CADSWES

The Center for Advanced Decision Support for Water and Environmental Systems

WELCOME

to the

Ninth Annual

RiverWare

User Group Meeting

Ninth Annual User Group Meeting

- Introductions
- Meeting Information
- Overview of Licensing Agreements
- Current users
- Overview of current applications
- Course curriculum development

RiverWare License MOU

- Original R&D funded by TVA, Reclamation (since 1992)
- RiverWare is made available to others in order to:
  - Contribute to more effective water management
  - Allow stakeholders to participate in operations/planning
  - Share the cost of software maintenance
- MOU between CU, Reclamation and TVA agreeing on terms of licensing RiverWare to others
- RiverWare is licensed by CU Office of Technology Transfer. License fees contribute to software maintenance (requires about $200K per year).
- Viewer license is cost-free

RiverWare Users

Bureau of Reclamation

- Lower Colorado
- Upper Colorado
- Lahontan AO
- Albuquerque AO
- Yuma
- Yakima
- Columbia Basin
- Grand Junction
- Durango
- Provo
- Billings
- Boise

Tennessee Valley Authority

- Tennessee Basin

U.S. Army Corps of Engineers

- Albuquerque
- Tulsa
- Ft. Worth
- Little Rock
- Kansas City
- Omaha

RiverWare Users

Other Federal Agencies

USGS – Albuquerque, Ft. Collins

U.S. Fish and Wildlife Service

BIA (Farmington, Albuquerque)

National Park Service (Gunnison)

National Renewable Energy Lab

Reno Federal Water Master

International Boundary & Water Commission

Tribes

Jicarilla Apache Nation

Pueblo of Jemez

States

Arizona DNR

Colorado Water Conservation Board

Colorado River Board of California

Colorado River Commission of Nevada

New Mexico Interstate Stream Commission

Kansas Water Office

Foreign Agencies

Mexico National Water Commission (CNA)

RiverWare Users

Water Districts, Authorities, Utilities

- Central Arizona Project
- Central Utah Water Conservation District
- Coachella Valley Water District
- Colorado River Water Conservation District
- Lower Colorado River Authority
- Lower Neches Valley Authority
- Metropolitan Water District of Southern California
- El Dorado Irrigation District
- New Jersey Water Supply Authority
- Southern Nevada Water Authority
- Truckee Meadows Water Authority
- Tarrant Regional Water District
- East Bay Municipal Utility District
- Southwest Power Administration
- Pacificorps

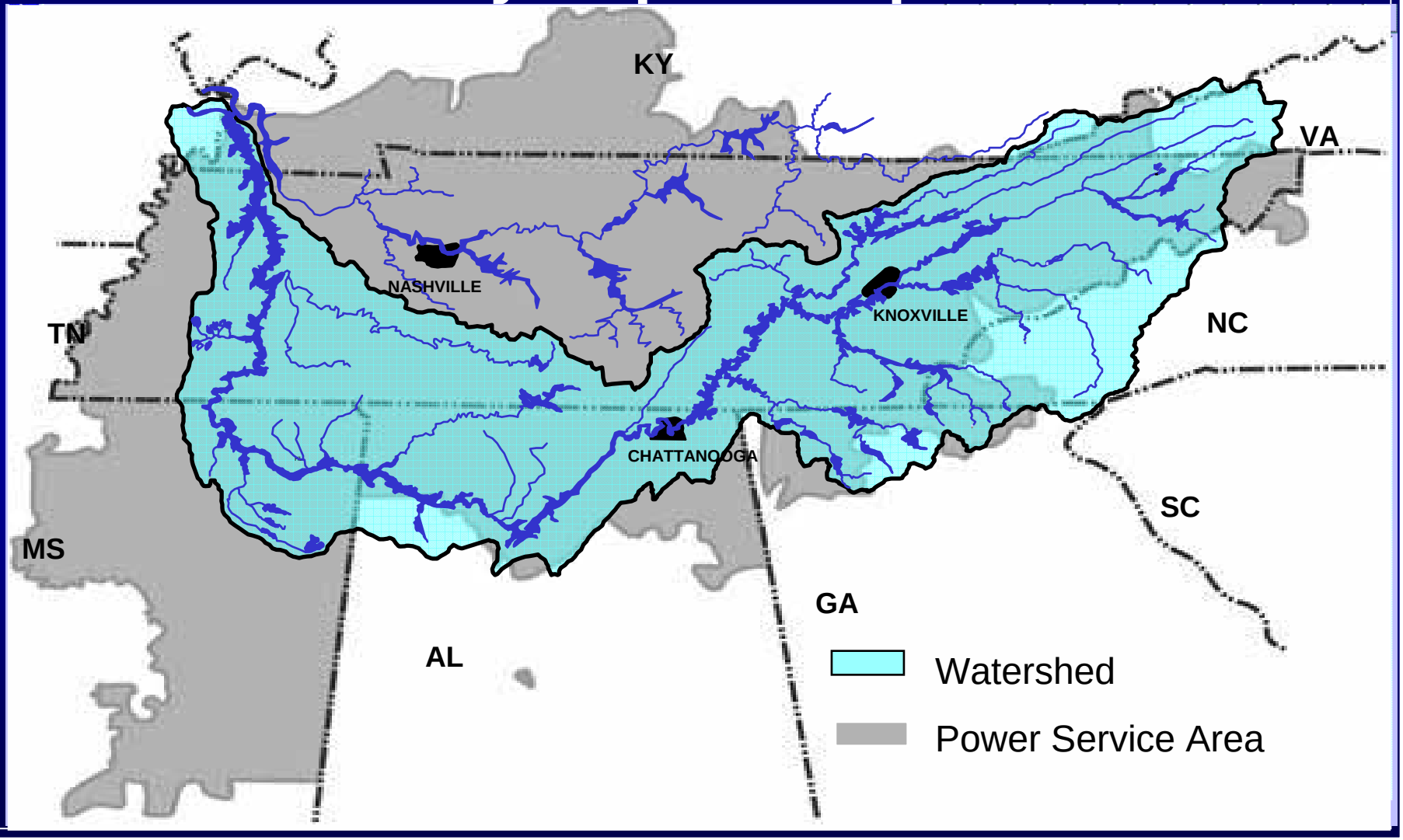
RiverWare Users
Consultants

- B&H Engineering
- Brown and Caldwell
- Hydrosphere Resource Consultants
- Keller - Bliesner Engineering
- Natural Resources Consulting Engineers
- R.J. Brandes
- Riverside Technology, inc.
- Stetson Engineers
- Stockton Engineering
- Tetra Tech, SWC
- Wave Engineering

