Great Salt Lake Basin Study: Survey of the RiverWare River Planning Model (RPM) Development Process

RiverWare User Group Meeting

August 28, 2006 - Boulder, CO

Steve Setzer – Hydros Consulting

Shane Coors – Precision Water Resources Engineering

P W R E PRECISION WATER RESOURCES ENGINEERING

BUREAU OF RECLAMATION

Water Resources

Hydros Consulting

GSL Basin Study (GSLBS)
River Planning Model

- The GSLBS requires the development of the RiverWare River Planning Model (RPM) – a monthly, accounting-enabled RiverWare model of the entire GSL Basin
- When developing a RiverWare model of a basin, always start by identifying the question(s) the model is being created to answer
- These become the basis for determining how you will model everything (workspace, logic, accounting, water rights, etc.)

P W R E Hydros Consulting

GSL Basin Study (GSLBS)
River Planning Model

- Primary modeling questions for the GSLBS are:
  - What are the impacts to the GSL Basin of a changing climate?
  - How well do specific management and infrastructure alterations mitigate these impacts?
- The RiverWare RPM model will serve as a tool to answer consequential "What if?" questions for the basin and its many stakeholders
- This is the basis for developing robust and effective management practices and/or identifying infrastructure improvements to mitigate the current deterioration of conditions at the GSL

P W R E Hydros Consulting

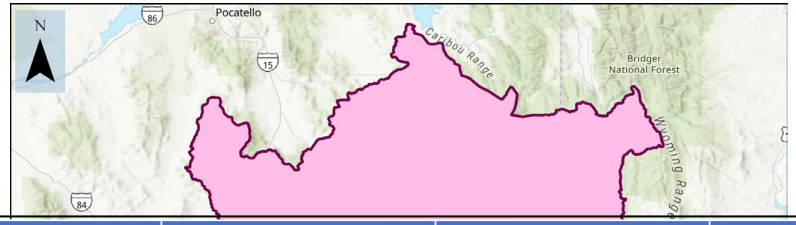
RPM Modeling Team

- Bear River – Ben Abel
- Weber River – Leland Dorchester
- Provo River/Utah Lake – Marin MacDonald
- Jordan River – Nick Mander
- Great Salt Lake Local – Steve Setzer
- Model Consistency/VIC linkage – Amber Spriggs
- Database Development – Andrew Gilmore
- Sr. Technical Oversight – Steve Setzer, John Carron, Shane Coors
- Project Management – Betsy Morgan

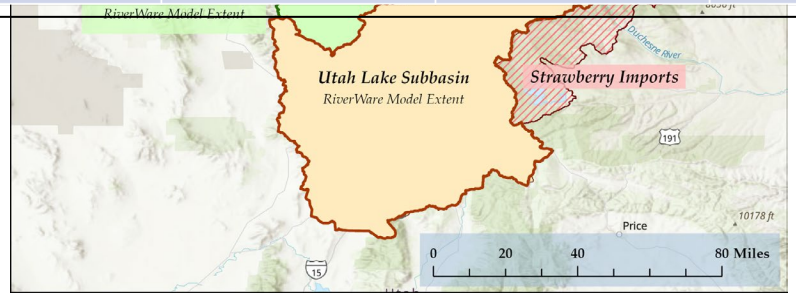
PWRE Hydros Consulting

GSL Subbasin Delineation

- The GSL basin is comprised of 5 major (and highly diverse) subbasins
  - Provo River/Utah Lake Basin
  - Weber River Basin
  - Bear River Basin
  - Jordan River Basin
  - Great Salt Lake (Local) Basin
- Each subbasin's model is being developed independently and consistently
- After calibration, the subbasin models will be combined into a single GSL RPM and used to make a suite of runs to for the GSLBS

