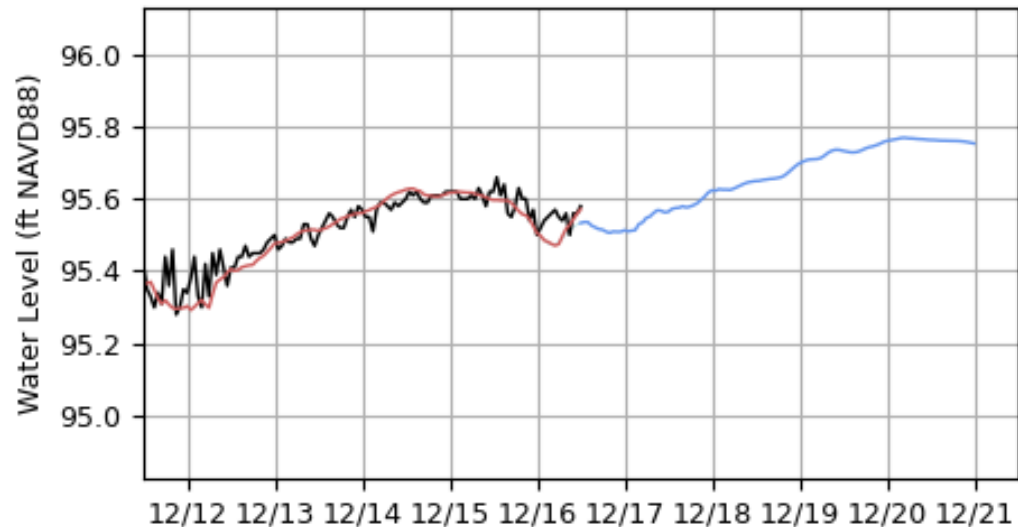
# Water Level ⓘ

<https://www.glerl.noaa.gov/res/champlain/>

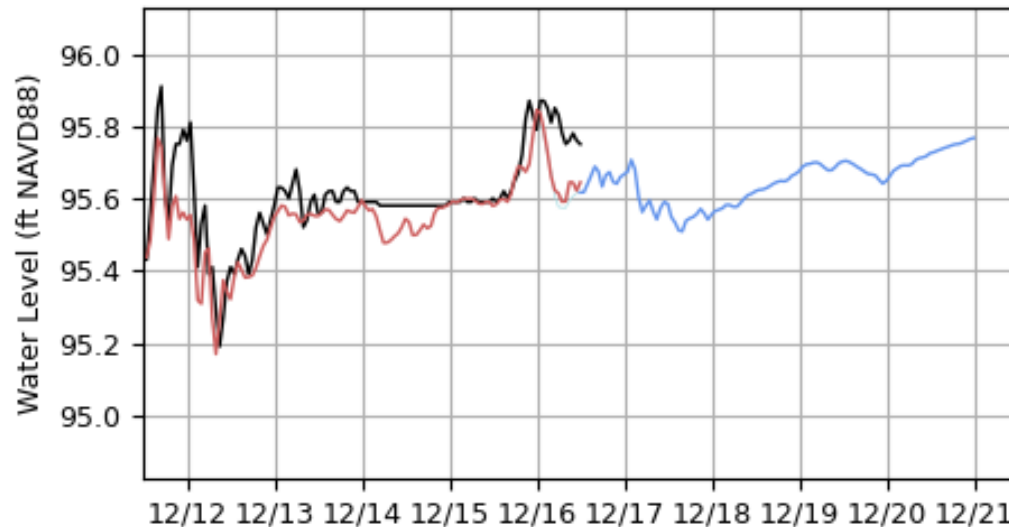
### Lake Champlain Nowcast / Forecast Dec 11, 2021 to Dec 21, 2021

