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Improving Watershed Models through Stakeholder Involvement

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50 Years of Watershed Modeling: Past, Present, and Future

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LimnoTech
Water | Environment | Scientists | Engineers

EPA's Watershed Approach Framework

People working together to protect public health and the environment - community by community, watershed by watershed.

Carol M. Browner, Administrator
U.S. Environmental Protection Agency, June 1996

- Preferred way to strategically address priority water resource goals in a hydrologically defined geographic area through…
  - Sound science
  - Integration of regulatory and voluntary programs
  - Stakeholder involvement
- Opportunity for more successful watershed planning and TMDLs with robust modeling <u>AND</u> stakeholder involvement
- Engaged stakeholders can…
  - Improve direction on project goals
  - Provide high quality, site-specific data
  - Actively use the model

Open Modeling Process:
Promotes Ongoing Communication and Peer Review

Clarify Objectives / Set Goals

↓

Select Model and Assemble/Review Available Data

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Design Conceptual Modeling Strategy

↓

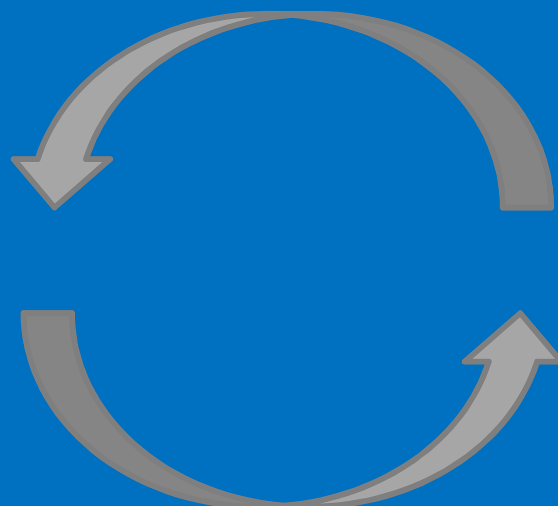
Develop/Calibrate Model

↓

Evaluate/Confirm Model

↓

Apply Model for Decision Support



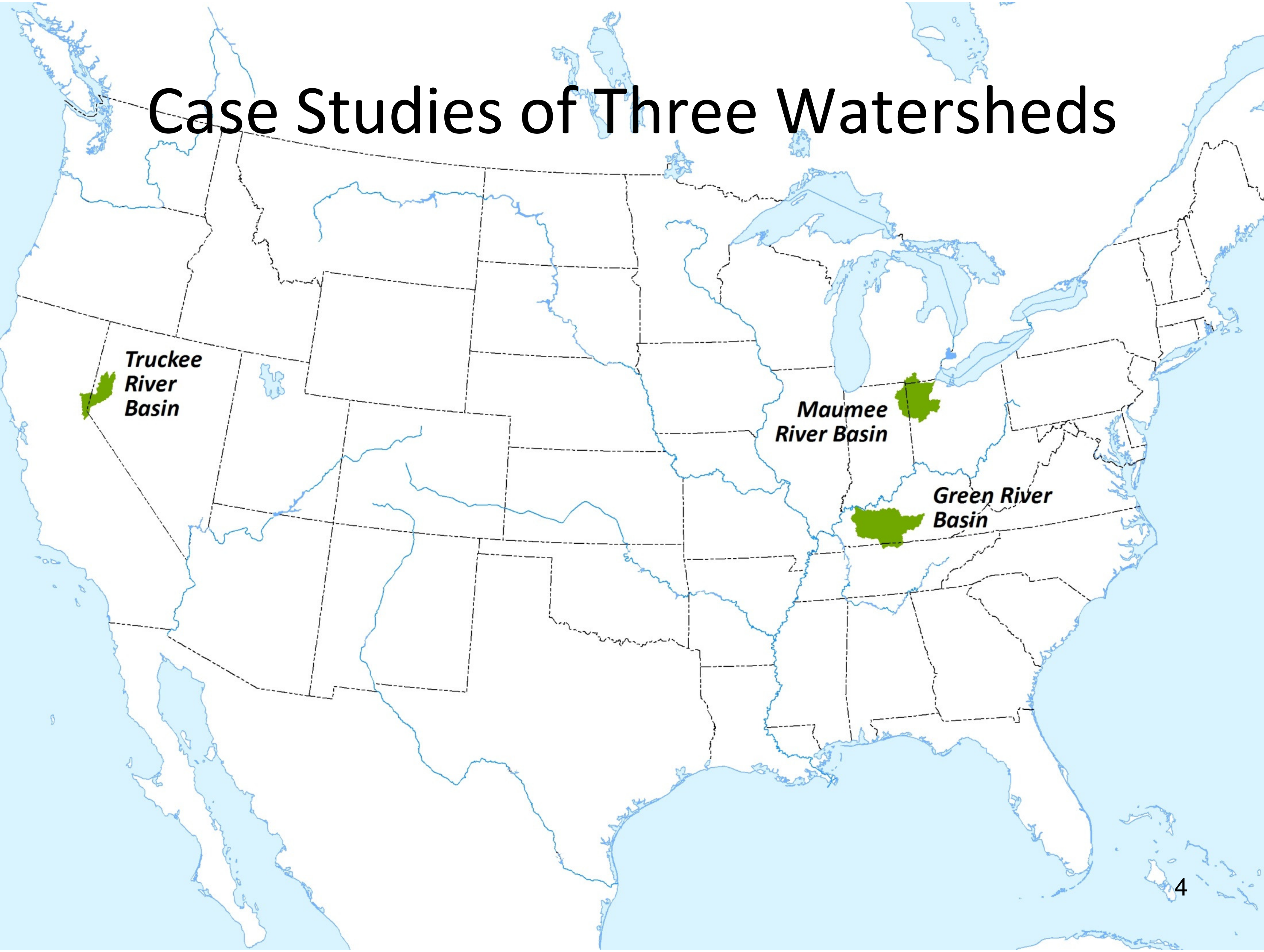
Ongoing Communication and Review

State Agencies

Science Advisory Panels

Watershed Stakeholders

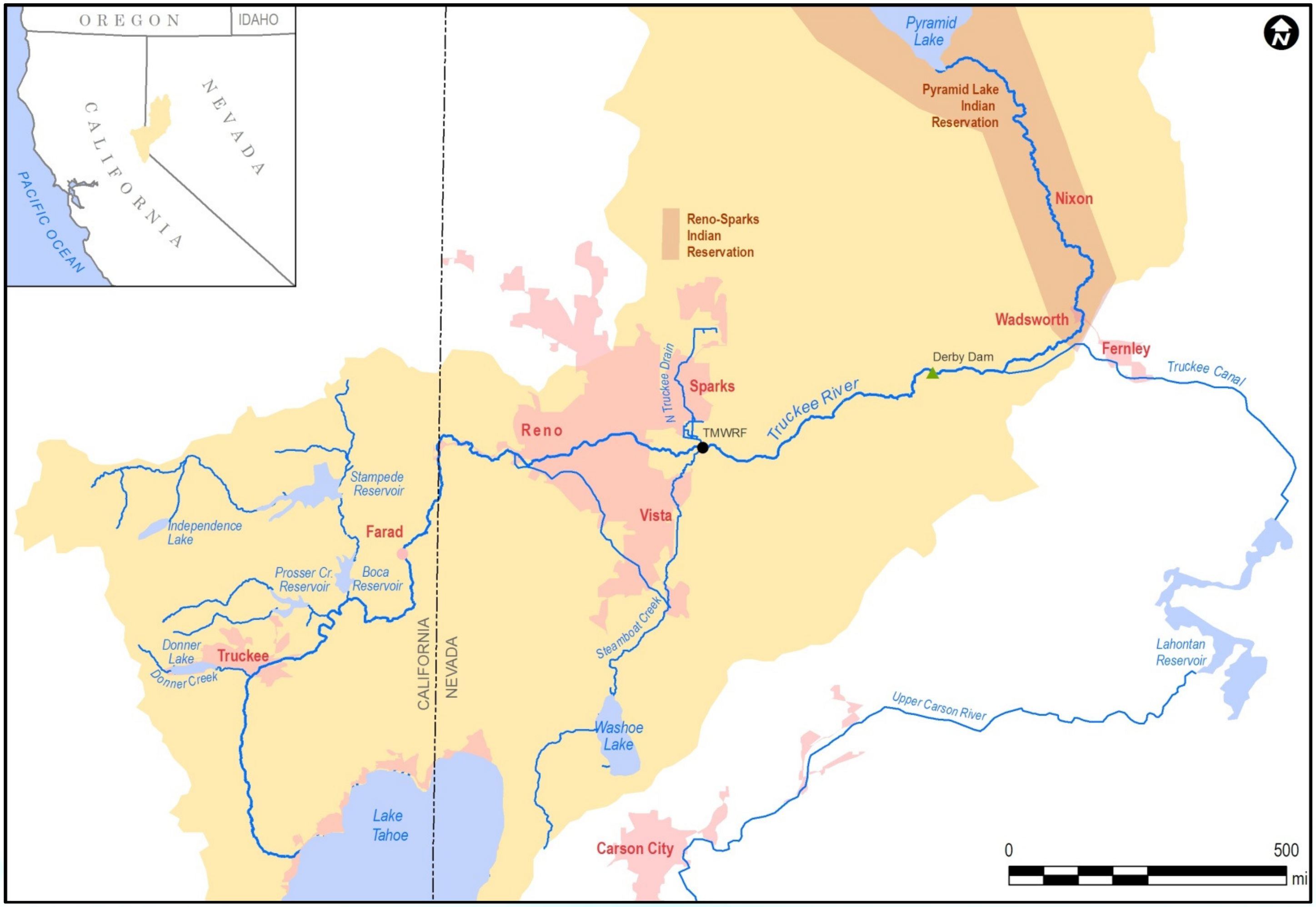
Case Studies of Three Watersheds



TRUCKEE RIVER, NV

The Watershed: Truckee River

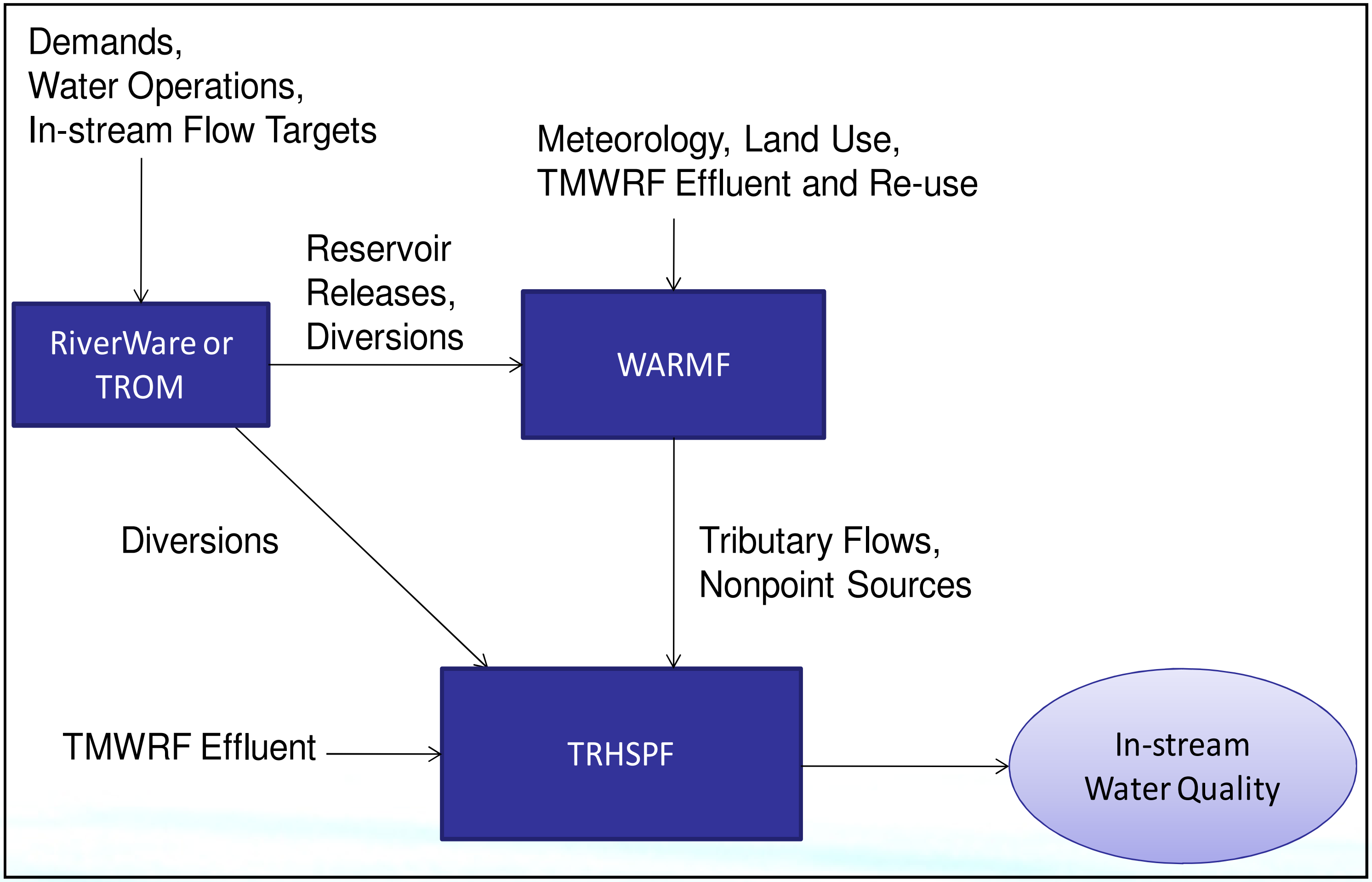
- 3000 mi^2 watershed
- 140 river miles from Lake Tahoe to Pyramid Lake
- Highly managed system
- Inter-basin transfer at Derby Dam
- Depleted flows in lower river
- Multiple state/tribal stakeholders with competing uses