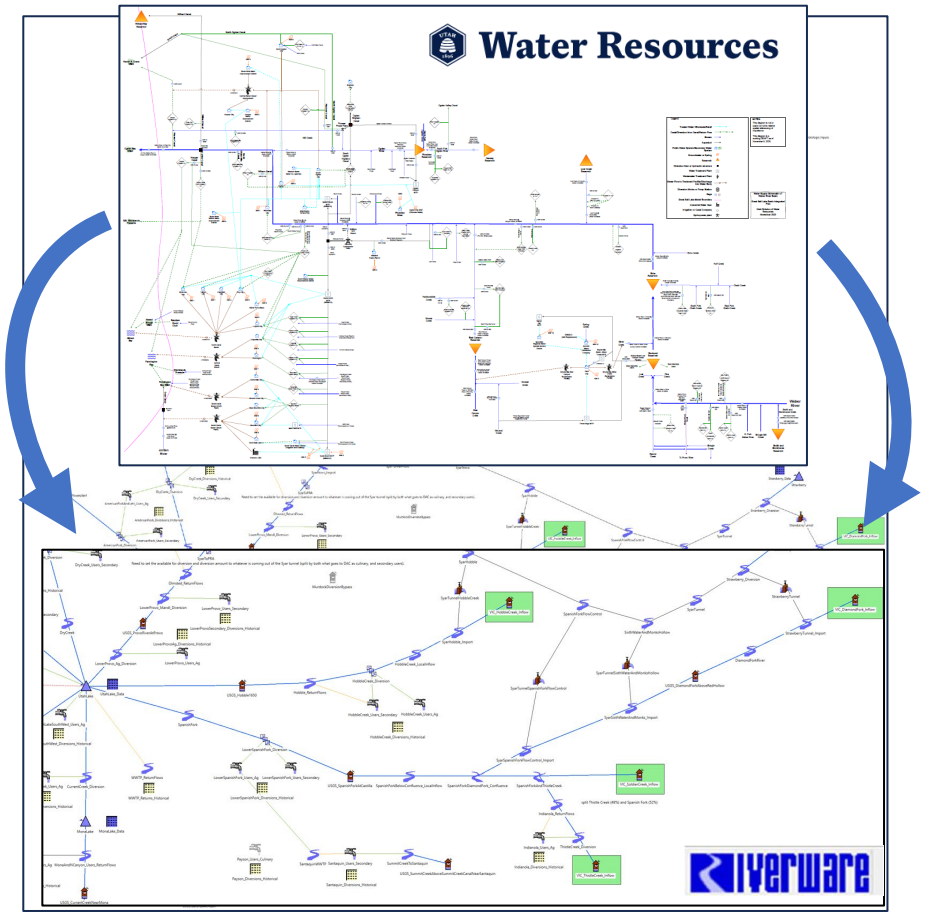


Subbasin	Area (Square Miles)	Population (apprx) (millions)	Agricultural Acreage
Bear	7,099	.27	~736,000
Weber	2,075	1.0	~ 100,000
Jordan	808	1.7	~ 13,000
Utah Lake	3,546 *(Including Strawberry imports)	1.4	~ 115,000
Great Salt Lake	1,820	.17	~ 76,000



RPM Workspace (Physical Representation)

- One of the early tasks was to assemble the RiverWare workspaces - the physical representation of the basins
- Which features to include and how much aggregation is appropriate are the critical design questions
- For each subbasin the UDWRe provided a schematic of the basin features and connectivity for the RMP Modeling team
- These schematics coupled with discussions of the basin features and operations in light of the modeling questions and available data provided the basis for developing the workspaces

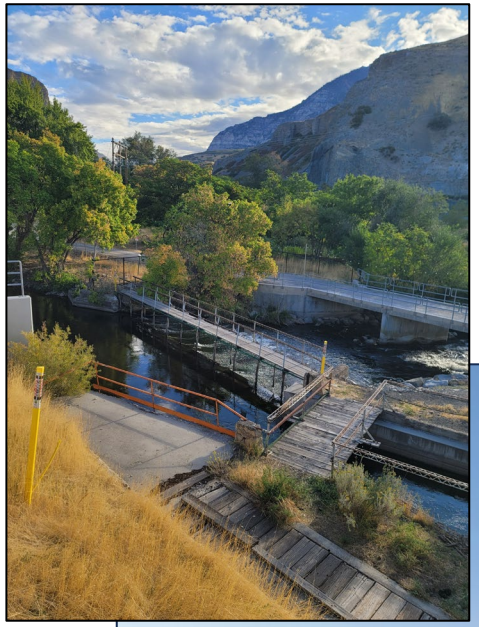


P W R E

Hydros Consulting

RPM Demands Representation

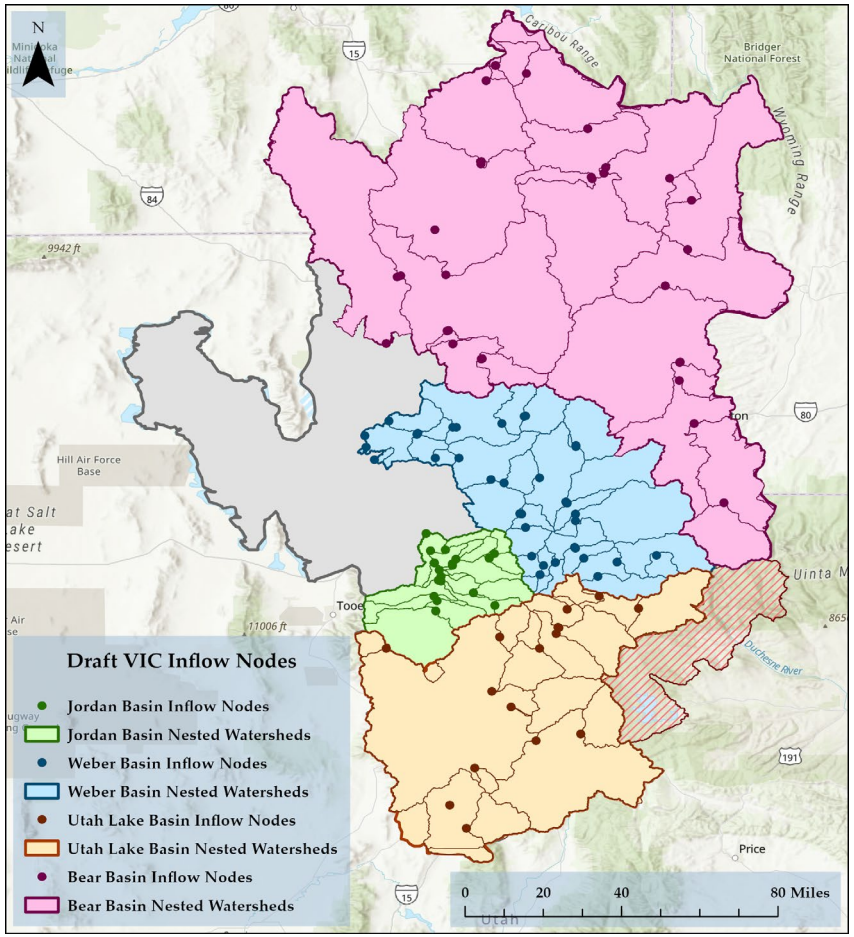
- Demands for the model are being provided by the UDWRe.
- Demands for the historical period are observed (where possible). Demands for the future period are generated by UDWRe's Water Demand Model
- Demands in the model are aggregated by type at each unique river diversion location
  - Municipal
  - Industrial
  - Agricultural
- Future demands will be based on the same climate assumptions as the future hydrology datasets