— Observed — Nowcast — Forecast

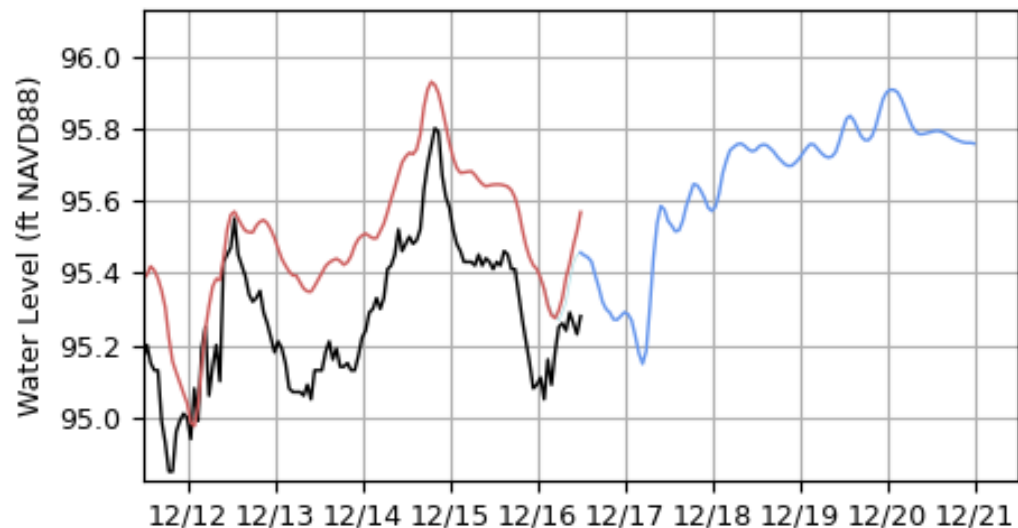
#### Burlington, VT



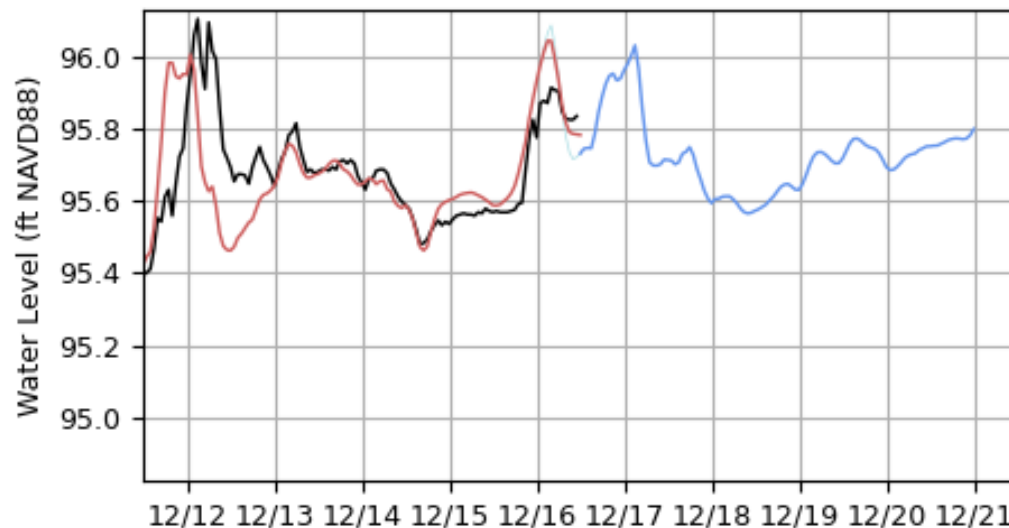
#### Rouses Point, NY



#### Whitehall, NY



#### Philipsburg, QC







Find Location

Flood Inundation Mapper

User Guide About Print

New York: Richelieu R (Lake Champlain) at Rouses Point (04295000)

