Modeling Reservoir and Canal Operations for Irrigation Projects in Saskatchewan, Canada

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Image Source

Presentation Overview

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II. Project Overview

III. Introduction to IMS/DMS

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   II. Short Term Operations Model

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Image Source

Introduction

- Across river basins in North America, there is high variability of:
  1. Thoroughness of policy
  2. Data quality
- Policy and data collection system develop when needs arise, and needs arise at different times across basins due to factors such as:
  - Development
  - Evolving Conflict
  - Climate Change

Framework Recommendation

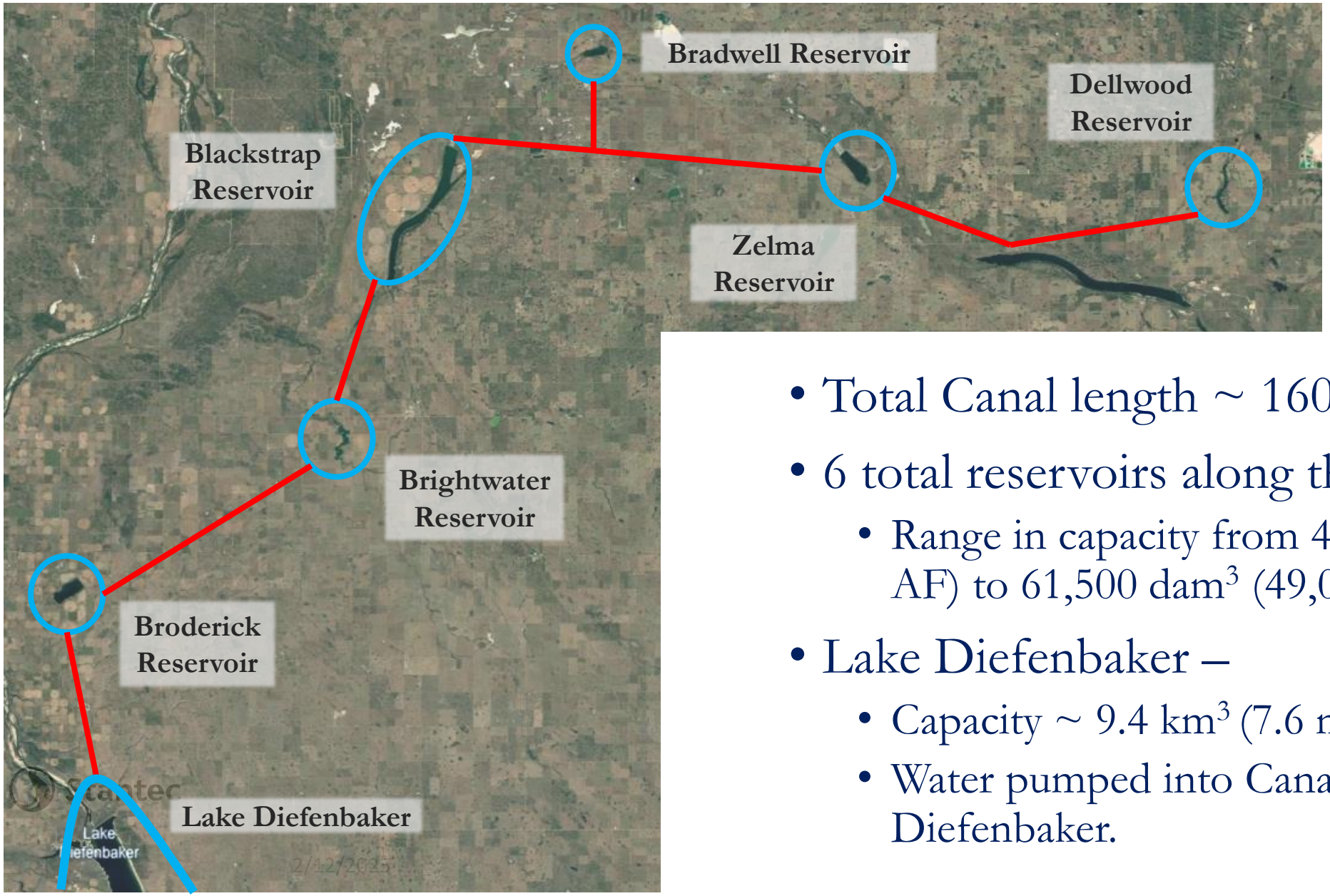
- **Initial model screening:** eliminated GOLDSIM, MODSIM, OASIS, RIBASIM, STELLA, WRIMS, and WRMM
- **Remaining models evaluated in detail:** HEC software, MIKE software, RiverWare, and WEAP
- **Model evaluation criteria:** simulation methodology, temporal resolution, technical support/user community, data management and interfacing capability, GUI and ease of use, and cost and level of effort.
- **Recommended modeling framework:** RiverWare + HEC-RAS

Project Overview

- **Client:** Water Security Agency (WSA)
- **Location:** Saskatchewan, Canada
- Responsible for conveying water to various users along a system of Canals
- Motivated to address water supply needs due to development and changing climate patterns.
- Commissioned Stantec and PWRE to develop a new modeling framework known as the Integrated Modeling System (IMS) to provide technical support for their evolving needs.