P W R E Hydros Consulting

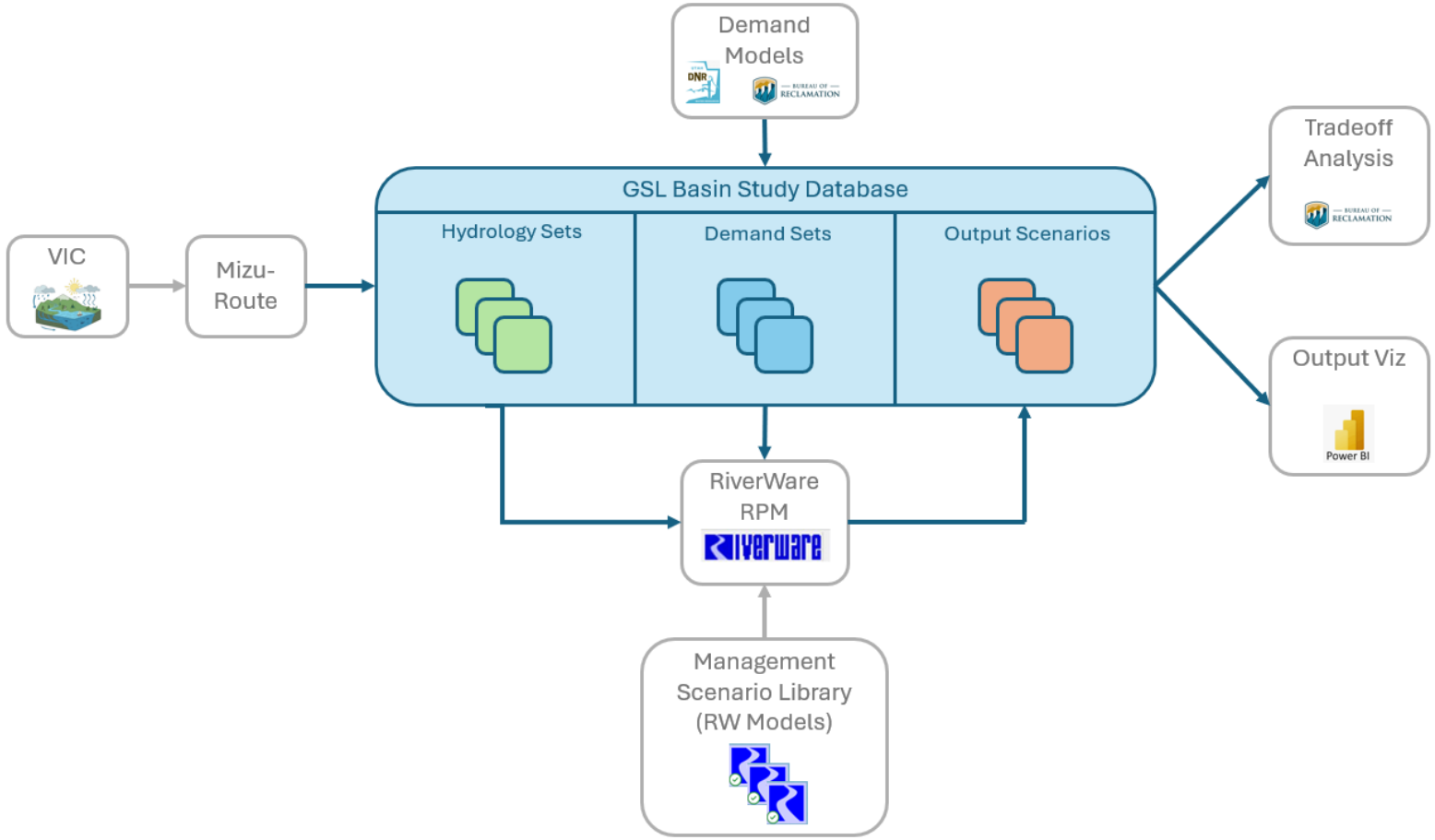
RPM Hydrology

- All inflows to the basin are captured in a hydrology set
- The hydrology to drive the RPM for the GSLBS will come from the VIC model being developed by Reclamation's Technical Services Center
- It is critical the all basin inflows are represented in the RiverWare model, and none are double-counted
- It is critical that the basin spatial disaggregation represented in the RiverWare model be consistent with the spatial disaggregation represented in the VIC



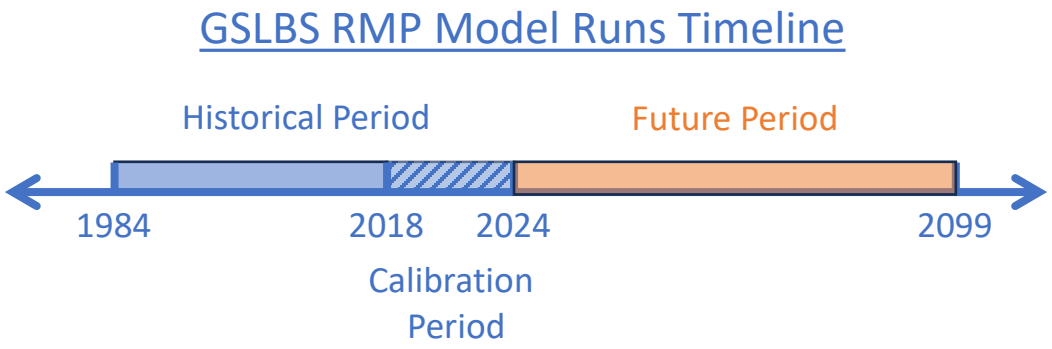
GSLBS Database

- Concurrent with model development is the development of a database to support the GSLBS
- The database will be portable and lightweight and adept at storing scenario-based data
- It will store hydrology datasets, demand datasets and output datasets.
- The database will connect directly with RiverWare and with the output tools to visualize and analyze model output