The Issues:
Dissolved Oxygen Impairment and TMDL Review and Revision

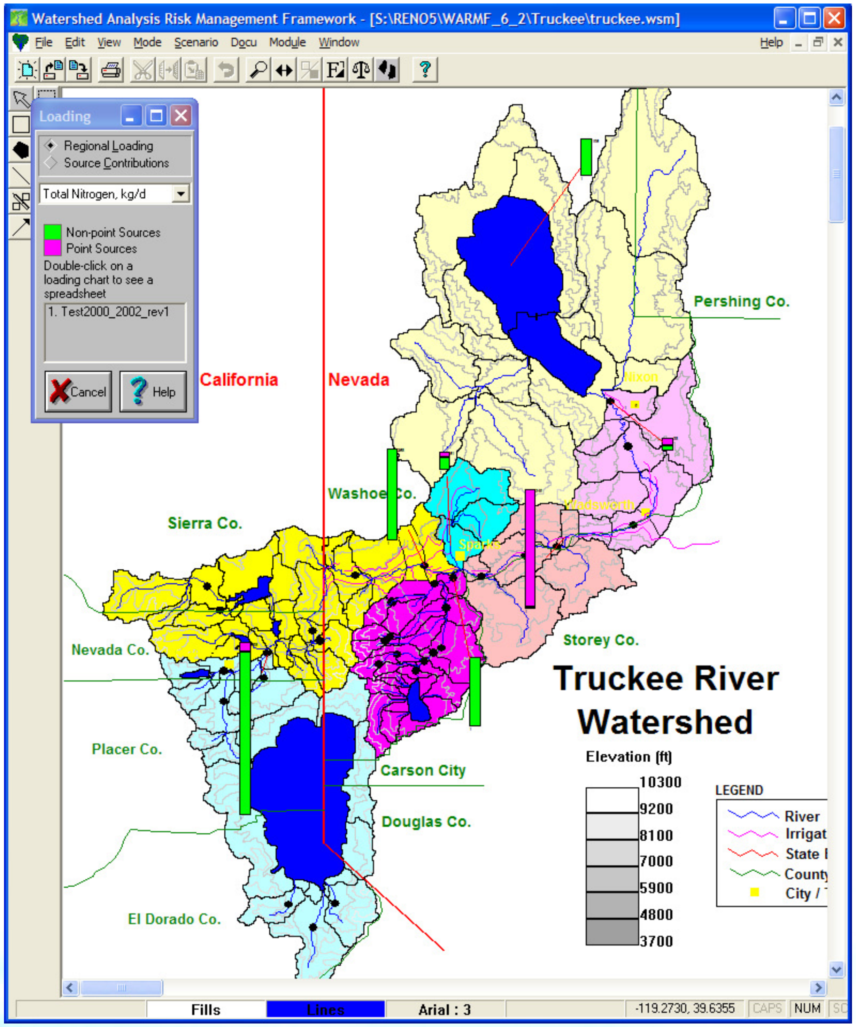
- Excess nutrients / low flow lead to reduced DO
- 1994 nutrient TMDL limits potential for regional growth
- Numeric N and P WQS are not site-specific, lack linkage to DO response
- 3rd-parties leading review / revision of numeric nutrient criteria and TMDL
  - Improved dataset /tools since 1994
  - Evolving water quantity management with improved “low flows”
  - NDEP supports need for action

The Tools: Linked Modeling Approach



WARMF: Watershed Analysis Risk Management Framework

- First developed in late 1990's under sponsorship from EPRI
- Peer-reviewed, public domain
- Applied throughout U.S.
- Predicts watershed flow and nonpoint loads based on:
  - land use
  - meteorological conditions
  - water management
  - watershed improvements
- Output linked to TRHSPF water quality model