Zoom to Location Share

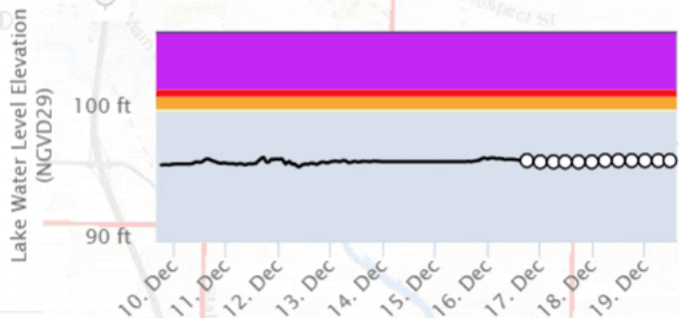


Explanation



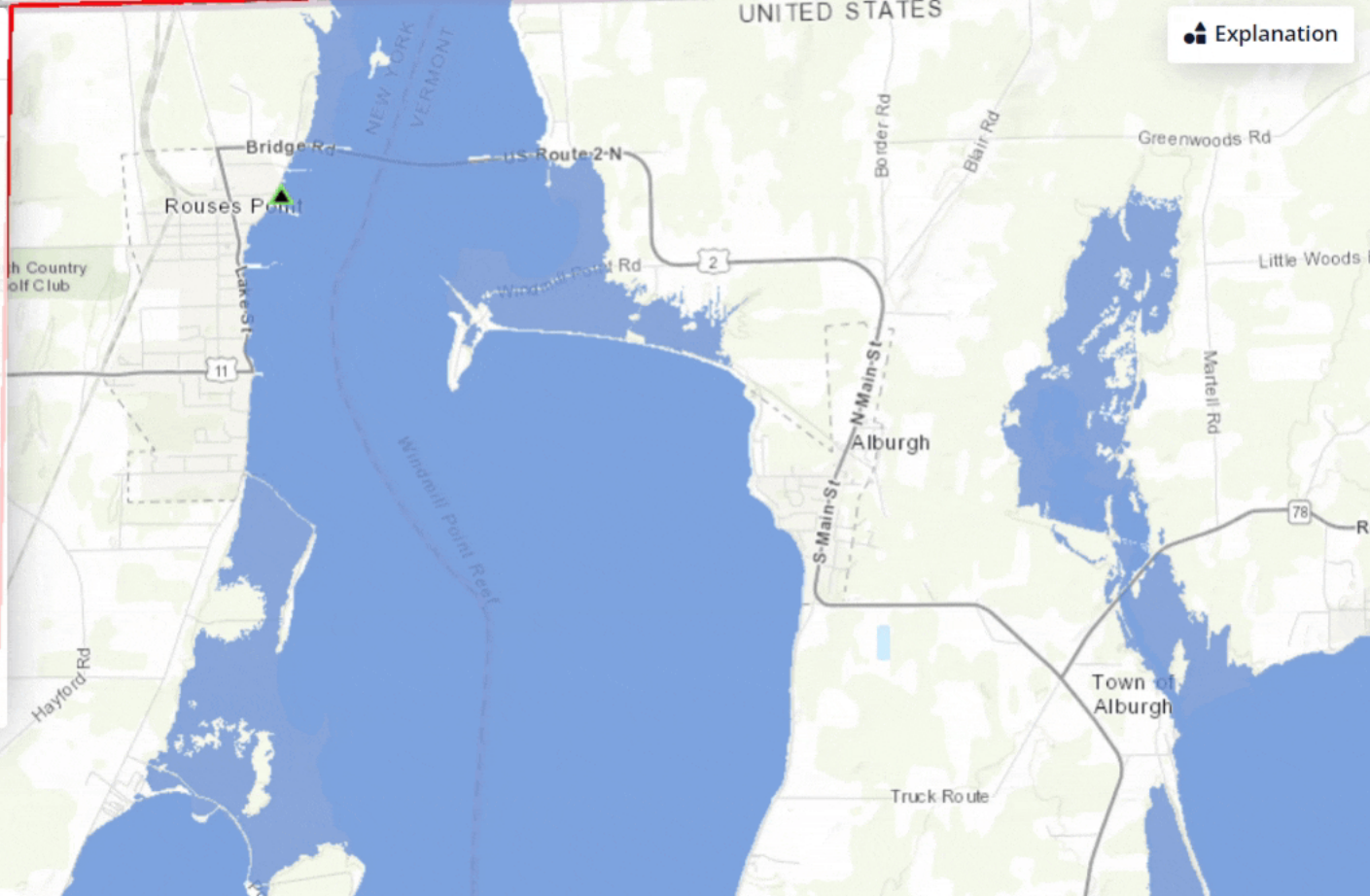
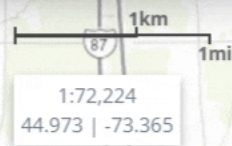
Site Info & Conditions Hydrograph Services & Data

New York: Richelieu R (Lake Champlain) at Rouses Point (04295000)

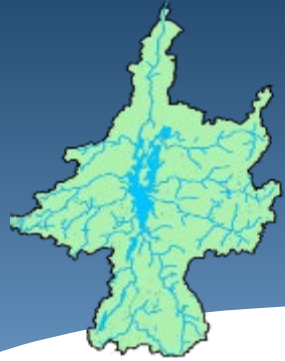


Selected Lake Water Level Elevation (NGVD29): 100.00ft  
Selected Discharge: N/Acfs  
 View Satellite Imagery  
 View Depth Grids

NWS Stages  
Major Extended Rating  
Moderate  
Minor Below Action  
Action





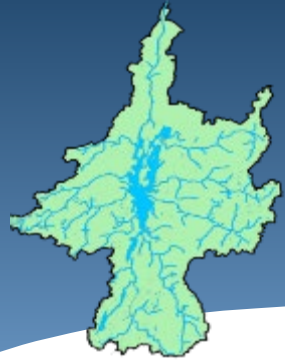


# Theme 3: Flood Response Key Findings

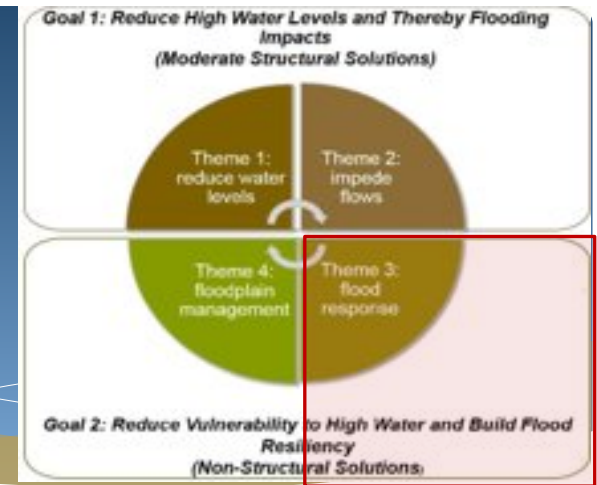


- The Study has created improved versions of the U.S. and Canadian flood forecasting and inundation mapping systems, including 5-day forecasting through improved hydrologic, hydraulic, hydrodynamic, and wave models of Lake Champlain and the surrounding basin.
- Advancements in modeling improve official forecasts and emergency response.
- The Study Board considered recommending joining the separate forecasts of lake and river levels across the border, but the consensus of expert advisors was that existing binational coordination works well.
- The two countries work together while producing mainly independent forecasts. The Study wants to encourage countries to continue to work together to ensure forecast and map coherency.