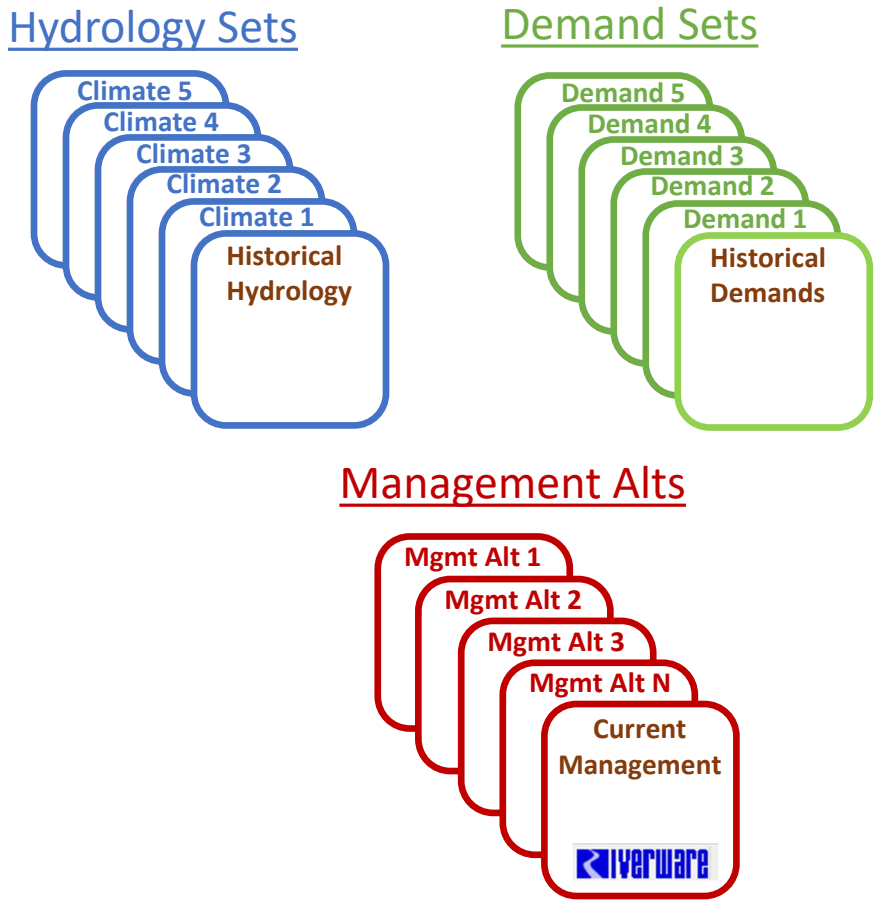
RPM Calibration – Historical Baseline Run

- Once the workspace and rules are complete the Historical Baseline Run is performed. Its first purpose is to calibrate (physical parameters) and validate (rules) the model.
- The Calibration Period is 2018-2024. This is the period for which there is good data for calibration, and the basin infrastructure and policy is consistent with current conditions.
- The Historical Baseline Run will span 1984-2024. This run will represent the current condition of the system
- This run will also serve to compute local inflows, some headwater reservoir inflows and other hydrologic quantities for a complete historical hydrology dataset



GSLBS Run Menu

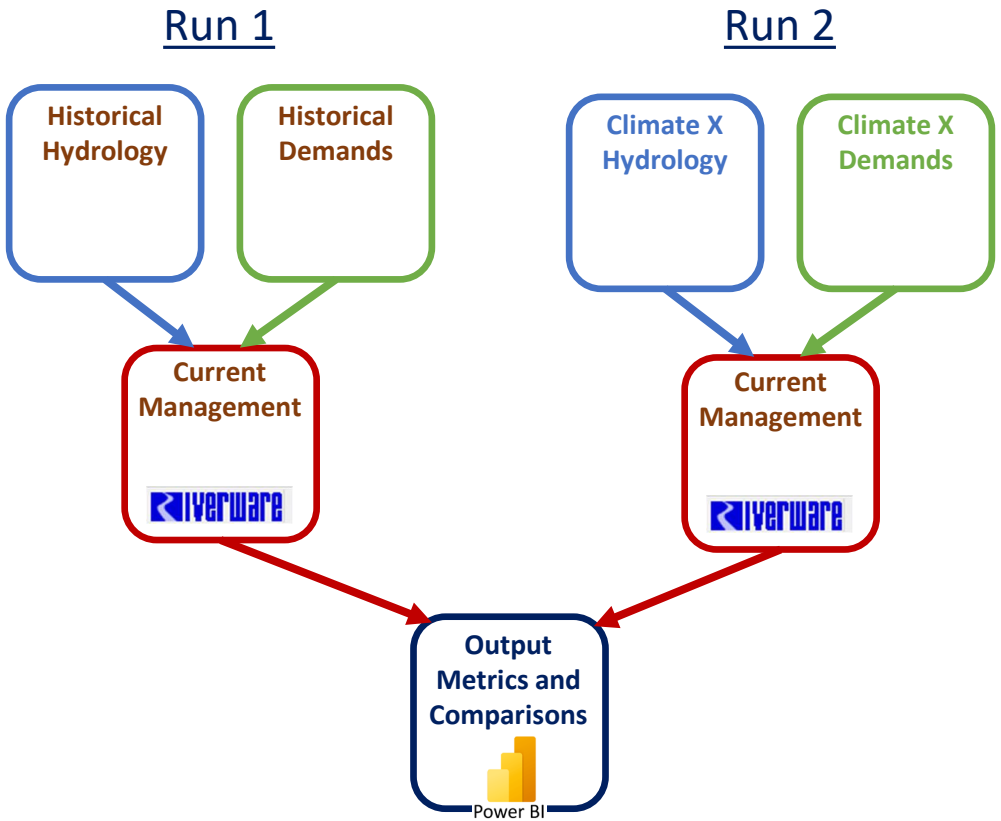
- To answer the primary Basin Study questions a GLBS Run Menu has been developed
- Five Future Climate (VIC) hydrology sets from Reclamation TSC, each from a different GCM representing a possible future hydrology. Accompanying these will be a corresponding Demand datasets from UDWRe
- Several alternative management options will be provided by Reclamation and UDWRe and will be of these types:
  - No Action
  - Water Demand Reductions (municipal, ag, industrial)
  - Alternative Reservoir Operational Policies
  - Wetland Management (Phragmite management)