Project Area Overview

Project Area Overview



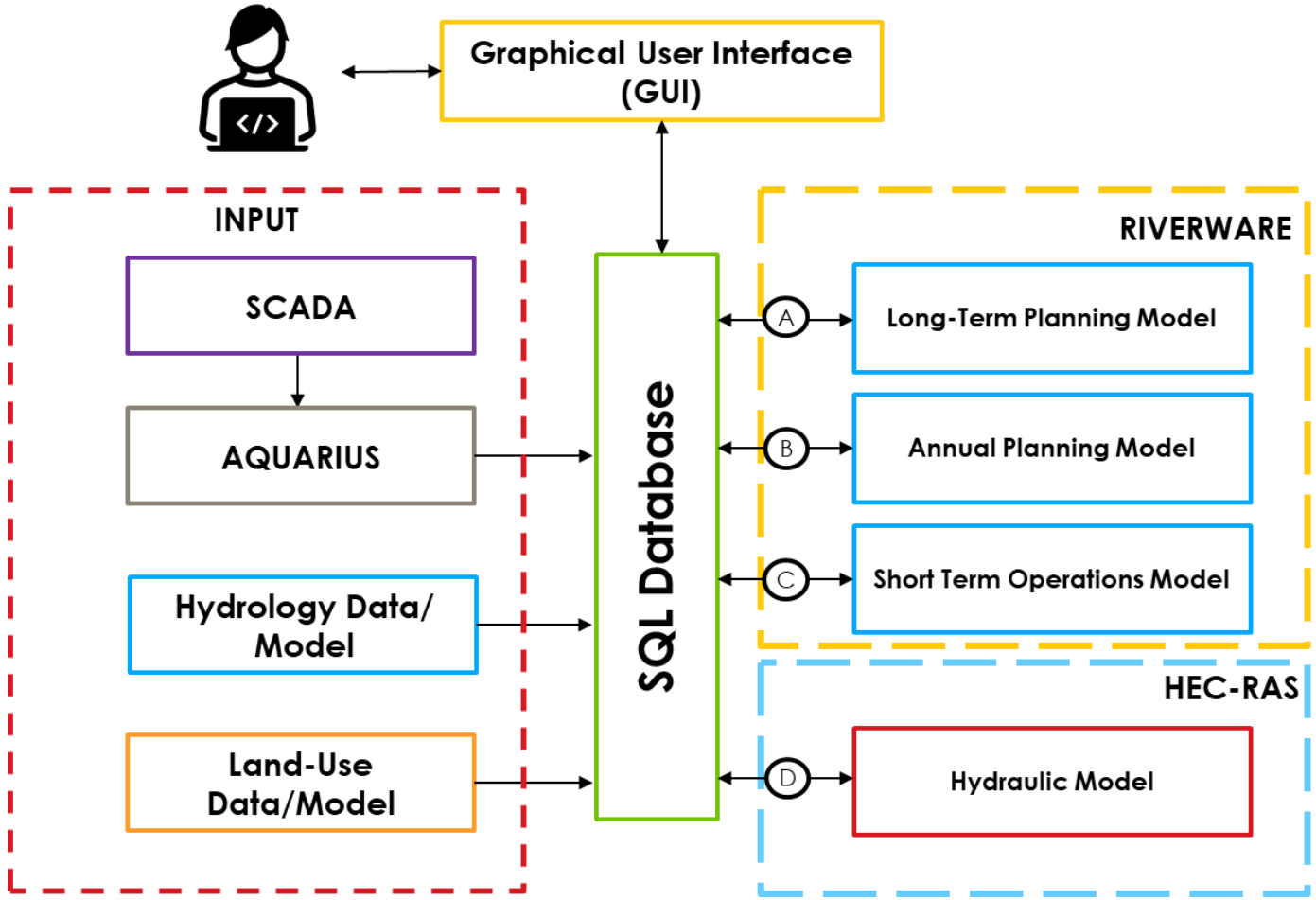
Canal

Reservoir

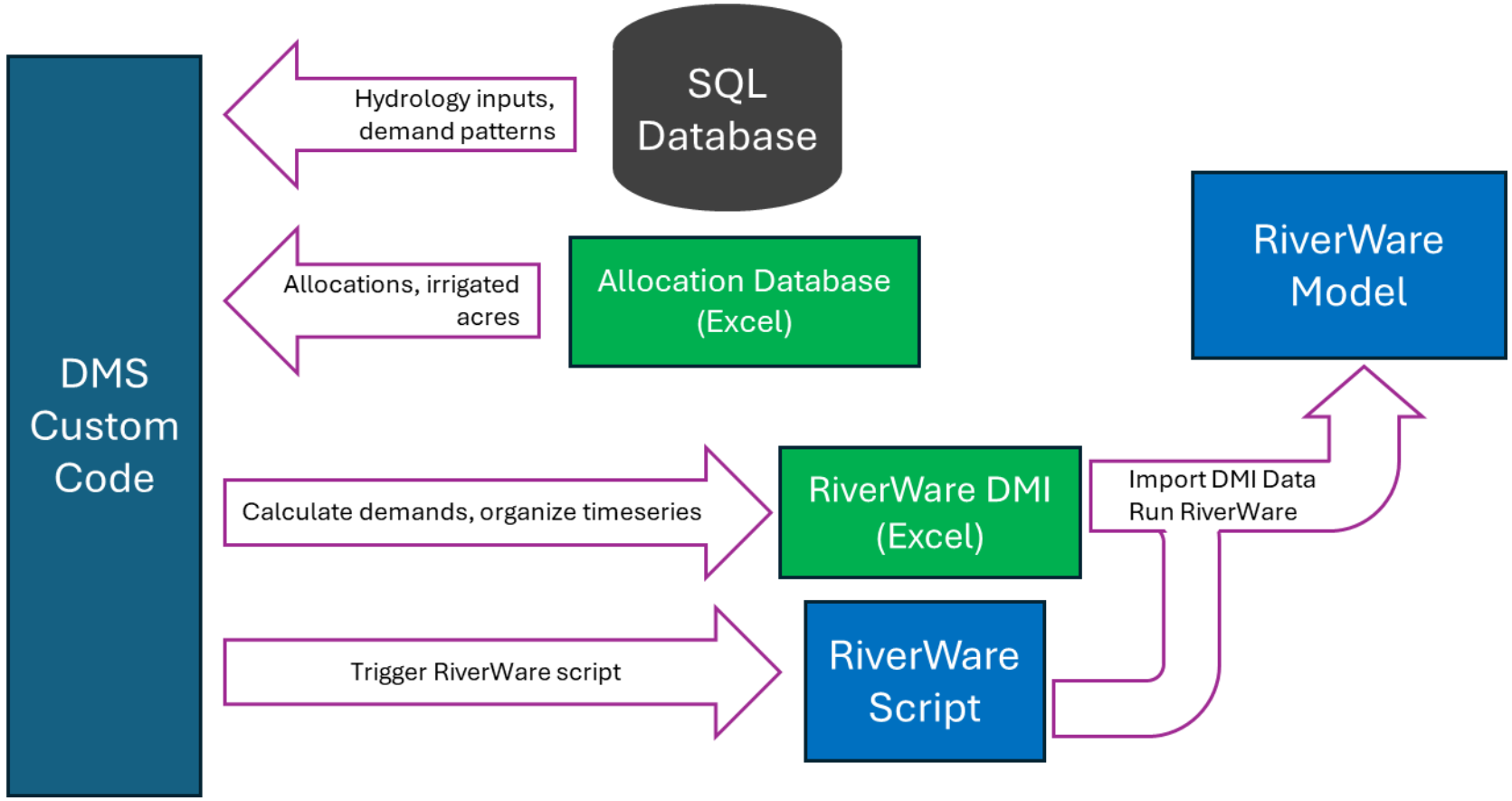
- Total Canal length ~ 160 km (100 mi)
- 6 total reservoirs along the Canal system
  - Range in capacity from 4,400 dam^3 (3,600 AF) to 61,500 dam^3 (49,000 AF)
- Lake Diefenbaker –
  - Capacity ~ 9.4 km^3 (7.6 million AF)
  - Water pumped into Canal system from Lake Diefenbaker.