RiverWare Users
Universities and Research Institutes

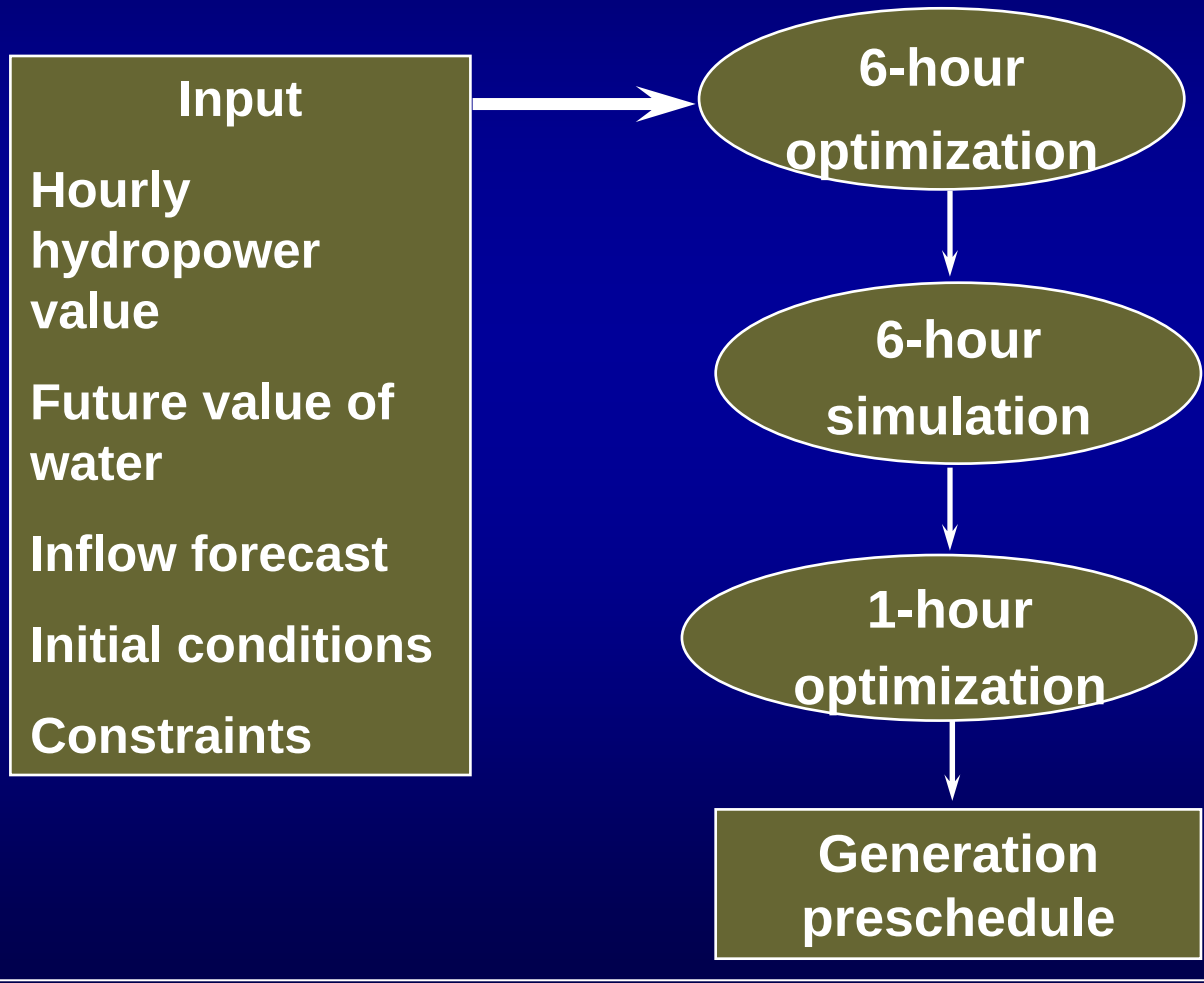
- University of Arizona - SAHRA
- New Mexico State University
- Texas A&M University, El Paso
- University of Nevada – Desert Research Institute
- Pacific Northwest National Laboratory
- Oak Ridge National Laboratory
- China Institute of Water and Hydropower Research
- Public Works Research Institute, Japan
- University of Ljubljana, Slovenia
- Indian Institute of Technology, Madras

TVA's reservoir system is modeled as a whole for hydropower optimization



RiverWare Applications:

TVA Optimization process used in daily scheduling



RiverWare Applications:

TVA Pool Elevation Constraints

- Ending Pool Elevation
- Operating Zone
- Flood Guide
- Balancing Guides
- Minimum Operation Guide
- Mosquito Operations

RiverWare Applications:
TVA Flow Constraints

- Minimum Flows
- Navigation Flows
- Recreation Flows
- Ramp Rates
- Tandem Operation
- Daily Volume
- Weekly Flow

RiverWare Applications:
TVA Other Constraints

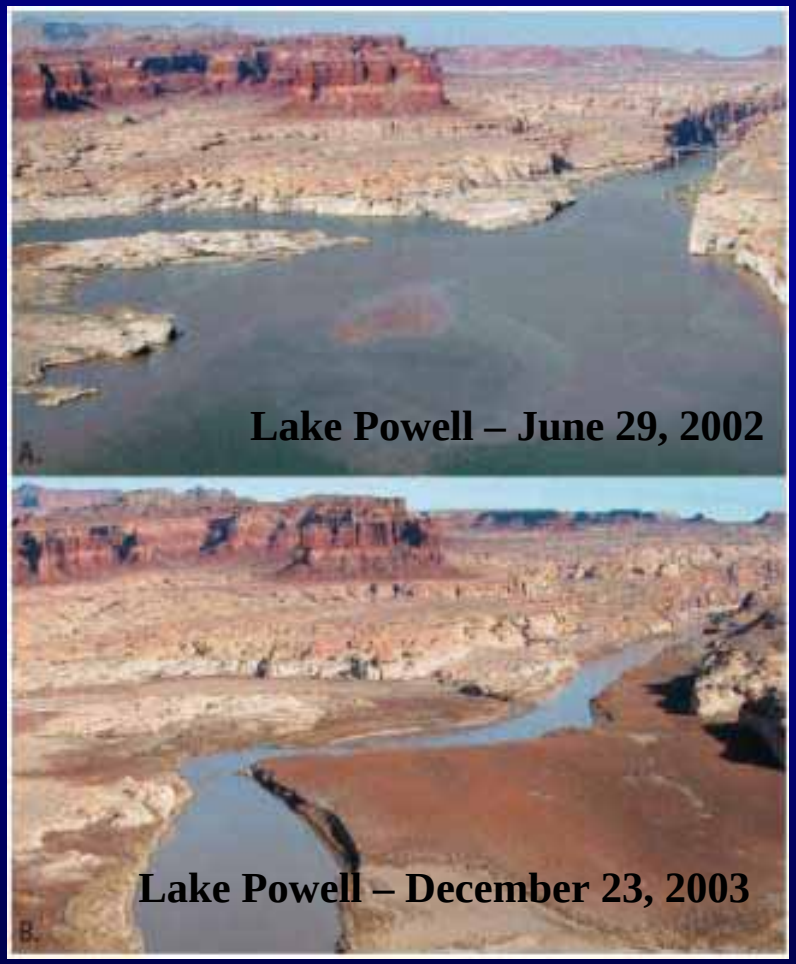
- Energy constraints
- Allowable Canal Slope
- Special Operations
  - Maintenance
  - Outage
  - Recreation

RiverWare Applications: Reclamation

Colorado River

- Lower Colorado Regional Office (Boulder City, NV)
- Upper Colorado Regional Office (Salt Lake City, UT)
- Area and Project Offices for Local Issues and Sub-basin Models
- **CRSS – Colorado River Simulation System is primary modeling tool for planning operations and evaluating policy**

RiverWare Applications: Reclamation – Colorado Basin Shortage EIS



Draft EIS on Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead

Used CRSS and CRSS-Lite, a screening model used to develop 5 proposed operational alternatives for the EIS

ALSO: CRSS used in the Draft EIS to evaluate the potential effects of 3 hydrologic scenarios, potential alternatives to the Index Sequential Method that uses the 99-year natural flow record