P W R E Hydros Consulting

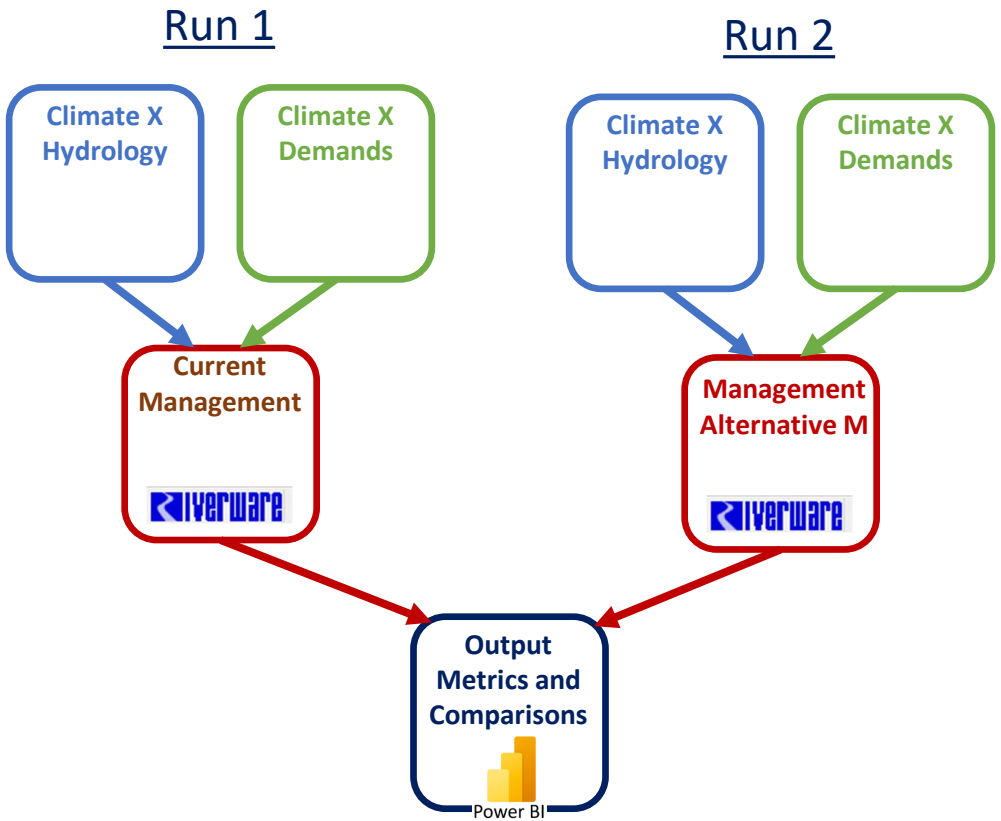
GSLBS Run Menu (2)

- Answering the driving questions of the GSLBS requires comparing pairs of RPM runs. Between the two models you can only change one thing.
- Question 1: *What are the impacts to the GSL system of future climate variability?*
  - Run 1: Historical Climate/Demands, Current Management
  - Run 2: Climate/Demand Scenario X, Current Management
  - Compare performance in Run 1 vs. Run 2 across all metrics to assess impacts due to **Climate X Hydrology**
- Because there are multiple Hydrology/Demand scenarios, there will be multiple versions of this impact identified to establish a range of possible impacts due to future climate



GSLBS Run Menu (3)

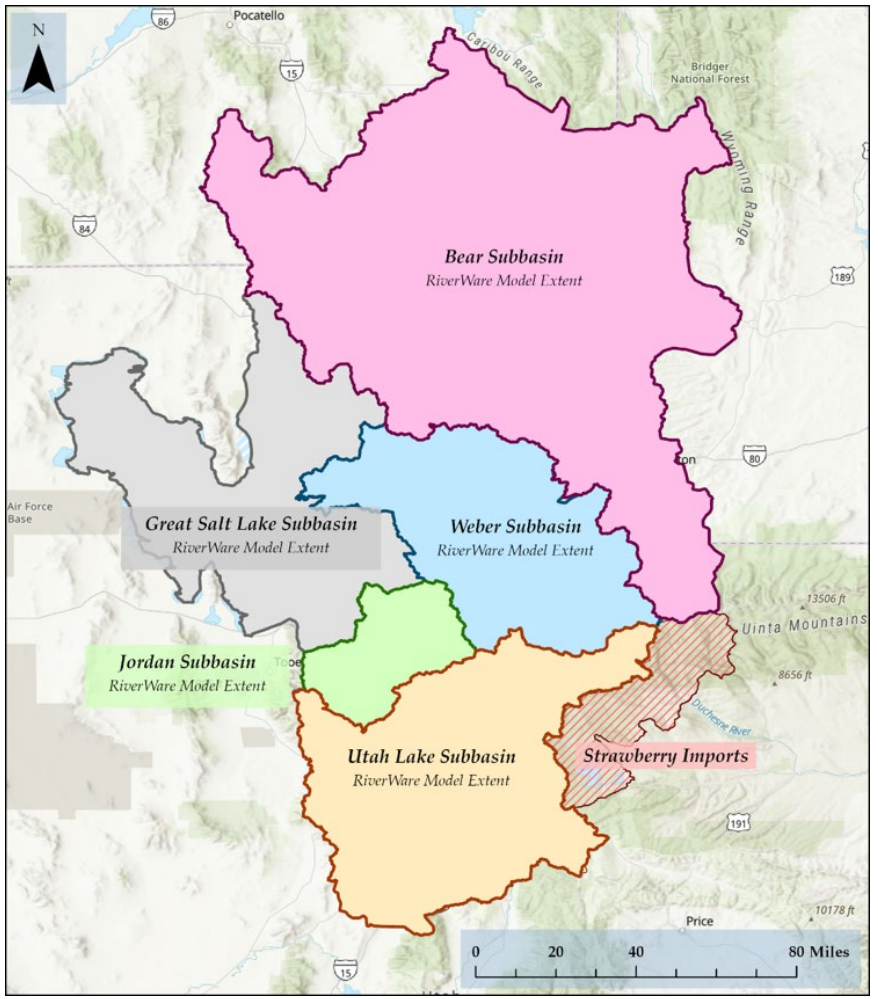
- Answering the driving questions of the GSLBS requires comparing pairs of RPM runs. Between the two model runs you can only change one thing.
- Question 2: *How well do proposed management scenarios mitigate the degraded performance identified in Question 1?*
  - Run 1: Climate/Demand Scenario X, Current Management
  - Run 2: Climate/Demand Scenario X, Management Scenario M
  - Compare performance (metrics) from these two runs to assess the level of mitigation accomplished by the **Alternative M Management** scenario
- Because there are multiple Hydrology/Demand Scenarios, a range of effectiveness will be determined for each management alternative