RiverWare

Introduction to IMS



Introduction to Data Management System (DMS)



RiverWare Modeling Overview

WSA desired three functions from RiverWare models to answer different management questions:

	Long Term Planning Modeling	Annual Operations Modeling	Short Term Operations Model
Timestep:	*Daily*	*Daily*	*Hourly*

RiverWare Modeling Overview

Long Term Planning

Goal: Allow WSA to explore different infrastructure improvements and strategies via analysis through a Long-Term Planning model over a 100-year hydrology dataset.

Where are canal capacities limiting in meeting current/future demands?

What demand can the current pumps reliably meet?

To meet anticipated future demands, how much increase in pumping capacity is necessary?

RiverWare Modeling Overview

Annual Operations Modeling

Goal: Allow WSA to explore/determine seasonal operations based on forecasted system conditions (i.e., demands/hydrology/pumping costs)

How will scheduled pumping outages impact demand deliveries?

How can measures be taken now to best meet demands if the remainder of the season is dry?

How much will pump operations cost this season given different hydrologic conditions?

RiverWare Modeling Overview

Short Term Operations Modeling

Goal: Allow WSA to determine near term operations through analysis of operational schemes in RiverWare using real-time, two-week forecasts.

How will demands, and therefore pumping, respond to the two-week forecast?

How should reservoirs be filled/utilized given two-week forecast?

How will special operations (i.e., pump outages) effect downstream reservoir elevations?

RiverWare Modeling Overview

Key Modeling Considerations:

1. How many models (i.e., workspaces) should be developed?
2. Given data limitations, how should this system being uniquely demand driven be accommodated?
3. Given policy/criteria limitations, how should demand cuts be applied?

RiverWare Modeling Overview

Key Modeling Considerations

How many RiverWare models?

- Though each have different goals, the RiverWare models have much overlap:
  - Operational Logic
  - System Representation
  - Demand Structures
- **Key Differences:** Timestep