ELECTRIC POWER RESEARCH INSTITUTE

The Stakeholders

WQS / TMDL Stakeholders

WQS / TMDL Principal Parties

3rd-Parties

- City of Reno
- City of Sparks
- Truckee Meadows Water Authority (TMWA)
- Washoe County

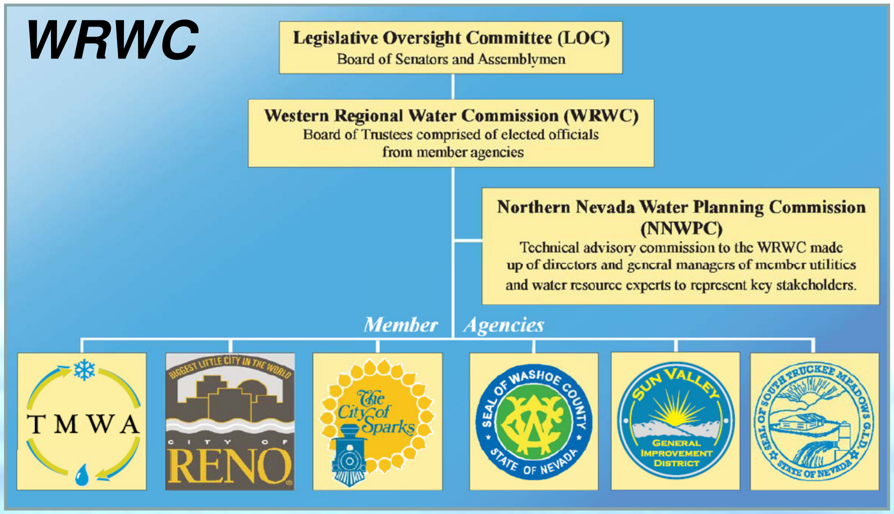
- US EPA
- NDEP

- City of Fernley
- City of Fallon
- US Fish and Wildlife Service
- US Bureau of Reclamation
- Pyramid Lake Paiute Tribe (PLPT)
- Truckee Carson Irrigation District
- Lyon County
- Storey County
- Churchill County

Stakeholder Input

- Funded by WRWC
- Joint process led by four “3rd-parties” (Reno, Sparks, TMWA, Washoe County)
- Active guidance, review and dialogue with NDEP and US EPA
- Data from many regional sources – TRIG (http://www.truckeeriverinfo.org/)
- Recent model database extension and confirmation runs
  - Land use data from various local sources
  - Detailed stakeholder review of results
- 3rd-parties lead one-on-one and broader stakeholder meetings
- Hands-on model training

Relationship building has been key!