RiverWare Applications: Reclamation – Colorado Basin

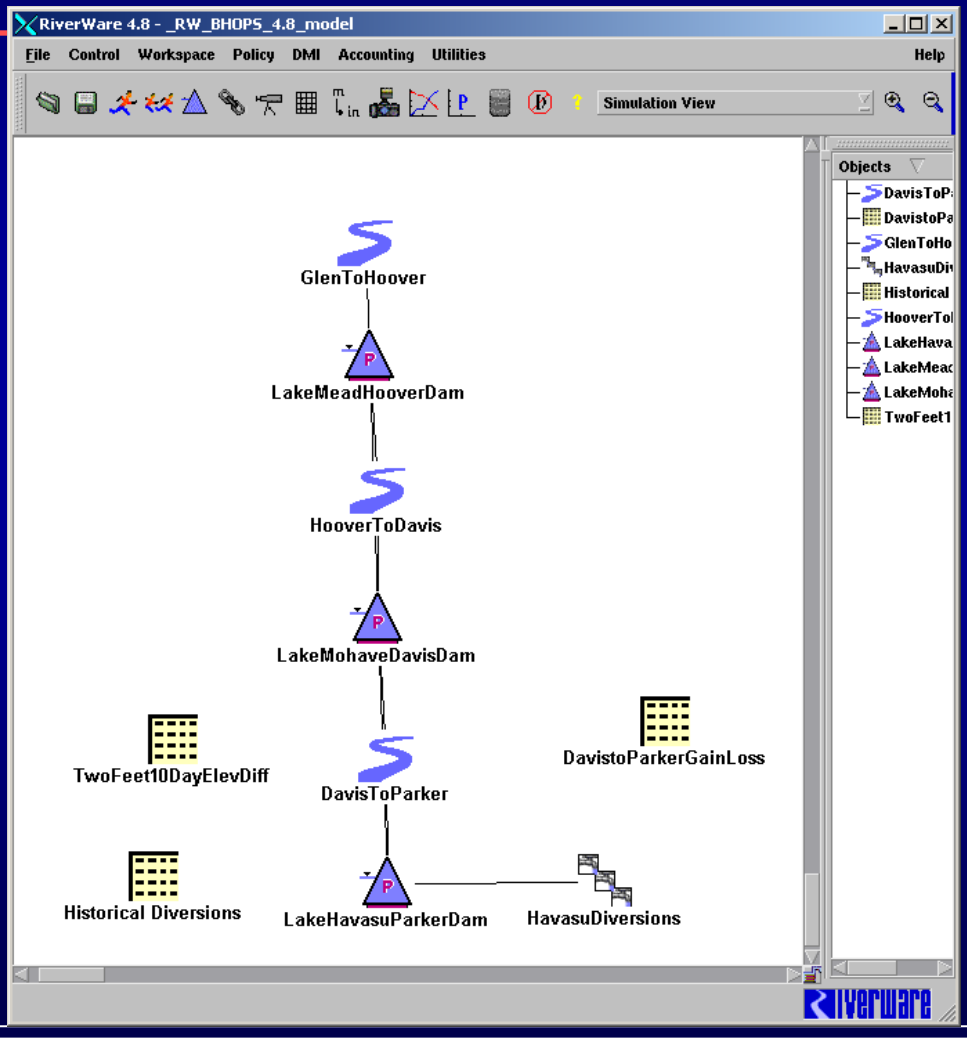
Stakeholders who use RiverWare CRSS

- Arizona Dept of Water Resources
- Central Arizona Project
- Colorado River Commission of Nevada
- Colorado River Commission of California
- State of Colorado Water Conservation Board
- Metropolitan Water District of S. California
- Southern Nevada Water Authority
- Mexico Comision Nacional del Agua

RiverWare Applications: Reclamation – Colorado Basin

Lower Colorado River Daily Operations Model

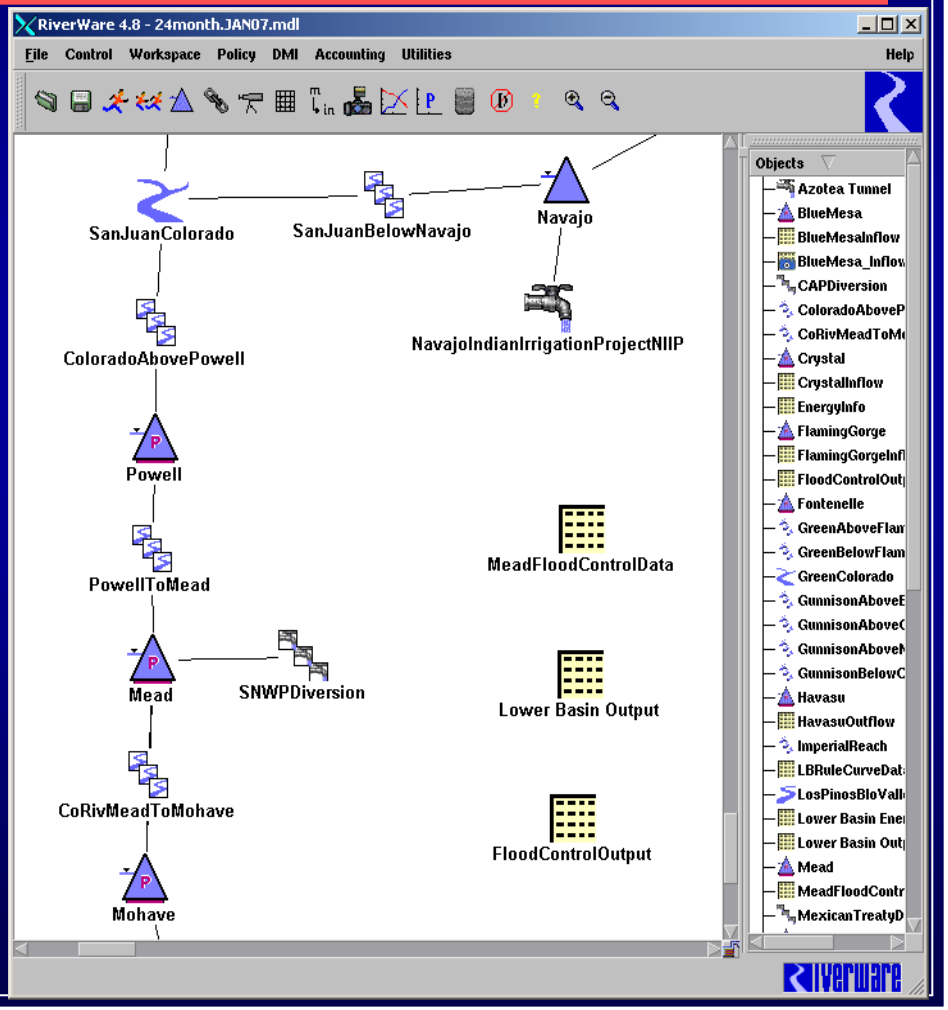
- Operation of Lake Mead
  - Meet downstream demand
  - Flood Control
- Operation of Lakes Mohave and Havasu
  - Water for downstream use
  - Environmental constraints
  - Recreational constraints
  - Flood Control



RiverWare Applications: Reclamation – Colorado Basin

Colorado River 24-Month Study

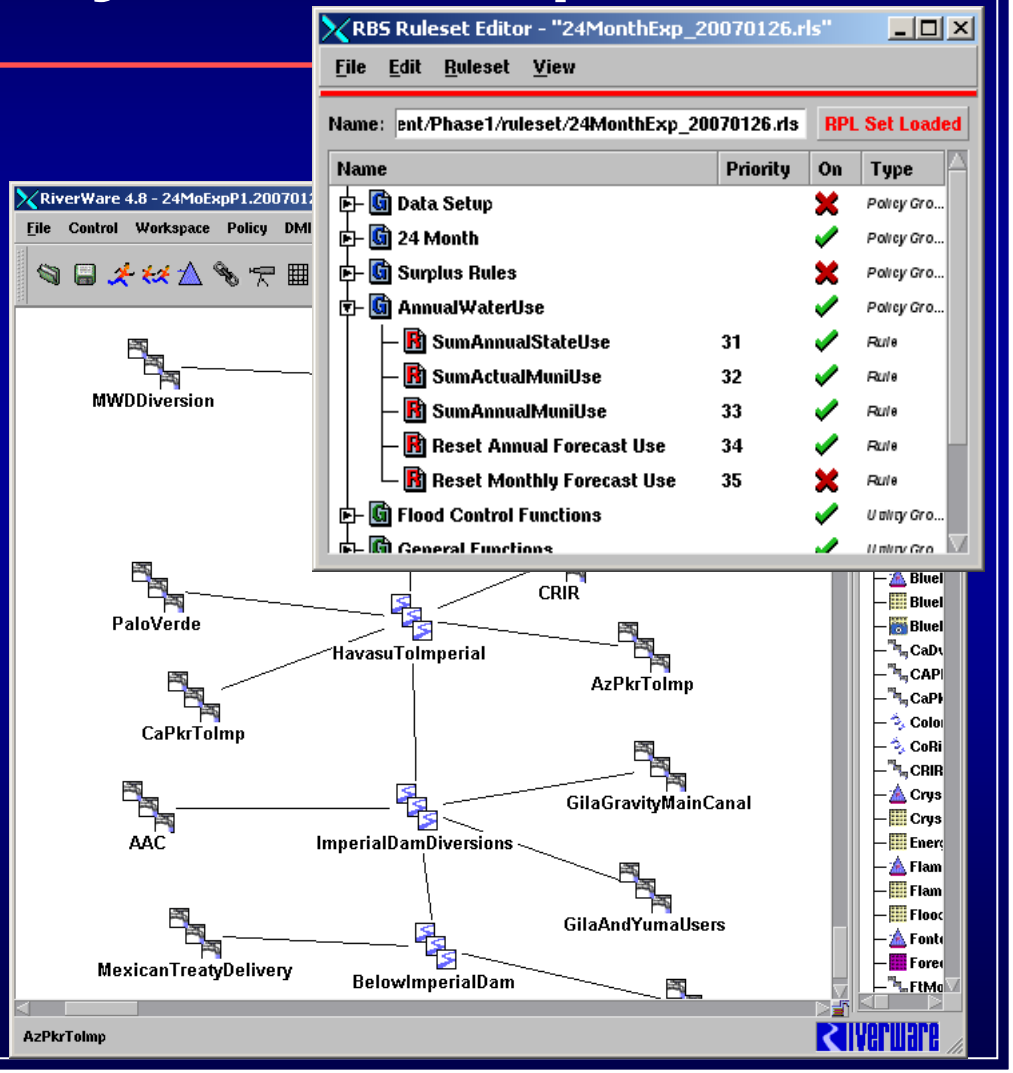
- Mid-Term Operations
- Basin-Wide Model (LC and UC collaborate)
- Used to develop the Annual Operating Plan
  - Normal, Surplus, Flood Control Conditions
- Updated monthly
  - Reflects changes in hydrology
  - Updated water demand