Image Source

RiverWare Modeling Overview

Key Modeling Considerations

- **How many RiverWare models?**

Long Term Planning Model

Annual Operations Modeling

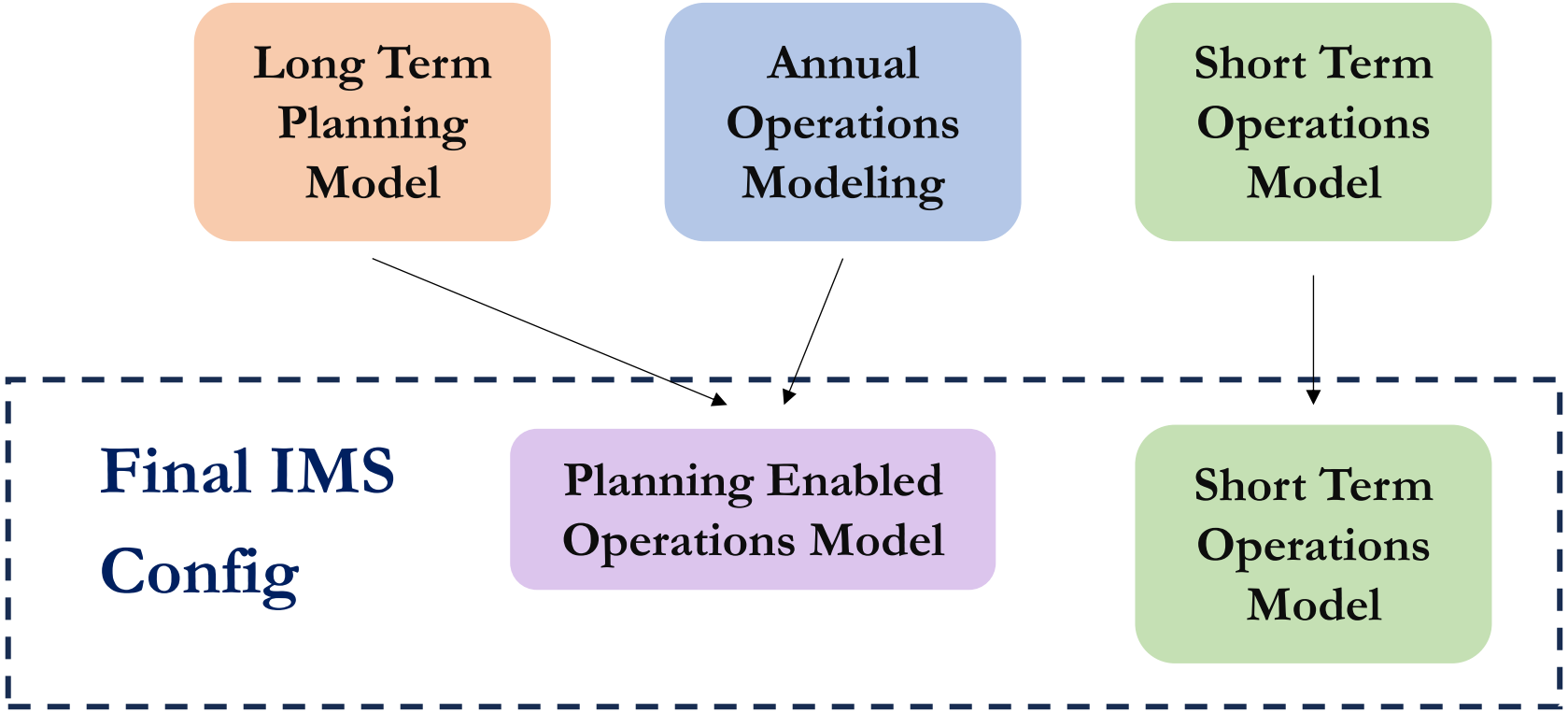
Short Term Operations Model

Share 80-90% overlap in terms of RPL logic, structure, **timestep**. Why build separate models?