P W R E Hydros Consulting

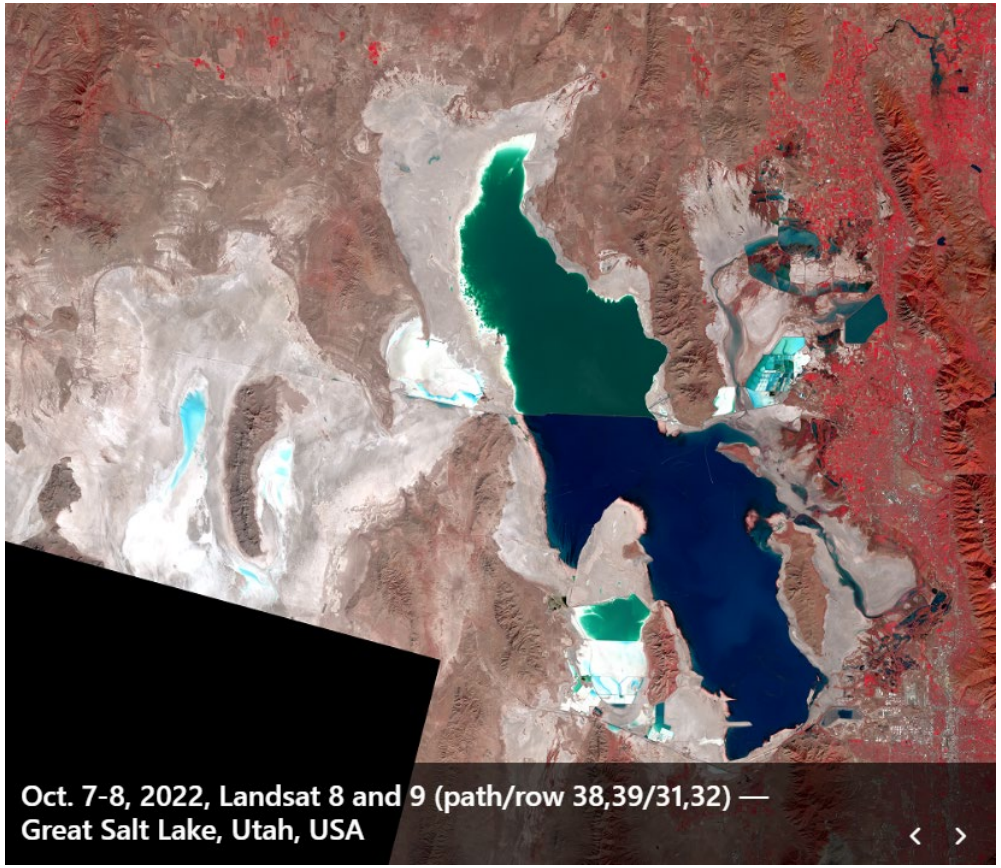
RPM Development

- Five subbasin model developed independently and then combined
- Bear River, Weber River, Provo River – Utah Lake, Jordan River, Great Salt Lake (GSL)
- Next slides focus on modeling GSL in RiverWare



Modeling the GSL Subbasin

- Model the entire GSL ecosystem
- Simulating arm/bays independently
- Causeway separating bays
- Playa areas/losses
- Wetland areas



North/South Arm and Bays

North Arm

South Arm

Bear River Bay (Bear River)

Ogden Bay (Weber River)

Farmington Bay (Jordan River)

Features of GSL

- Arms/Bay independently controlled
- Playas
- Mineral Company Depletions
- Managed Wetlands