RiverWare Applications: Reclamation – Colorado Basin

24-Month Study Development

- Expand model to include more detail in Lower Basin
  - Diversions, tributary inflow
- Expand rule-based capabilities
  - Water allocation policies
  - Surplus water assignments



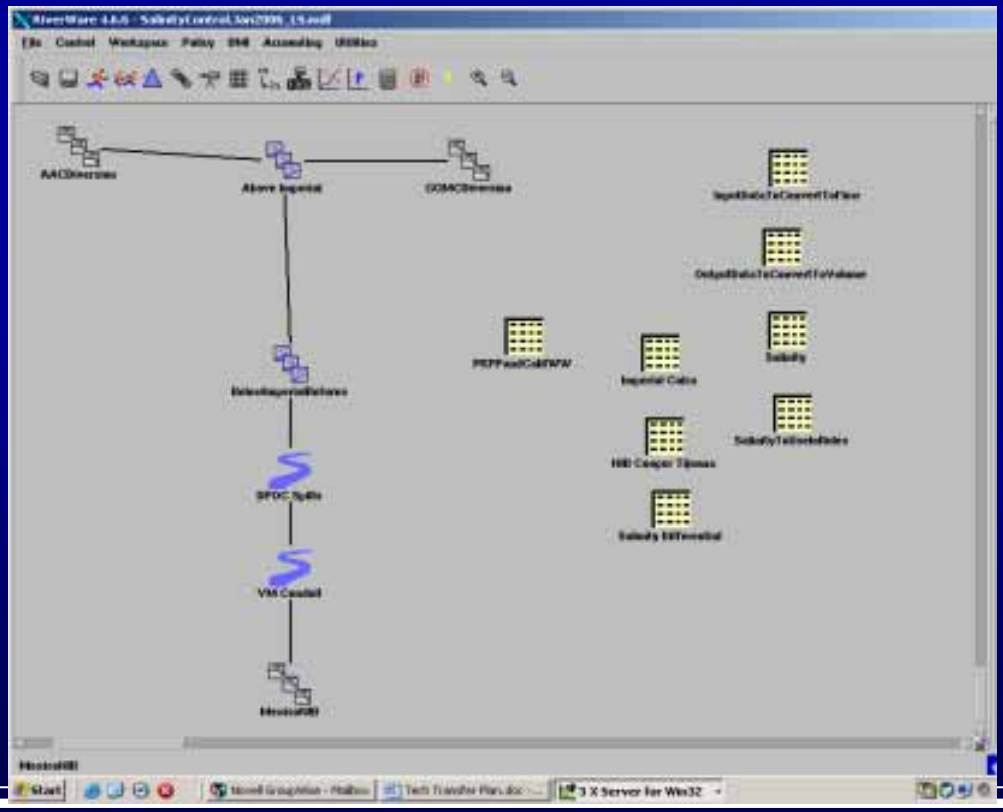
RiverWare Applications: Reclamation – Colorado Basin

Yuma Area Office Salinity Operations Models

Minute 242 of the U.S.- Mexico International Boundary and Water Commission of 1973 required U.S. to take actions to reduce the salinity of water being delivered to Mexico at Morelos Dam

Operational Constraints:

- Agricultural drainage water salinity
- Manage ground water levels
- Meet delivery requirements to Mexico (quantitative and qualitative)



RiverWare Applications: Reclamation – Colorado Basin

Flaming Gorge EIS

Operations of Flaming Gorge Dam to protect and assist in recovery of endangered fish and critical habitats on Green and Colorado River Basins

EIS 2000 to 2006 (ROD signed in February 2006)
RiverWare model used to develop alternatives

Current Model: to evaluate the effects of operations under the ROD for the next 70 years. Uses MRM with natural flows 1922-2004.

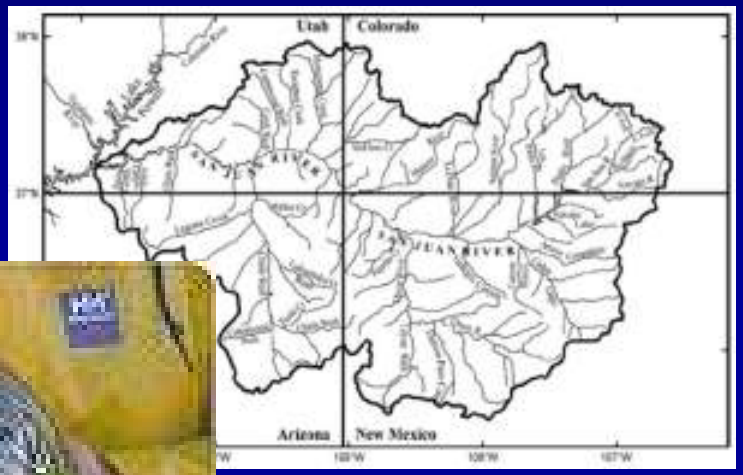
RiverWare Applications: Reclamation – Colorado Basin

Aspinall Operations EIS

The Upper Colorado River Basin Recovery Program has prepared flow recommendations for the Gunnison River to assist in the recovery of endangered fish. The EIS will evaluate alternative operations that assist in meeting the flow recommendations while maintaining the congressionally authorized purposes of the Aspinall Unit. In addition to Reclamation, the National Park Service uses RiverWare to explore alternatives

San Juan Recovery Implementation Program

To help recover endangered fish while allowing water development to continue in the San Juan Basin



Razorback Sucker

Reclamation, BIA, FWS, Tribes, BLM, Colorado, NM

Keller-Bleisner, Tribes and Reclamation use RW Model

Evaluate alternative operations of Navajo Dam

RiverWare Applications: Reclamation – Rio Grande

Upper Rio Grande Water Operations Model (URGWOM)

URGWOM

A collaborative effort

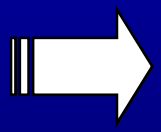
Reclamation	NMISC
USACE	Albuquerque
USGS	Santa Fe
FWS	MRGCD
BIA	Colorado
IBWC	Tribes

Upper Rio Grande Basin

Upper Rio Grande Water Operations Model (URGWOM)

4 Models Developed and Used by Reclamation, Corps of Engineers, USGS and New Mexico Instate Stream Commission

- **Water Accounting model**
- **Daily Operations model**
- **Forecast model**
- **Planning/EIS model**