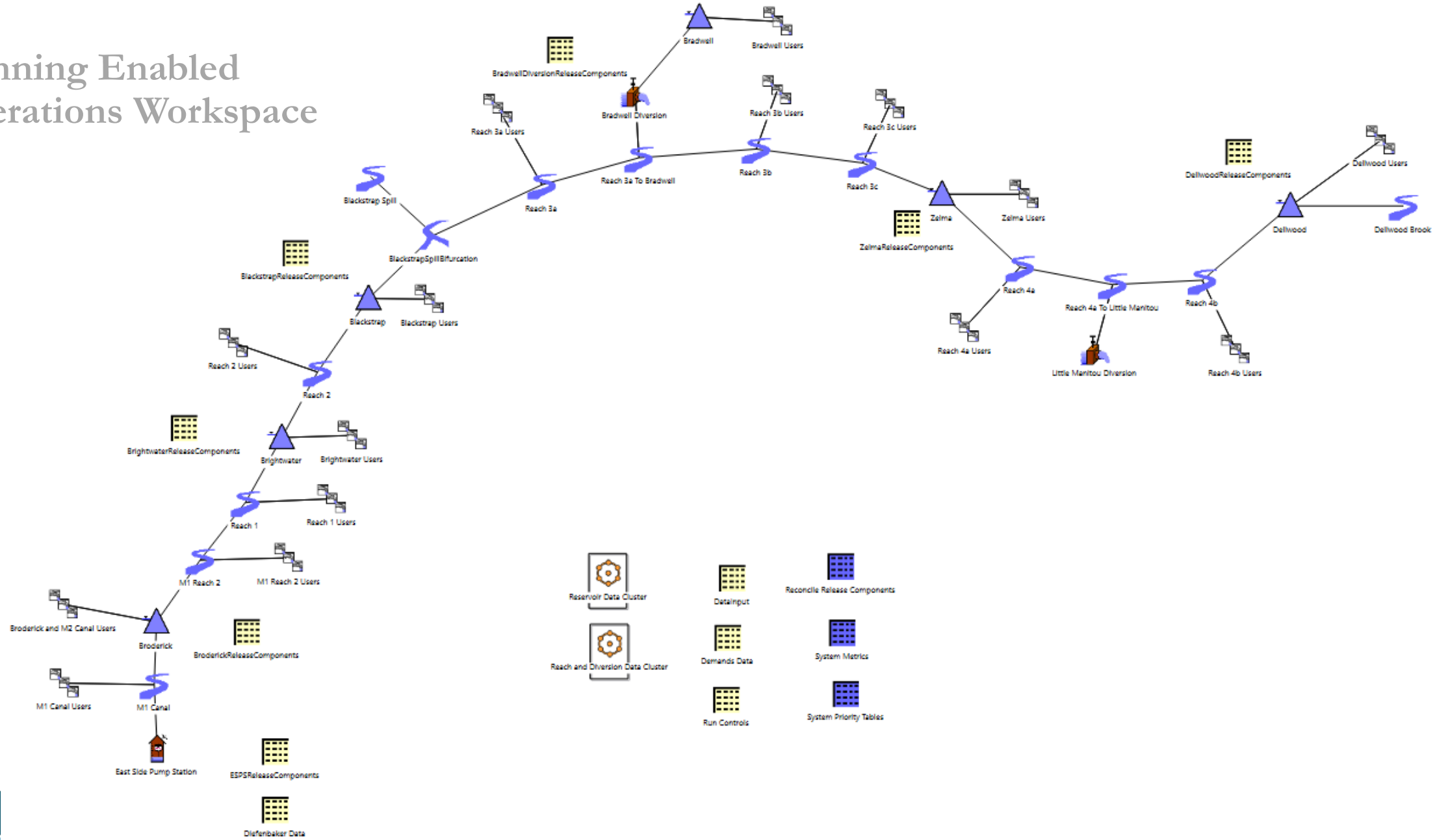
RiverWare Modeling Overview

Key Modeling Considerations

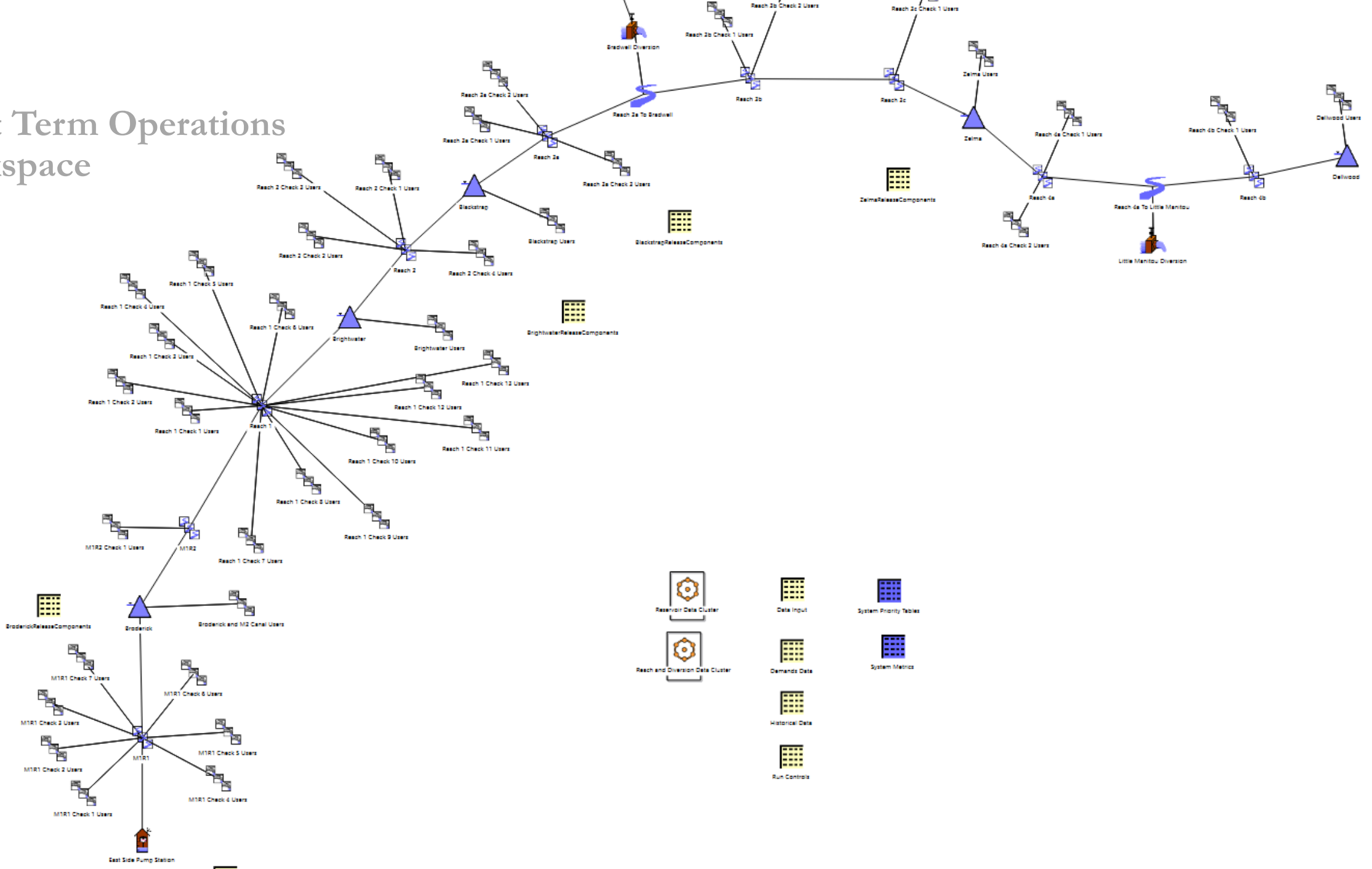
- How many RiverWare models?