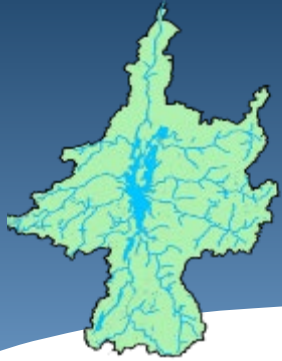
# Draft Recommendation on Theme 3: Flood Response



The Study Board recommends that the IJC advise the governments that:

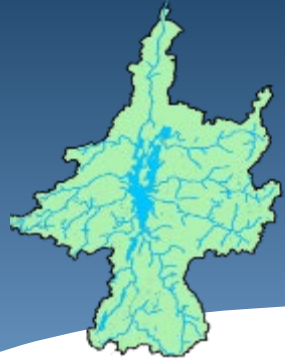
- Work to improve the functionality and implementation of coherent risk assessment systems will need to be supported after the Study in both countries.
- State-of-the-art modelling tools (such as the Integrated, Social, Economic and Environmental system <sup>TM</sup>) developed for the Lake Champlain-Richelieu River basin can greatly aid flood response planning and should be maintained.





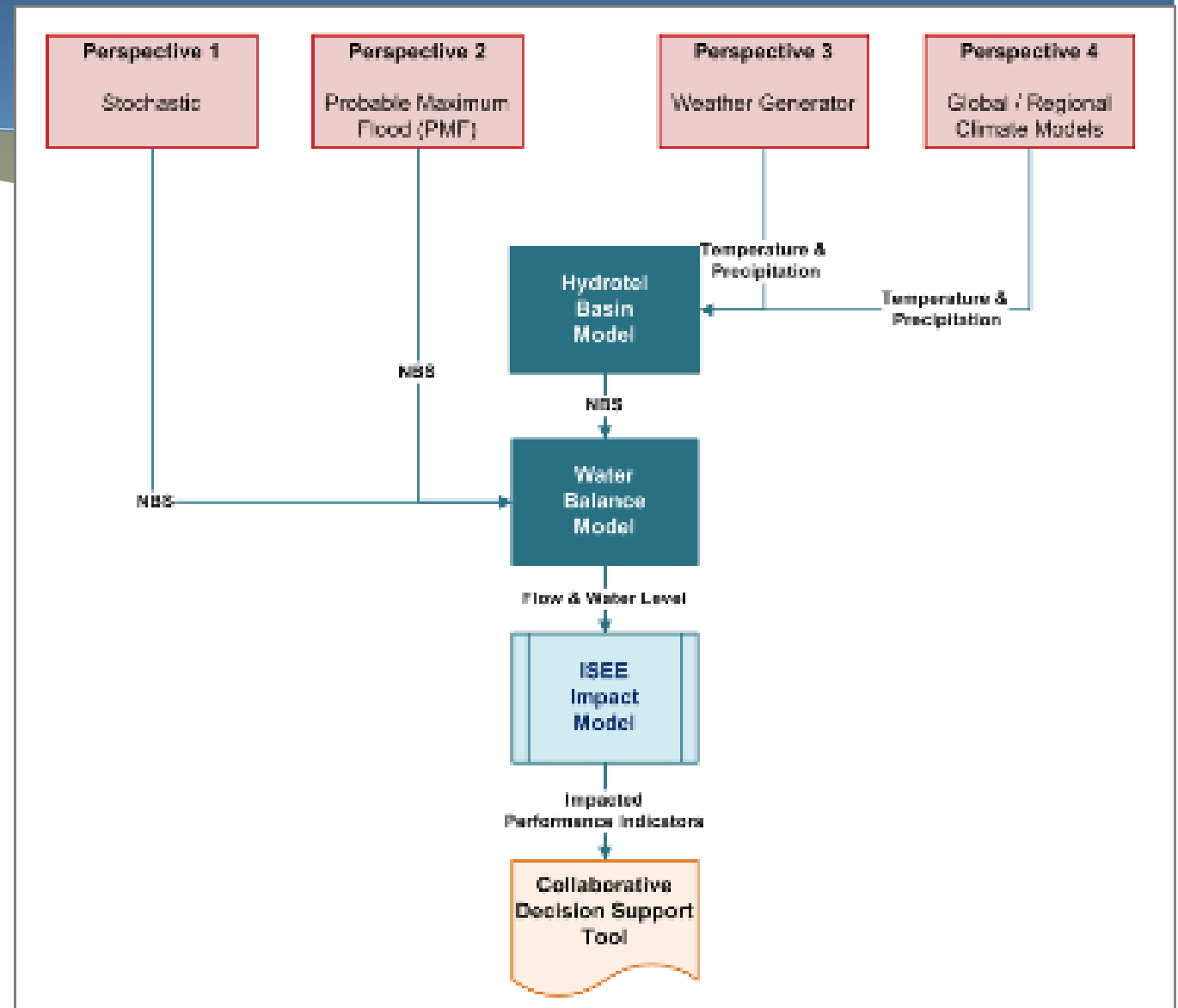
# Discussion: Forecasting

1. Do you think that this recommendation is (will be) acceptable to (residents, lake-related businesses, recreationalists and environmentalists, local/state governments) in the basin? Why or why not?
2. Do you think that this recommendation can be feasibly implemented by local, state and federal governments and agencies? Why or why not?
3. What obstacles to implementation do you foresee?
4. What plans, programs, or communication and coordination needs to fall into place in order for implementation to occur smoothly?
5. What can federal, state and local governments do to increase the potential for successful implementation of this recommendation?



# Climate Change

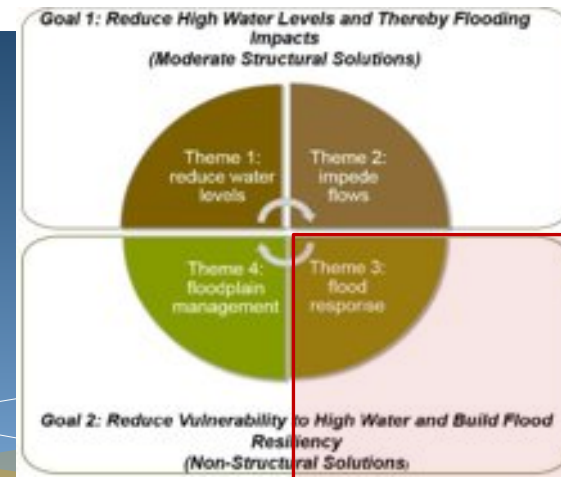
- The Study is using decision scaling, following the IJC Climate Change Guidance Framework
- Climate is deeply uncertain, one cannot plan on any one prediction, so we look for resilient plans that work under a variety of plausible futures
- The Study assessed climate change from four different analytic perspectives: stochastic models, probable maximum flood, a weather generator, and global/regional climate models