Stakeholders Developing Alternatives and Approving Model

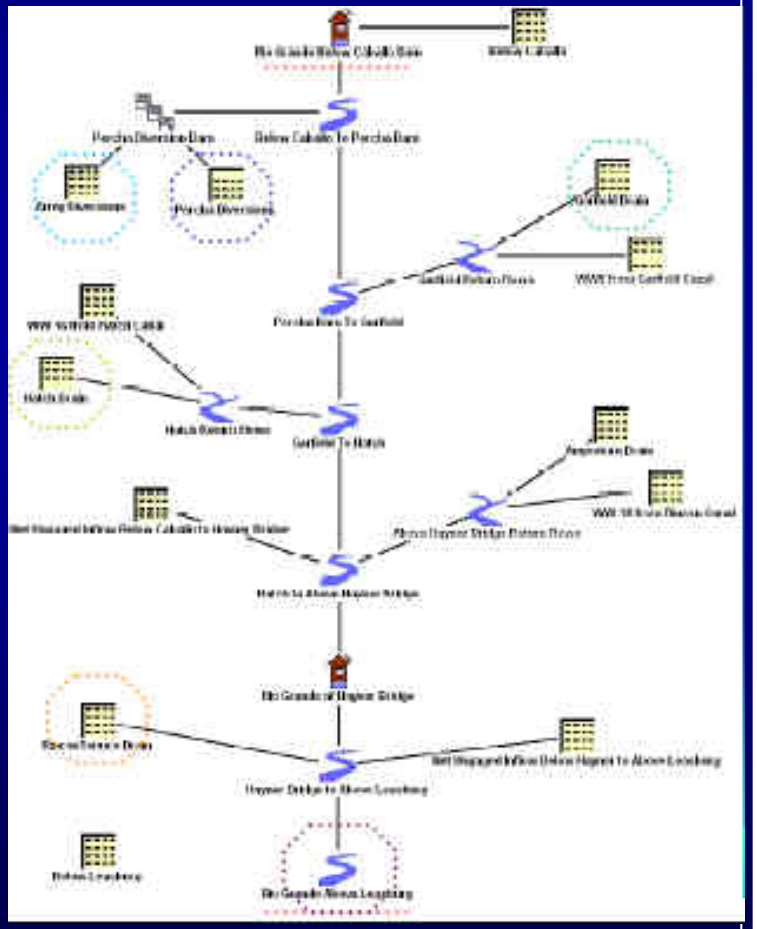
Upper Rio Grande Water Operations Model (URGWOM)

- RiverWare R&D Funding in 2006-7 for:
  - Water Accounting Enhancements
  - Rulebased Simulation Enhancements
  - GW-SW Interactions: RiverWare methods and MODFLOW links in development
  - HDB / DSS / CWMS RiverWare Linkages
  - Performance Improvements
  - Scenario management

RiverWare Applications: Reclamation – Rio Grande

Lower Rio Grande (Rincon Reach) Flood Control Planning

- By New Mexico State University (Phil King and Sue Tillery), and Texas A&M at El Paso (Zhuping Sheng)
- Model uses transfer functions to characterize the interaction between groundwater and surface water in the Mesilla Basin and Rincon Valley
- Monthly timestep

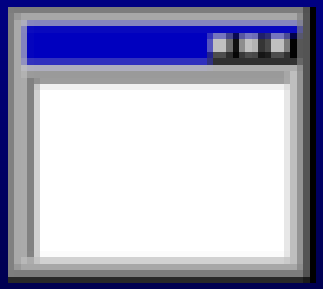


Rio Jemez Basin Indian Water Rights Settlement

RiverWare model developed by Natural Resources Consulting Engineers (NRCE)

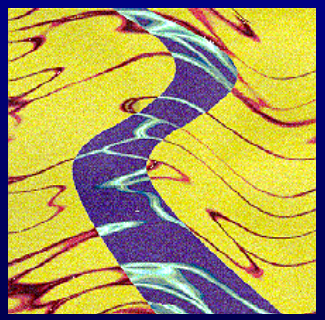
Linking an External Water Rights Solution Method to a RiverWare Model

Water Rights Solver (WRS)



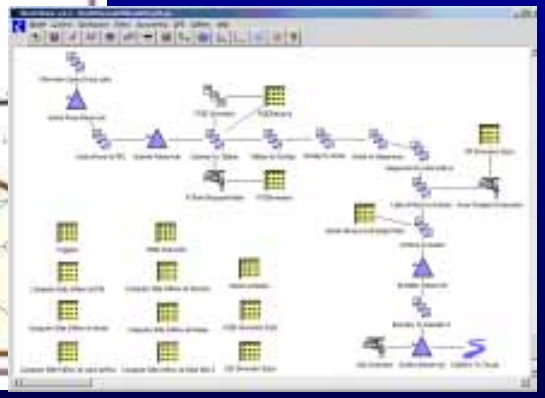
← RCL + DMI →

RiverWare (Model)



RiverWare Applications: Pecos River Basin

Carlsbad Project Water Operations and Water Supply Conservation EIS



Reclamation and NMISC

RiverWare model developed by Hydrosphere and Tetra Tech

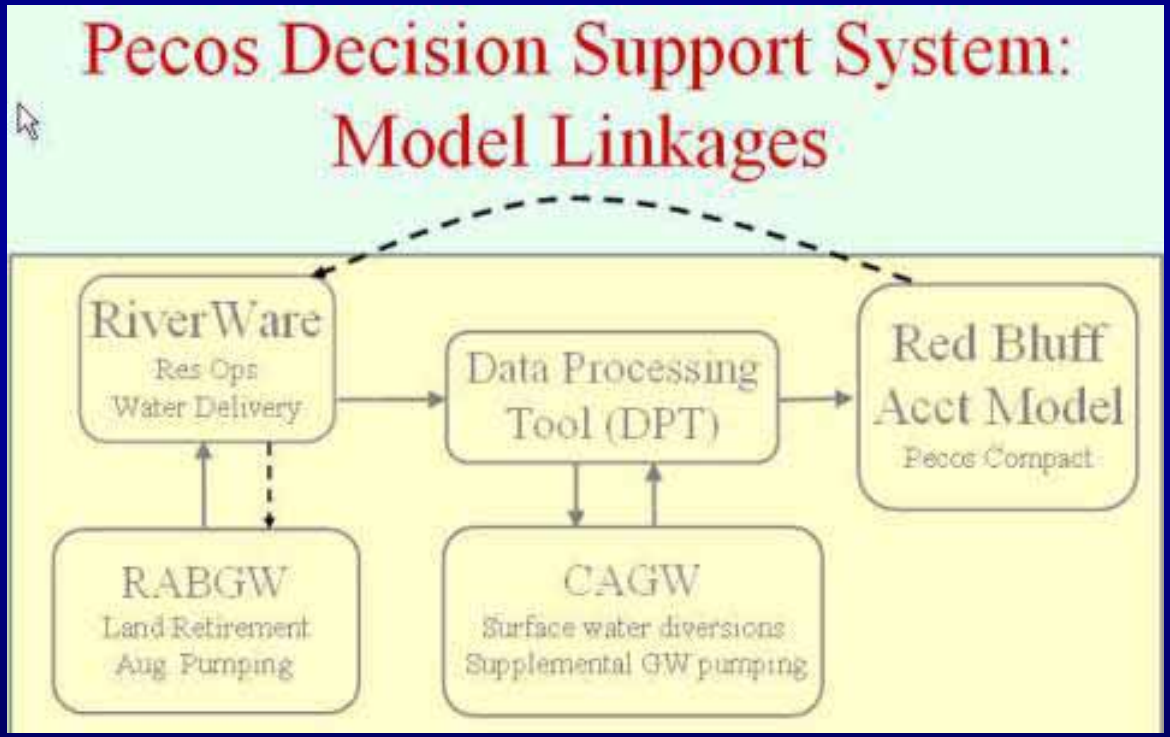
Alternative operations of Sumner Dam to protect the bluntnose shiner and conserve the water supply of the Carlsbad Irrigation Project

ROD: June 2006

RiverWare Applications: Pecos River Basin

Pecos Adjudication Settlement EIS and Pecos River DSS

DSS links a RiverWare model of Pecos River with 2 MODFLOW models, an accounting model and various I/O tools (see presentation Carron UGM '03)



RiverWare Applications: Reclamation

Truckee-Carson Basin

Hydrologic Data

1

RiverWare Accounting Model

RiverWare Forecasting Model

RiverWare Operations Model

Hydrologic Data

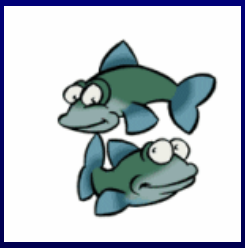
Forecasted Hydrology

Forecasted Flows, Storages, etc.

Accounting Data

TROF Spreadsheet

1



Reno

Carson City

RiverWare Applications: Reclamation

Truckee-Carson Basin Updates

Current conditions models

- Models in full use operationally!
  - Basin stakeholders have come to expect good results and forecasting from RiverWare
- Transition beginning to shift model use over to local officials (and eventually stakeholders)
- Extremely helpful last year in high water situation
  - One of top ten years in last 100
- Already helpful in opposite case this year!
  - On track to be one of bottom ten!