Planning Enabled Operations Workspace



Short Term Operations Workspace



RiverWare Modeling Overview

Key Modeling Considerations

Unique Demand Driven System

- Inflow to canal system (outside of what is pumped into it) is typically minimal.
- Thus, flow through/storage in system largely determined by what is pumped in.
- What is pumped in largely determined by *demands*

System uniquely sensitive to the demands as compared to a natural system.

RiverWare Modeling Overview

Key Modeling Considerations

Unique Demand Driven System

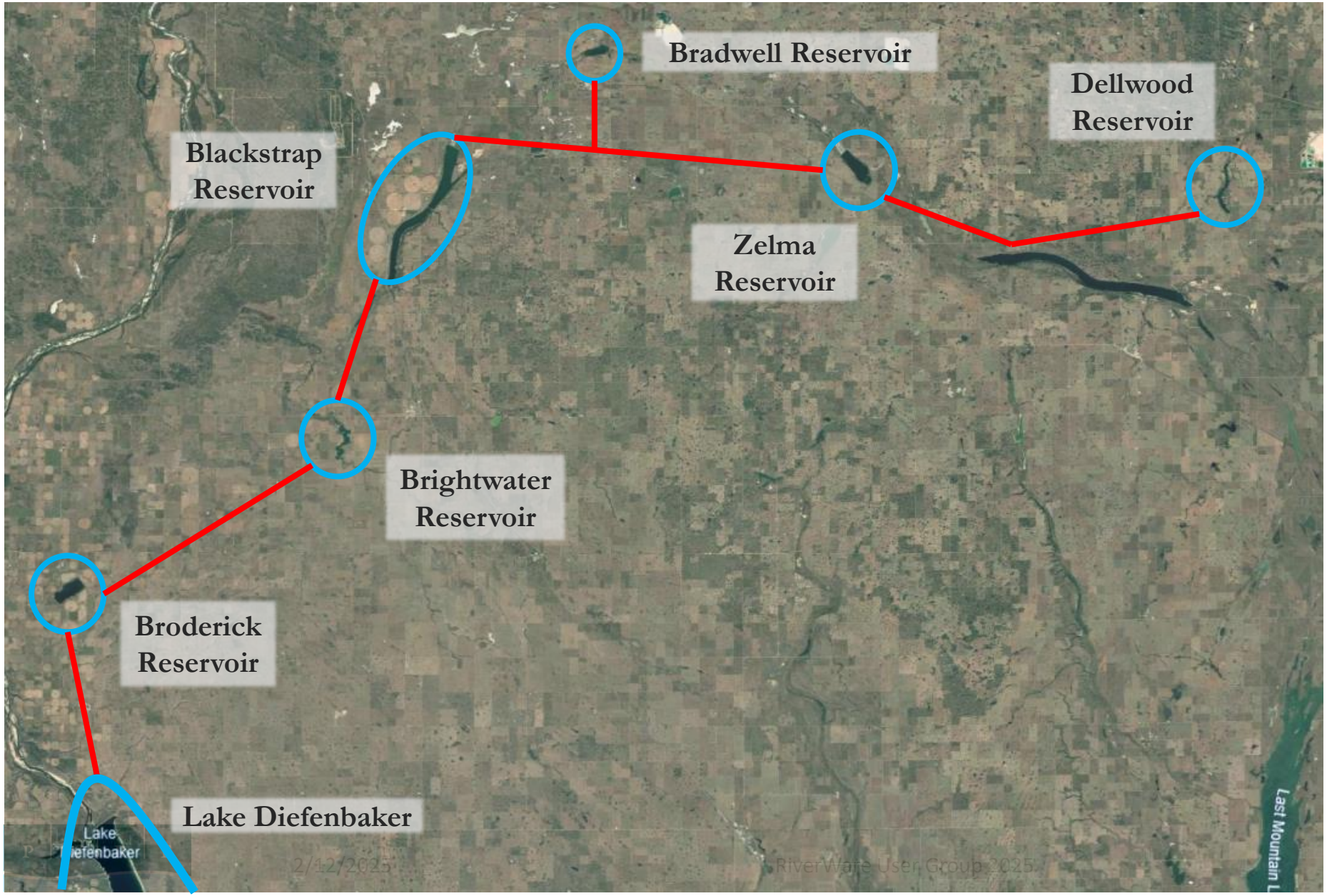
- Minimal observed demand data for system.
- Demand calculator developed based on water allocations, and crop type.
  - For use in Annual Operations/Short Term Operations modes, adapts to rainfall forecasts.
- As more demand data collected, model can flex to updated demands.