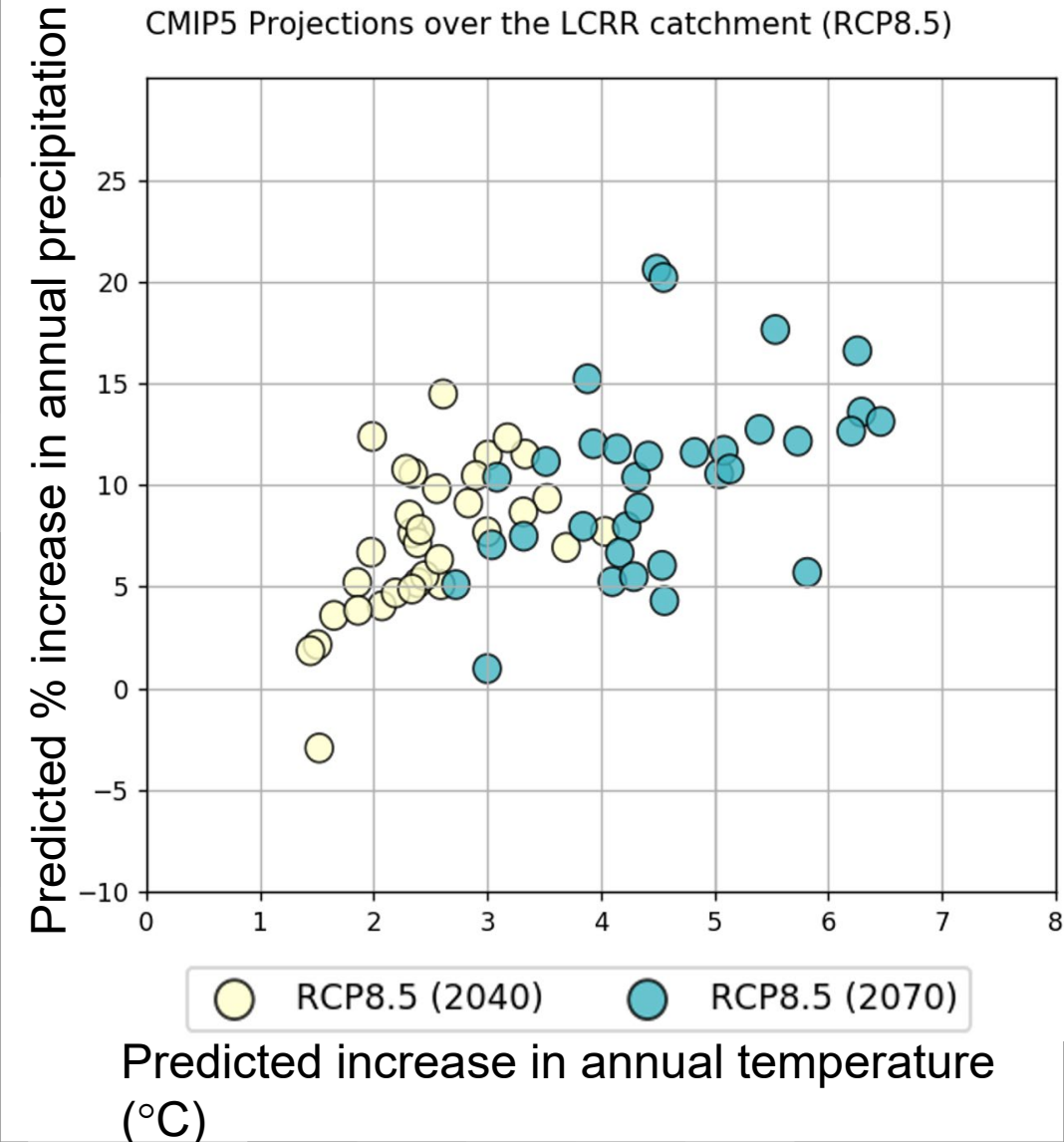




# Theme 3: Climate Change Key Findings



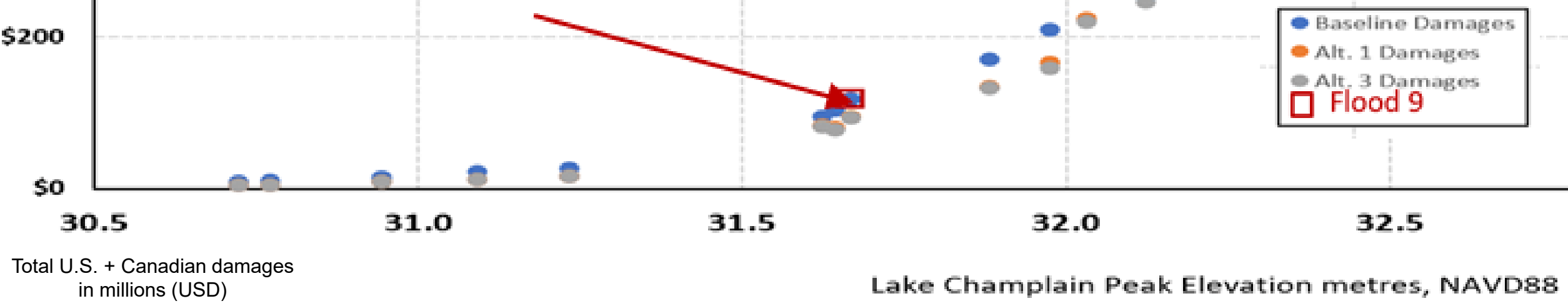
CMIP5 Projections over the LCRR catchment (RCP8.5)

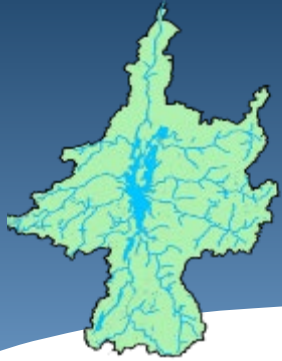


- The Study modeled future climate scenarios
- Predictions varied from slightly less to slightly more inflows to Lake Champlain later this century
- Although there is variability in future scenarios, modeling indicated that a flood larger than that of 2011 is not very likely but is possible.

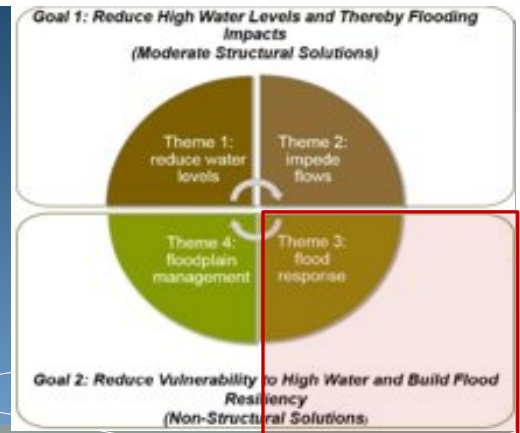
# Damages are non-linear

*0.3 m higher than 2011*



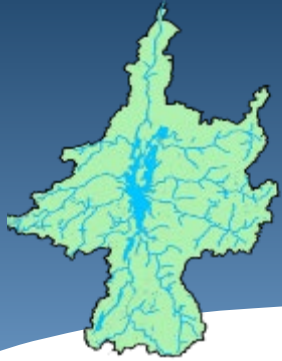


# Draft Recommendation on Theme 3: Climate Change & Flood Response



- The Study Board recommends that the IJC advise the governments that the variety of climate modeling approaches applied by the Study all indicated the potential for larger, more damaging floods than 2011. This information should be shared with communities and its consideration in their floodplain management and emergency plans should be encouraged.