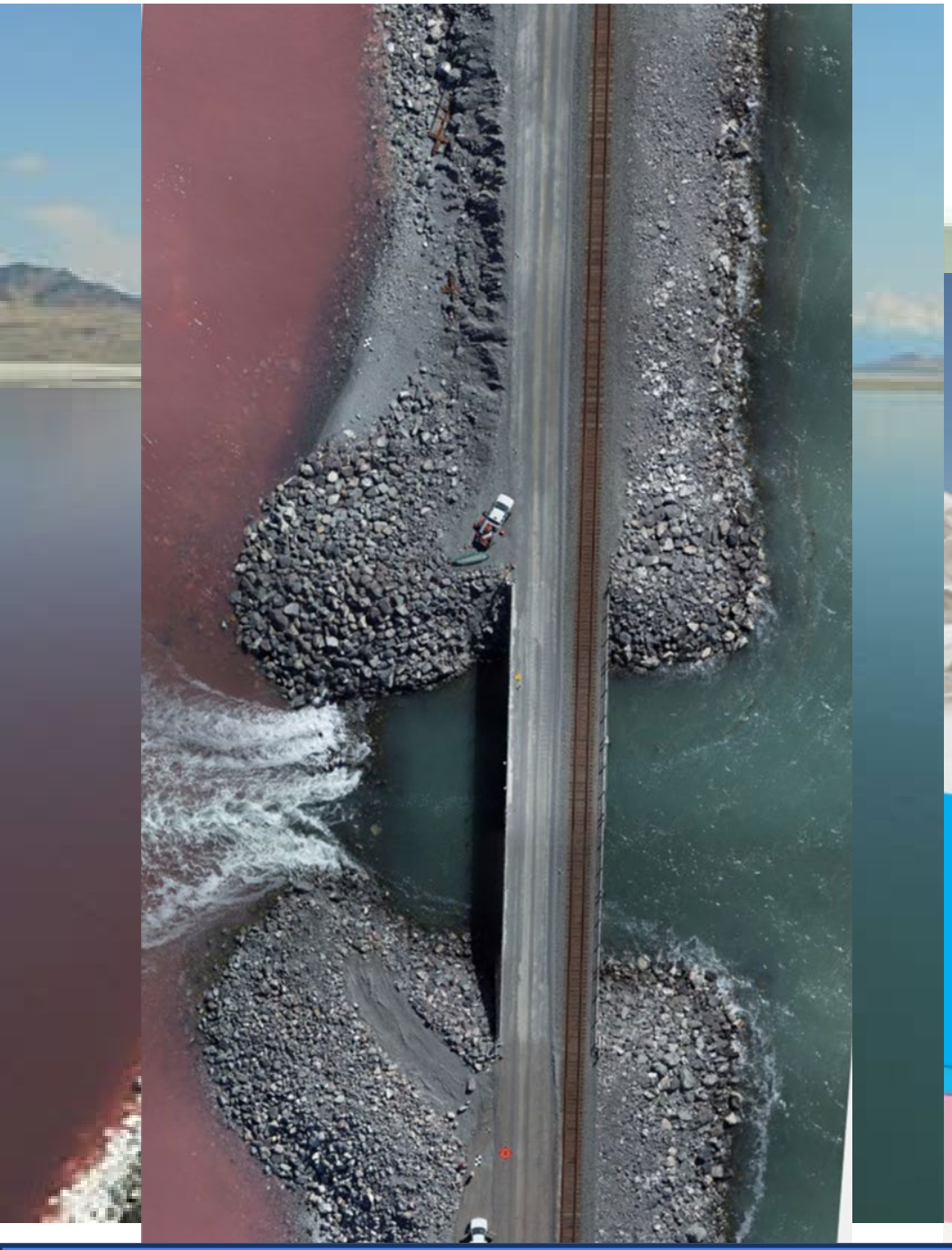
Areal Extent of GSL Over Time

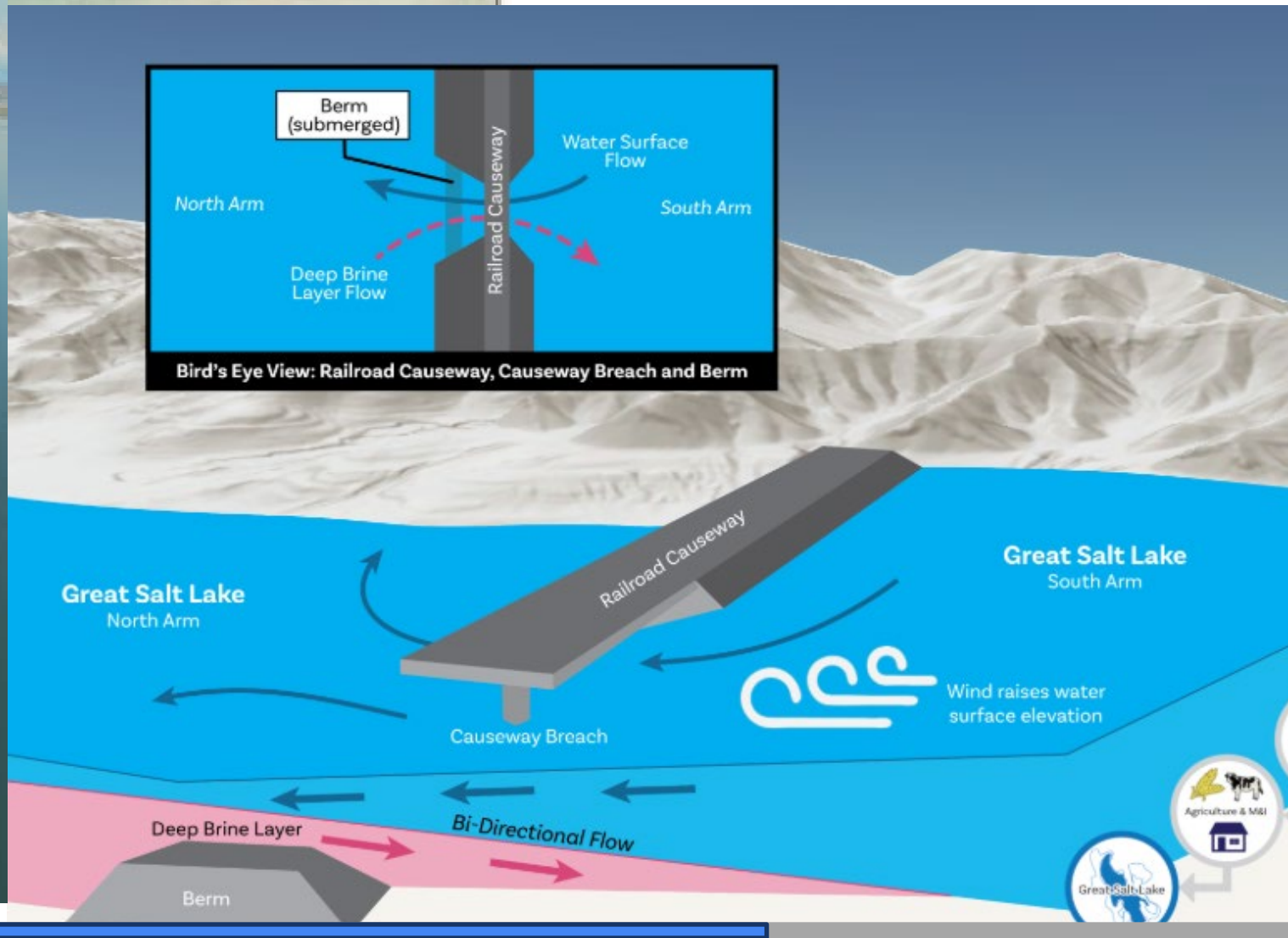
1986

2002

2021

UPRR Causeway Breach





Farmington Bay Causeway

Managed Wetland Areas

- Managed wetland areas (public and private): ~180,000 acres
- Controlled by system of dikes
- Deplete ~12-17% of surface inflows to GSL
- Wetland depletion of surface water: ~200 KAF/year (estimates vary widely)

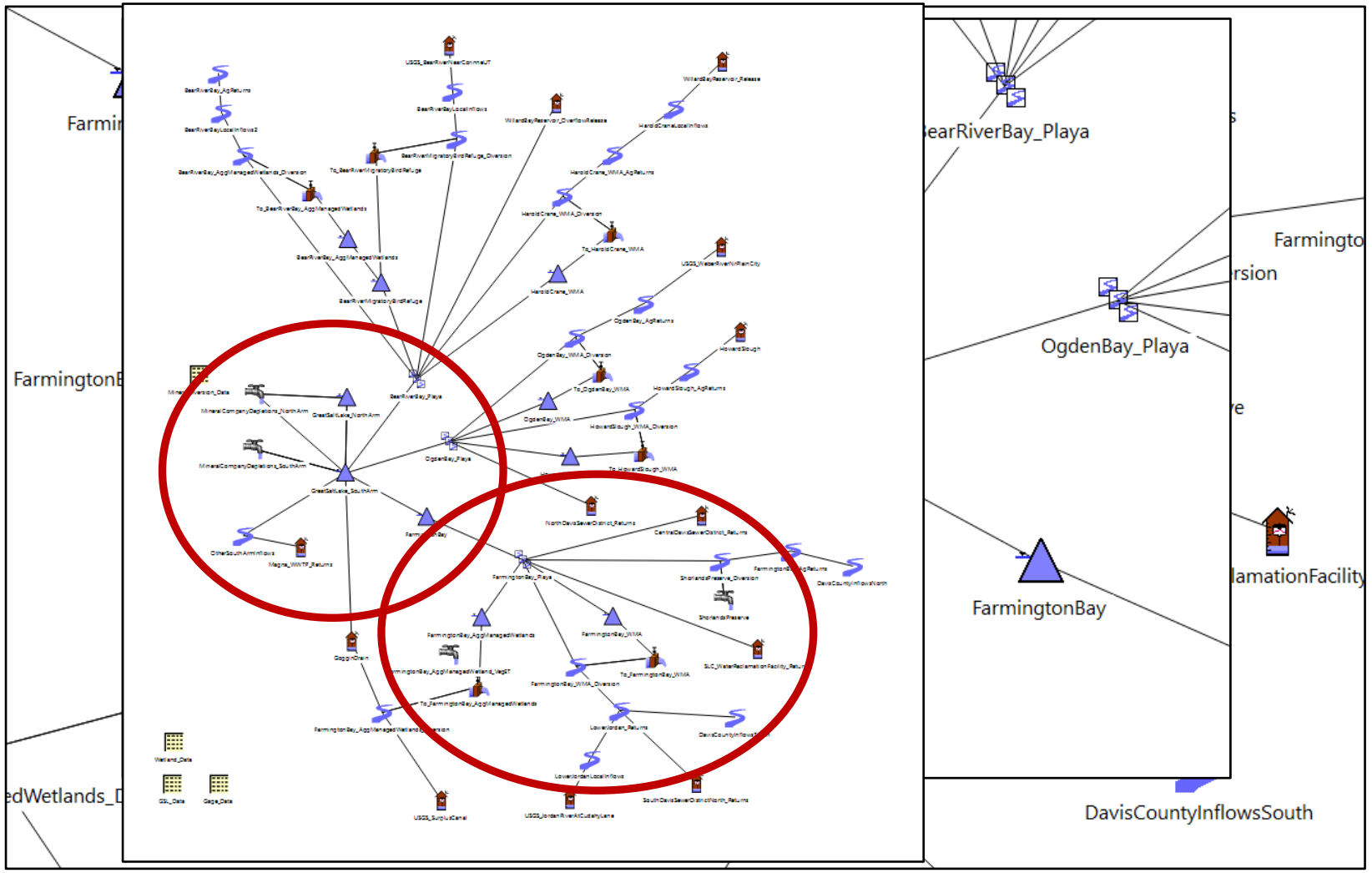
Managed Wetland Inundation

2023

1988

RiverWare Model of the GSL

- Lake itself
- Playa areas
- Wetland areas



Summary of Modeling Challenges

- Simulate bays/arms as separate reservoir objects
  - Farmington Bay can merge with South Arm and act as single reservoir
  - Evaporation rate is function of lake salinity
- Routing losses in playa need to be turned off when inundated by lake
- Managed wetlands simulated as reservoir objects
  - Evap and precip must be disable when inundated

Where are we now and what's next?

- Remaining historical data
- Subbasin models are running and computing residuals
- Refinement and Calibration
- Develop operating rules
- Historical Baseline Model
- Management Alternatives and Future Climate Scenarios

Questions?

Water Resources

PWRE

PRECISION
WATER RESOURCES ENGINEERING

BUREAU OF
RECLAMATION

Hydros
Consulting