RiverWare Modeling Overview

Key Modeling Considerations

- **Demand Cuts/Shortages**
  - Because of history of surplus supply in the project, system demands have typically been met.
  - Consulting Team worked closely with WSA to determine a method of applying demand cuts **"As proportionally as possible"**.

RiverWare Modeling Overview



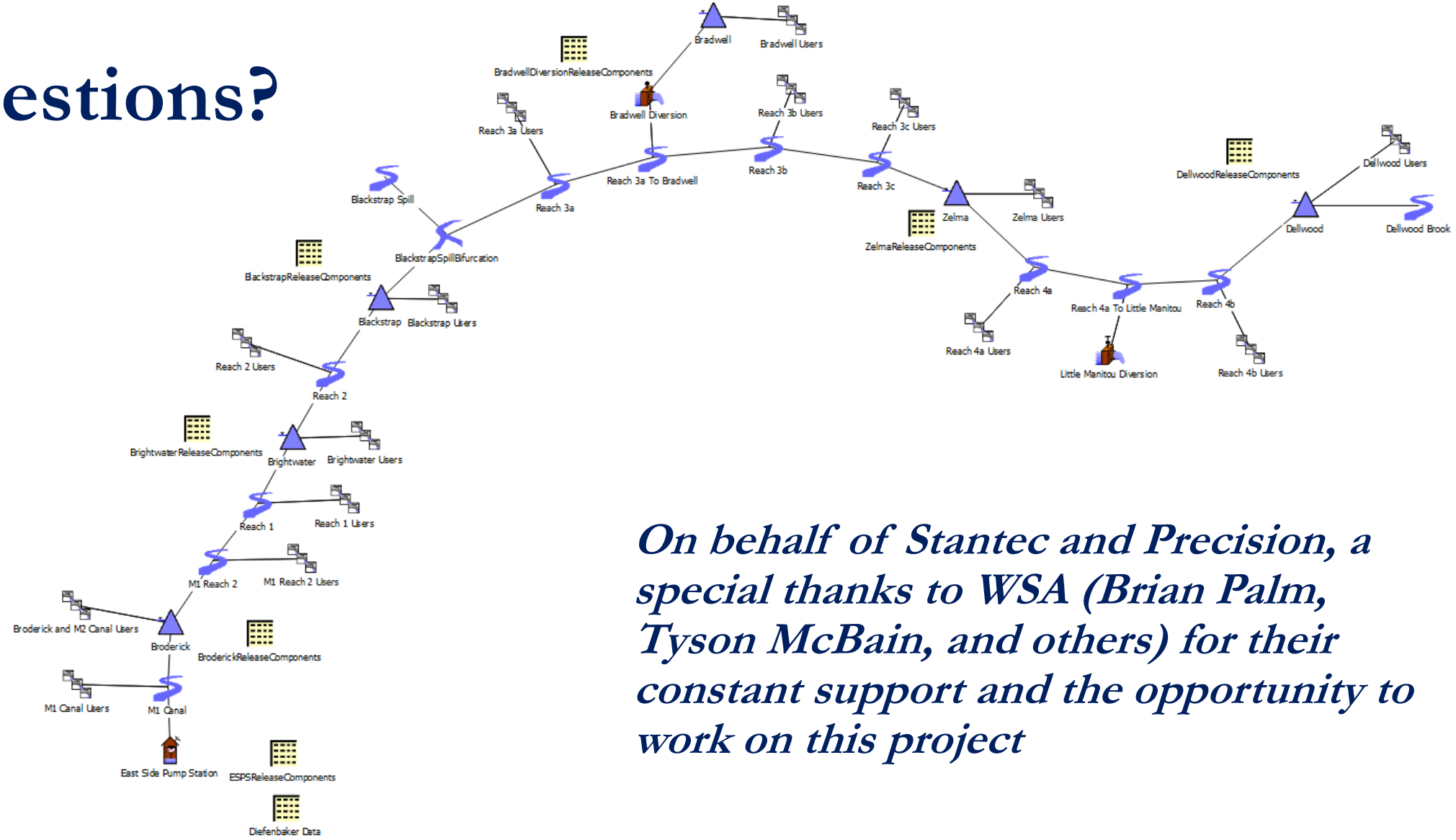
Canal

Reservoir

Conclusions

- IMS is currently under review by WSA
- RiverWare's framework provided tremendous flexibility, allowing designers to:
  1. Meet varying client needs by developing models to answer a wide array of questions.
  2. Codify complex system operations within the model robustly and transparently.
  3. Codify RiverWare models to reduce level of effort of future maintenance as updates in data/infrastructure development occur.

Questions?



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