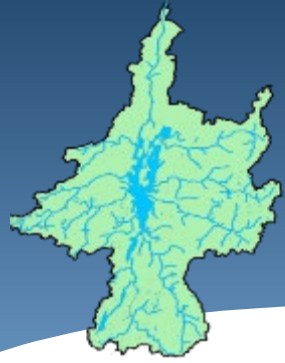




# Discussion: Climate Change and Flood Response

1. Do you think that this recommendation is (will be) acceptable to (residents, lake-related businesses, recreationalists and environmentalists, local/state governments) in the basin? Why or why not?
2. Do you think that this recommendation can be feasibly implemented by local, state and federal governments and agencies? Why or why not?
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# Theme 4: Floodplain Management Key Findings

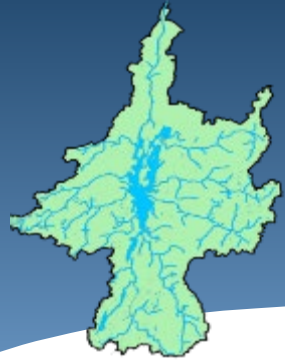


## 1. Flood Mapping

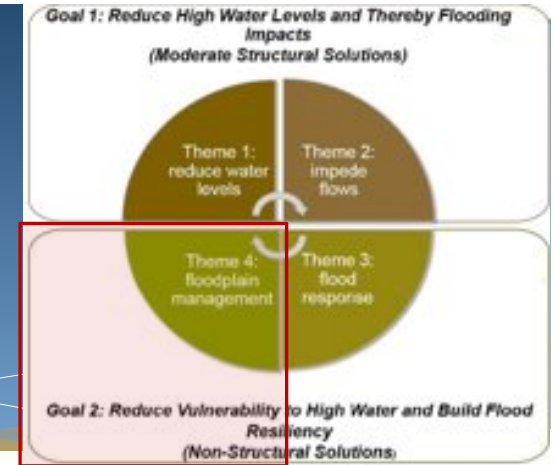
- Create maps for targeted audiences
- Update maps to add more detail to planning maps

## 2. Flood risk communication

- Encourage insurance take-up
- Encourage community-level flood emergency planning
- Inform potential buyers about flood risk to properties
- Adopt best practices for effective campaigns and messages



# Theme 4: Floodplain Management Key Findings

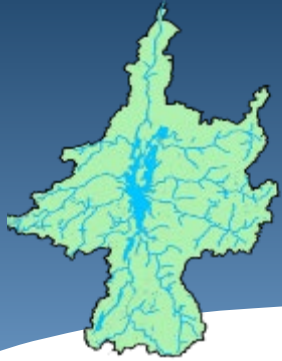


## 3. Management of Floodplain Occupancy

- Update land use regulations based on flood risk
- Shield development in high-risk flood zones

## 4. Flood Insurance

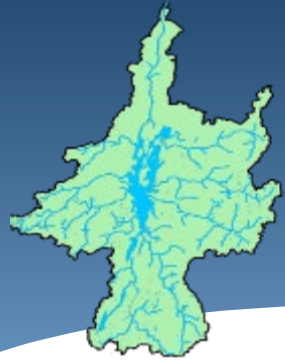
- Investigate the state of flood insurance
- Negotiate a layered arrangement to share financial liability
- Use multiple levers to motivate insurance purchase



# Flood Insurance Efforts in Canada

- We are working closely with Canadian efforts to explore a flood insurance program. Canada is one of only two OECD (Organization for Economic Cooperation and Development) countries in the world that does not have flood insurance for those in the 100-year floodplain.
- The study has developed a three-layer flood insurance model to promote flood resiliency, which is under review by Public Safety Canada.
- Our collaboration in the Richelieu River may help Canada evolve into an approach more consistent with U.S. floodplain management approaches.





# Draft Recommendation on Theme 4: Floodplain Management



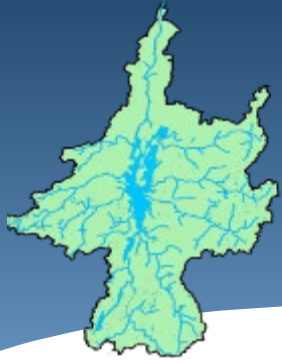
The Study Board recommends that the IJC encourage the governments to work with the jurisdictions, private sector and communities to explore the ideas and analytical modelling approaches presented in the Study's *Integrated Flood Risk Management Strategy for the Lake Champlain -Richelieu River basin*.



The Lake Champlain Committee

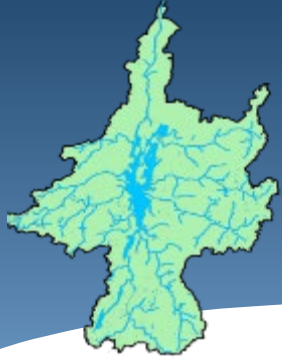






# Discussion: Floodplain Management

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3. What obstacles to implementation do you foresee?
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5. What can federal, state and local governments do to increase the potential for successful implementation of this recommendation?