RiverWare Applications: Reclamation

Truckee-Carson Basin

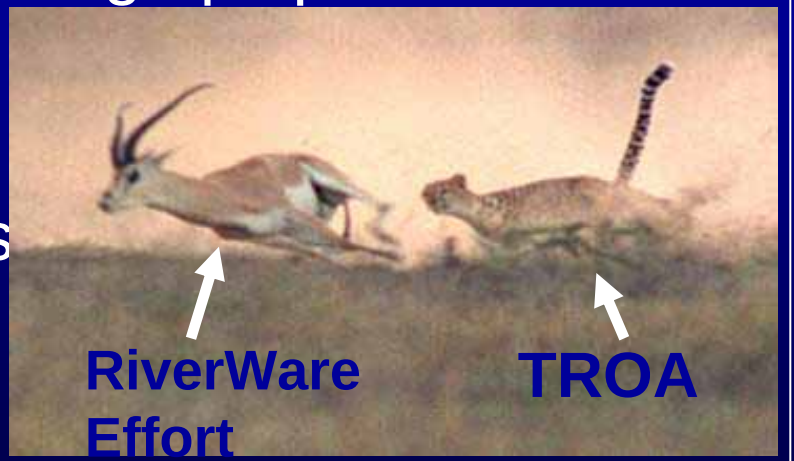
2006-2007 Change in perspective!

RiverWare Applications: Reclamation

Truckee-Carson Basin

Next-generation development underway

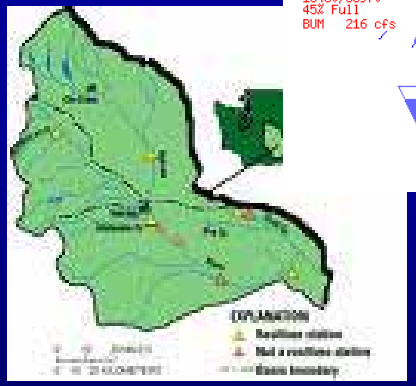
- TROA Negotiations have concluded!!!
  - Focus about to shift to models (which means pressure applied to the modelers!)
- Combo-model development picking up speed
  - Shane Coors headed to duty station in Boulder, CO
- More complexity being address
  - Credit storage
  - Transfers/exchanges

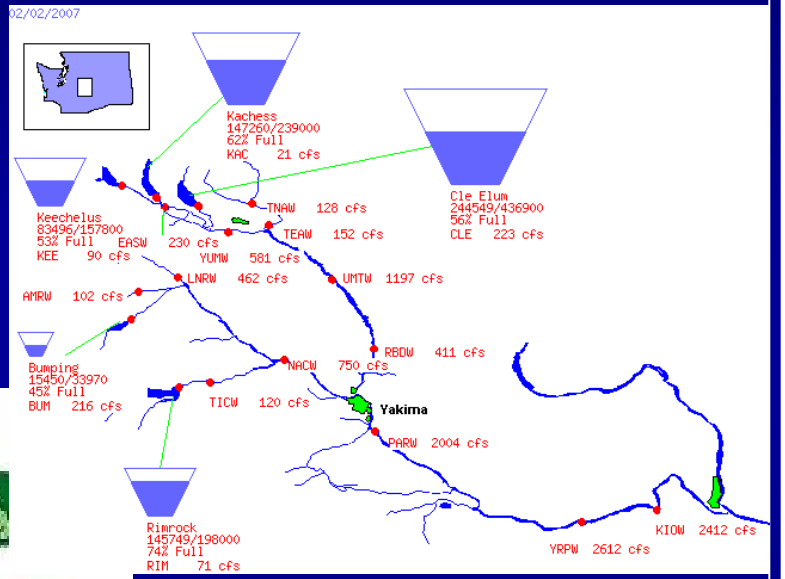


RiverWare Applications: Reclamation – Upper Columbia Area Office

Yakima River Basin Water Storage Feasibility Study

To examine feasibility and acceptability of storage augmentation in the Yakima River Basin in order to improve conditions for fisheries and water supply.



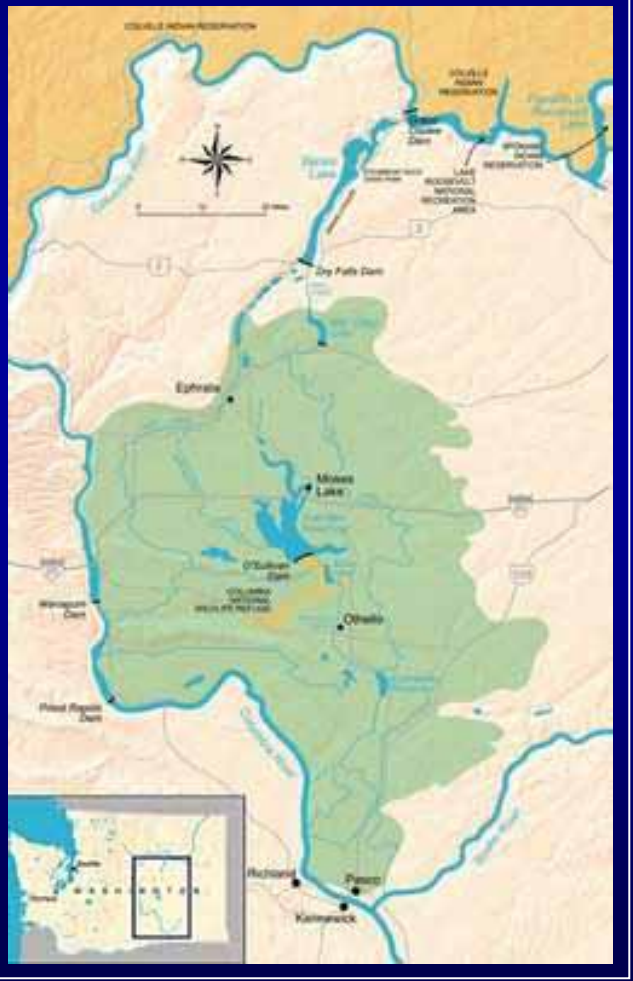


RiverWare was used to evaluate alternative plans; report issued Nov 2006; EIS will follow

RiverWare Applications: Reclamation – Upper Columbia Area Office

Columbia Basins Project: Odessa Subarea Special Study

Investigate possibility of extending development of the Columbia Basins Project to deliver project water to lands currently using groundwater



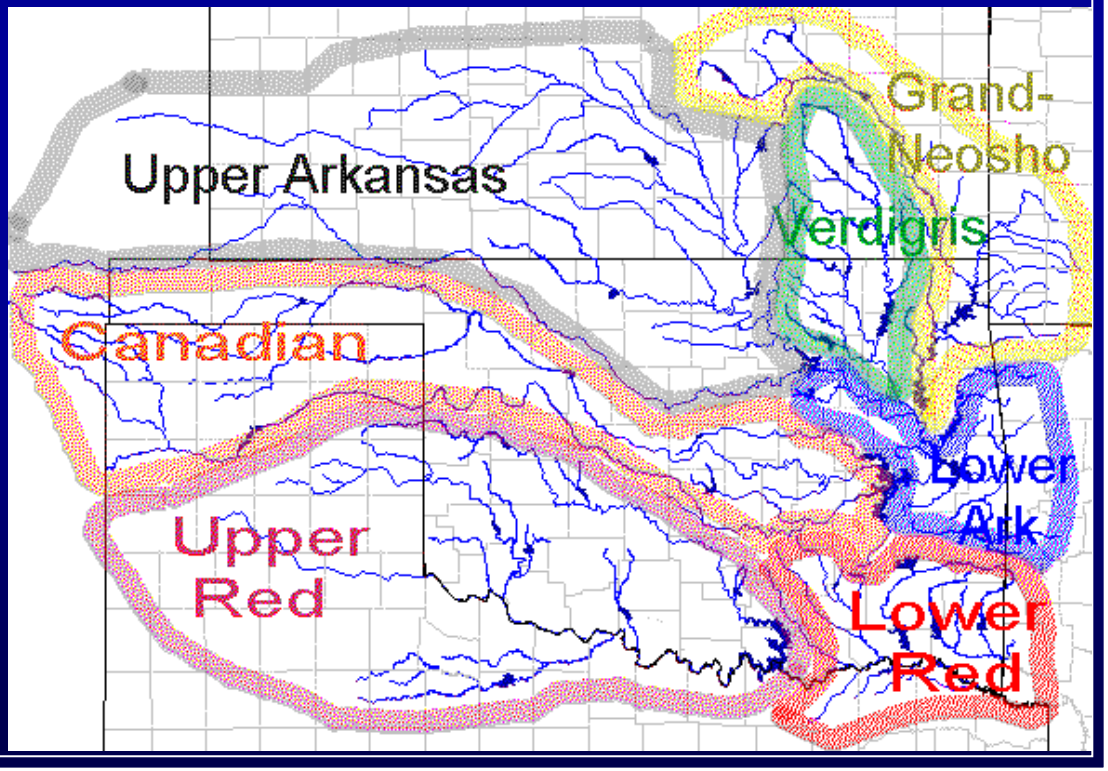
Reclamation's Columbia Basin Irrigation Project RiverWare Model (CBIP-RW) was used to assess the impacts and ability of the CBP infrastructure to deliver water to the Odessa Subarea (Report Nov06)