# Next Steps after the Study

The Study will present recommendations to the IJC in March, 2022



The IJC will hold additional public and stakeholder meetings to receive feedback on the Study findings and recommendations

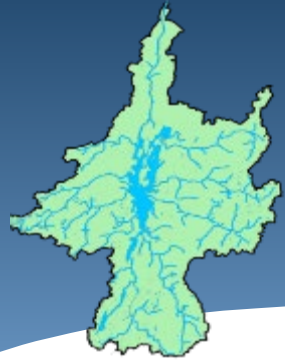


The IJC will deliver finalized recommendations to the Federal governments of Canada and the US by December, 2022



The Governments will decide on the implementation of the Study recommendations





Thank you



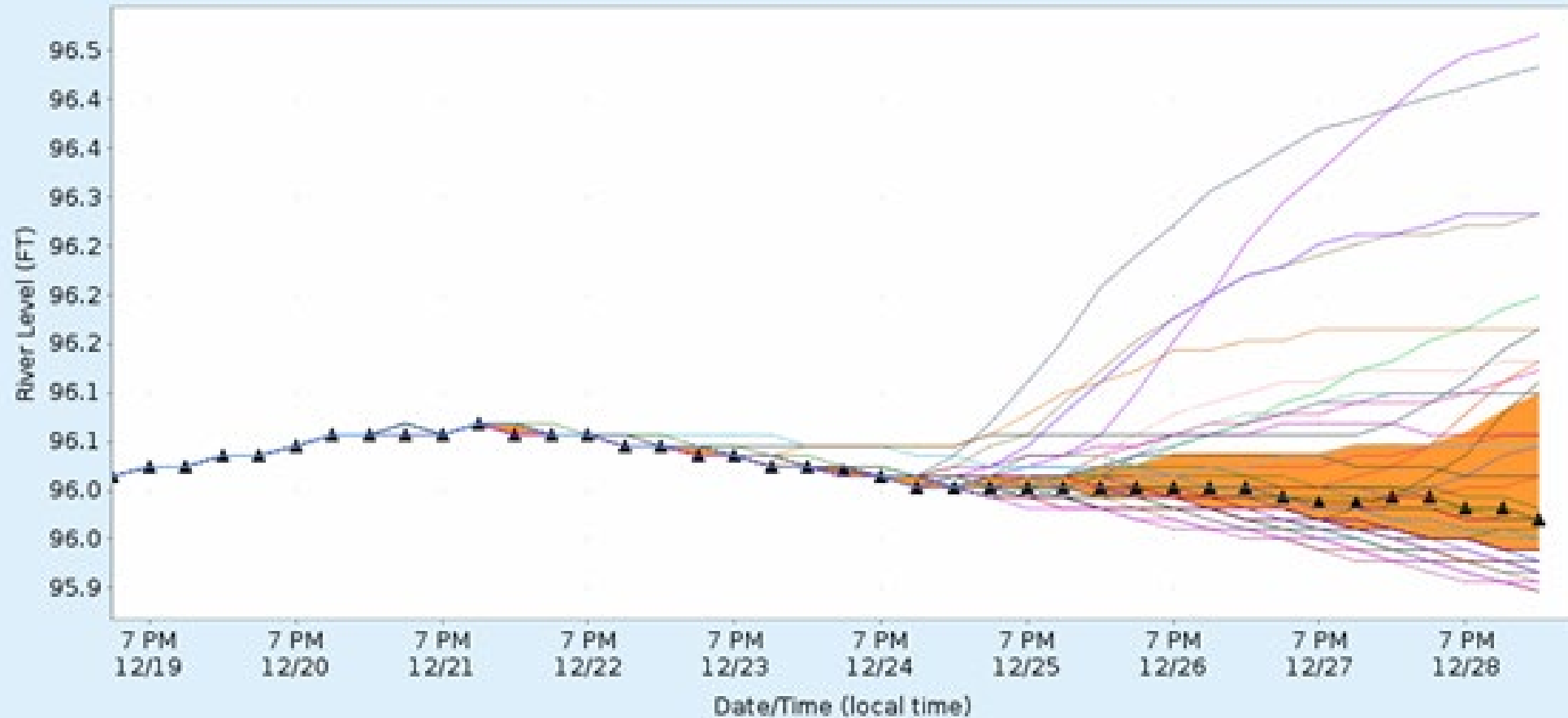


# 7 Day NAEFS River Level Simulations

Used to Estimate the Chance of Flooding and the Range of Possible River Levels  
Each Line Shows an Individual Model Simulation (42 Total)



## Richelieu River at Rouses Point, NY (ROUN6)



- Individual Model Simulations (42 Total)
- ▲ Median River Level (Simulations indicate a 50% Chance of Exceeding this Level)
- More Likely Range (Simulations indicate a 40% chance river levels will fall within this range)