RiverWare Applications: US Army Corps of Engineers

Tulsa District

Period of Record simulations for:

- North Canadian River
- Red River
- Arkansas River
- Wichita River

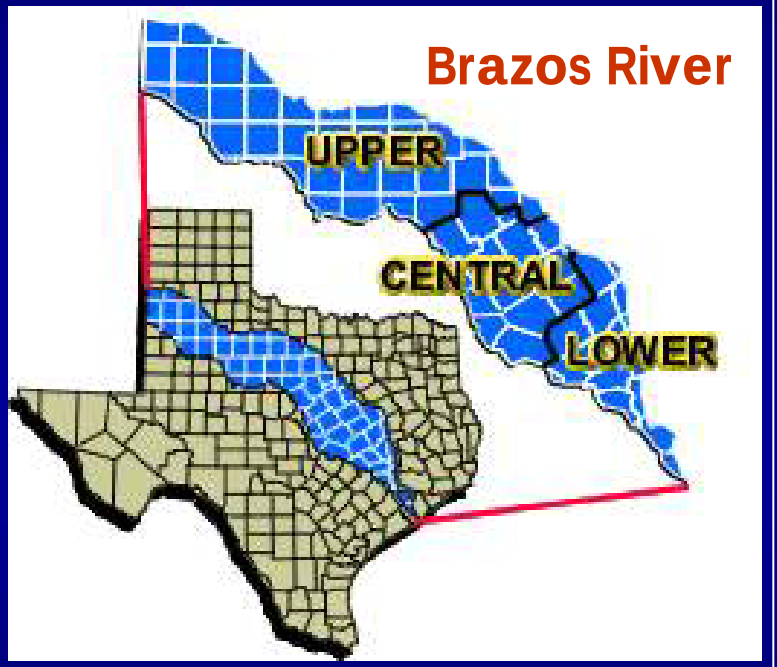


US Army Corps of Engineers ®

RiverWare Applications: US Army Corps of Engineers

Ft Worth District

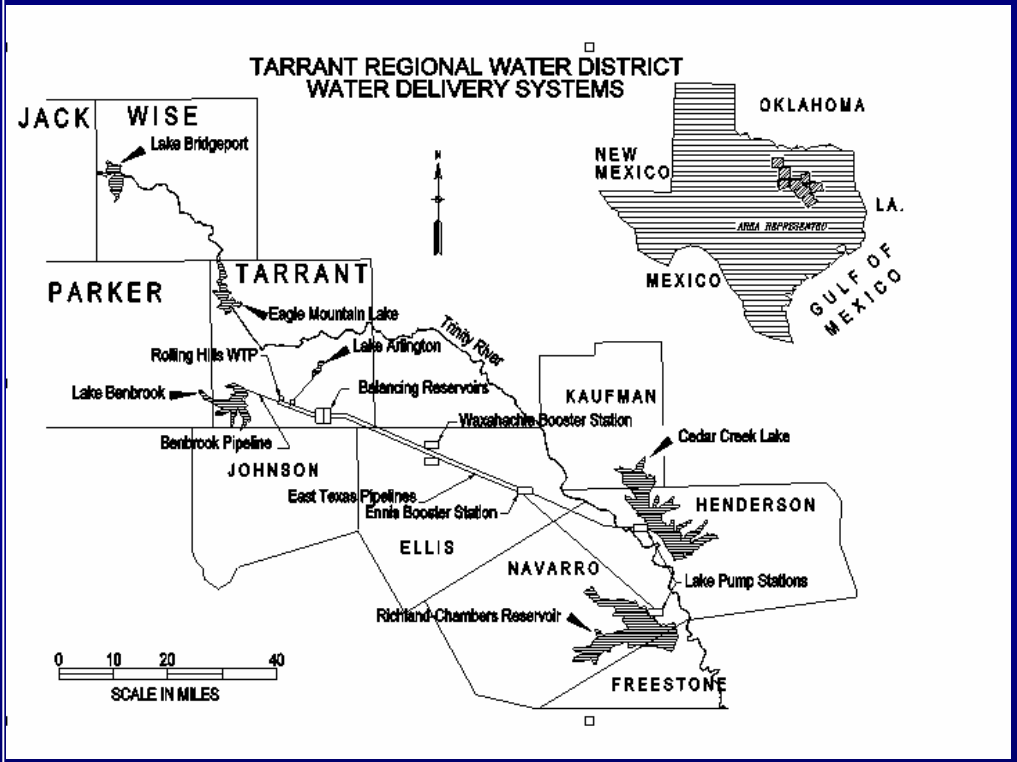
- Yield Studies for 9 projects on the Brazos River
- Revised Rule curves for the Neches River Project (Sam Rayburn Dam)



US Army Corps of Engineers

RiverWare Applications:

Tarrent County Regional Water District

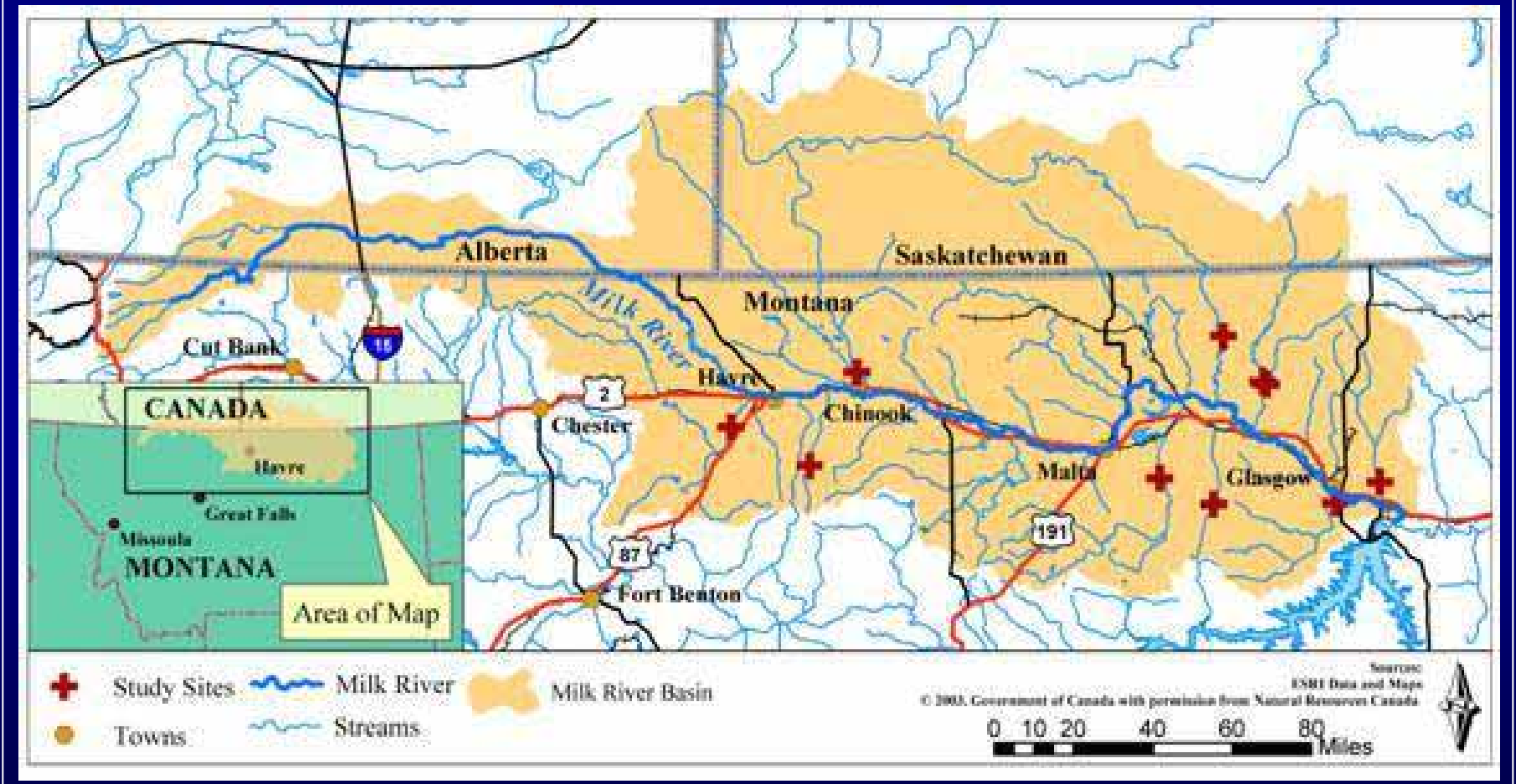


- Long Range Planning Model
- Water Supply Reliability and Drought Response Planning Studies

(TCRWD, Wave Engineering and Hydrosphere Resource Consultants)

RiverWare Applications: State of Montana

Milk River Basin, Montana



RiverWare Applications: State of Montana

Milk River Basin, Montana

- State of Montana has developed a RiverWare model of St. Mary and Milk River Systems.
- Planning model runs rulebased simulations at a daily timestep for 1959-2003 hydrologic record; hope to use for operations eventually
- Model could be used for future NEPA process for rehab of St Mary's canal

RiverWare Applications: Santa Ynez River, CA

Daily Operations Model (Stetson)

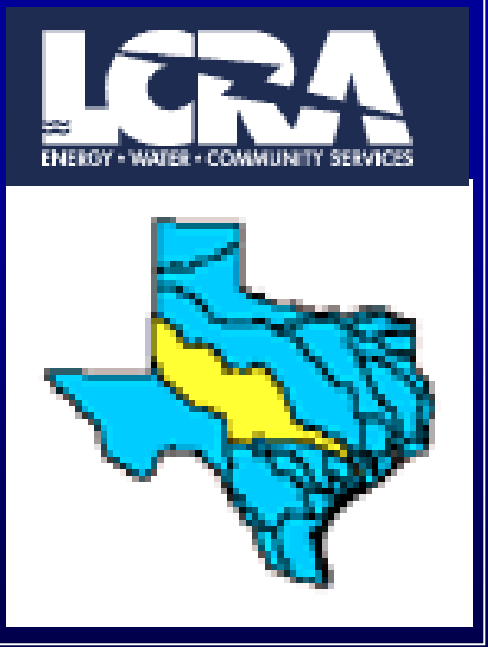
- Santa Ynez River is major source of water supply for Santa Barbara County, California
- Current watershed model is in DOS-Basic and experiencing memory limitations –new model being developed in RiverWare!
- Rules will incorporate existing agreements and legal requirements
- Interesting hydrologic features: reservoir operations for endangered Southern steelhead, tunnel infiltration, cloudseeding operations, interactive surface and groundwater involving recharge program

RiverWare Applications:

Lower Colorado River Authority

- **Monthly timestep planning model that simulates priority administration of water rights, including run-of-river irrigation rights, M&I rights, and storage rights.**
- **Daily model development upcoming**
- **Comparisons with WAM and other LCRA modeling tools**

(LCRA with Wave Engineering and Hydrosphere)



RiverWare Applications:

Lower Neches Valley Authority

LNVA's new salt water barrier

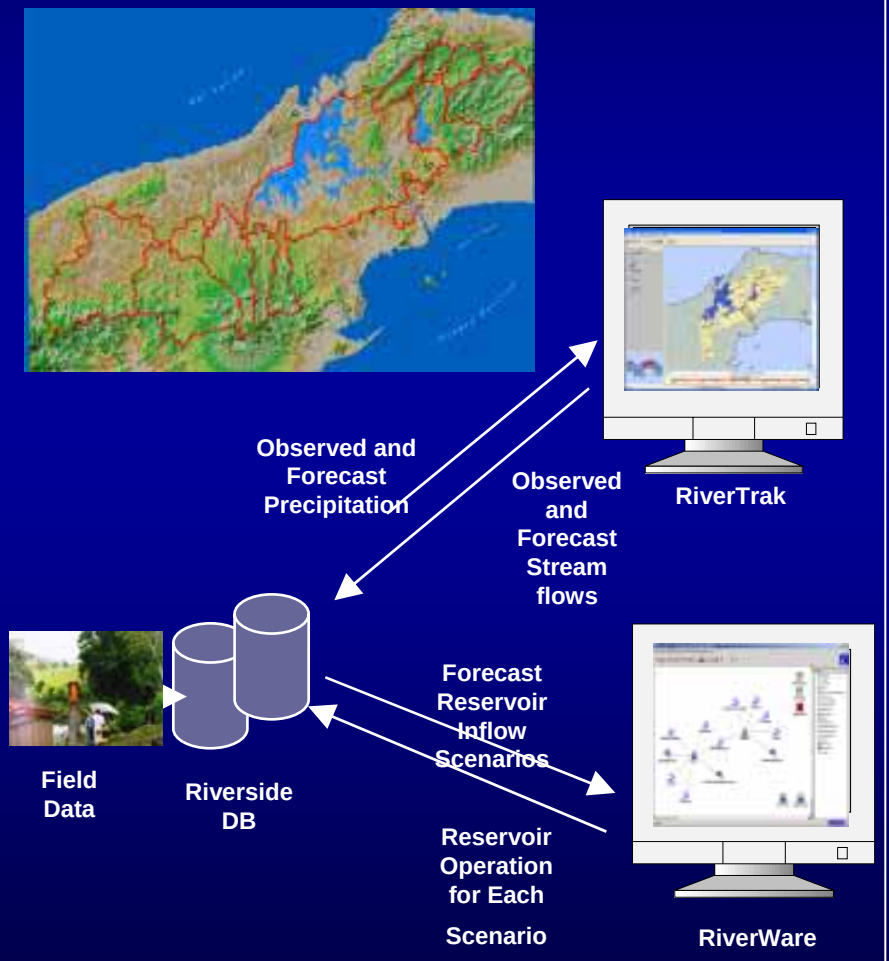
RiverWare: Development of a Water Rights model to explore allocation of water that was previously used to control salt water intrusion.

(Wave Engr, CADSWES and LVNA)

RiverWare Applications: Riverside Technology, inc.

Panama Canal Study

- Coupled RiverWare with RTi's realtime DB and RiverTrak to forecast streamflows
- Rules predict operations in flood conditions



RiverWare Applications
Other Applications

- Kansas River model (Corps of Engineers)
  RiverWare model used for planning and operations
- Emery County: Cottonwood Creek water rights and real time operations (water rights) Dave King and Provo AO (Reclamation - ongoing)
- Raritan River Basin, New Jersey
  Yield study and analysis for new storage New Jersey Water Authority (completed 2006)
- El Dorado Irrigation District – Development of Daily Operations Model (Hydrosphere; ongoing)
- Yasu River Basin, Japan
  Study for low flow operations (PWRI 2004)
- Methow River Basin (Reclamation 2003)- evaluation of storage alternatives (Roger Sonnichsen CBAO)

RiverWare
Development of Class Curriculum

- **Reservoir System Design and Management**
- Covers design and operation of reservoirs. Uses RiverWare for modeling exercises, demonstrating concepts, and class projects.
- Level: Seniors and M.S. students
- Sponsored by CADSWES in collaboration with Dr. Beth Eschenbach of Humboldt State University, Arcata, California
- Currently applying for NSF funds to expand effort
- Seeking interested collaborators