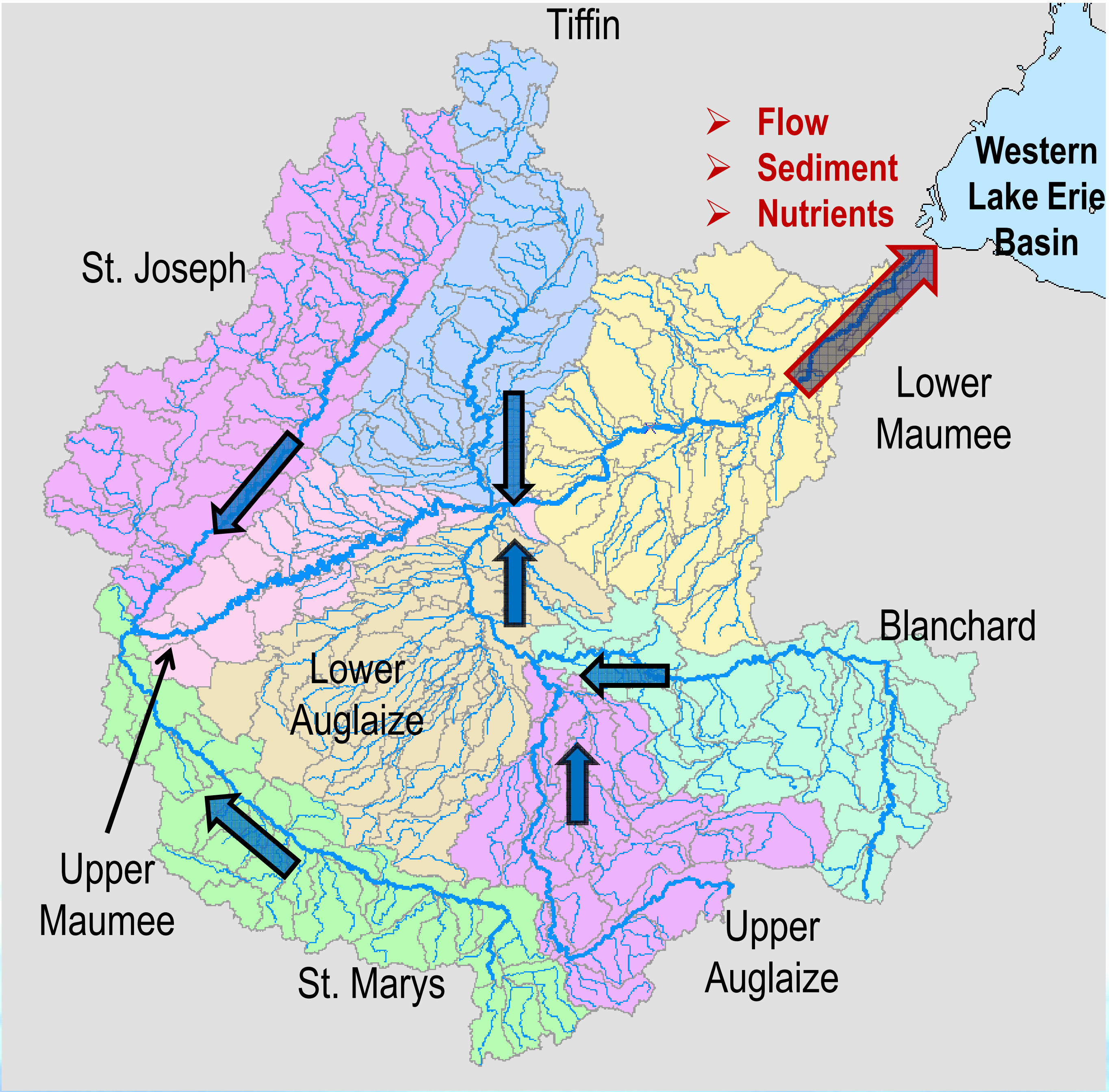
Value Gained / Lessons Learned

- 3rd-Party Process <u>requires</u> regulator coordination/approval and stakeholder support
- The process is slow and complex
  - Lack of momentum (recent delays with WQS review)
  - Competing water quantity issues in watershed
  - Ongoing education of involved parties
- Frequent meetings / discussions have broken down <u>some</u> barriers within group – important to build trust
- Technical tools provide foundation for open discussion
  - Common language for discussion
  - Can reduce tendencies to gravitate to emotional / political differences
- Success in regional water planning and management hinges on effective stakeholder collaboration

MAUMEE BASIN, OH

The Watershed: Maumee River

- 6,300 mi^2
- Major tributary of the Western Basin of Lake Erie
- Highly agricultural watershed (>70% cropland)



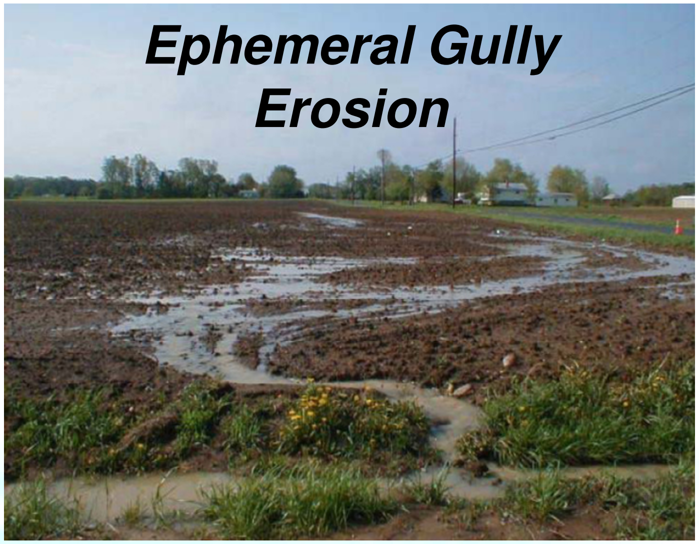
The Issues: Ecological Concerns

- Watershed export of sediment and nutrients:
  - Phosphorus (P), especially **soluble reactive P**
  - Nitrogen (N)
  - Suspended solids
- Eutrophication & sedimentation impacts in Western Lake Erie Basin (WLEB):

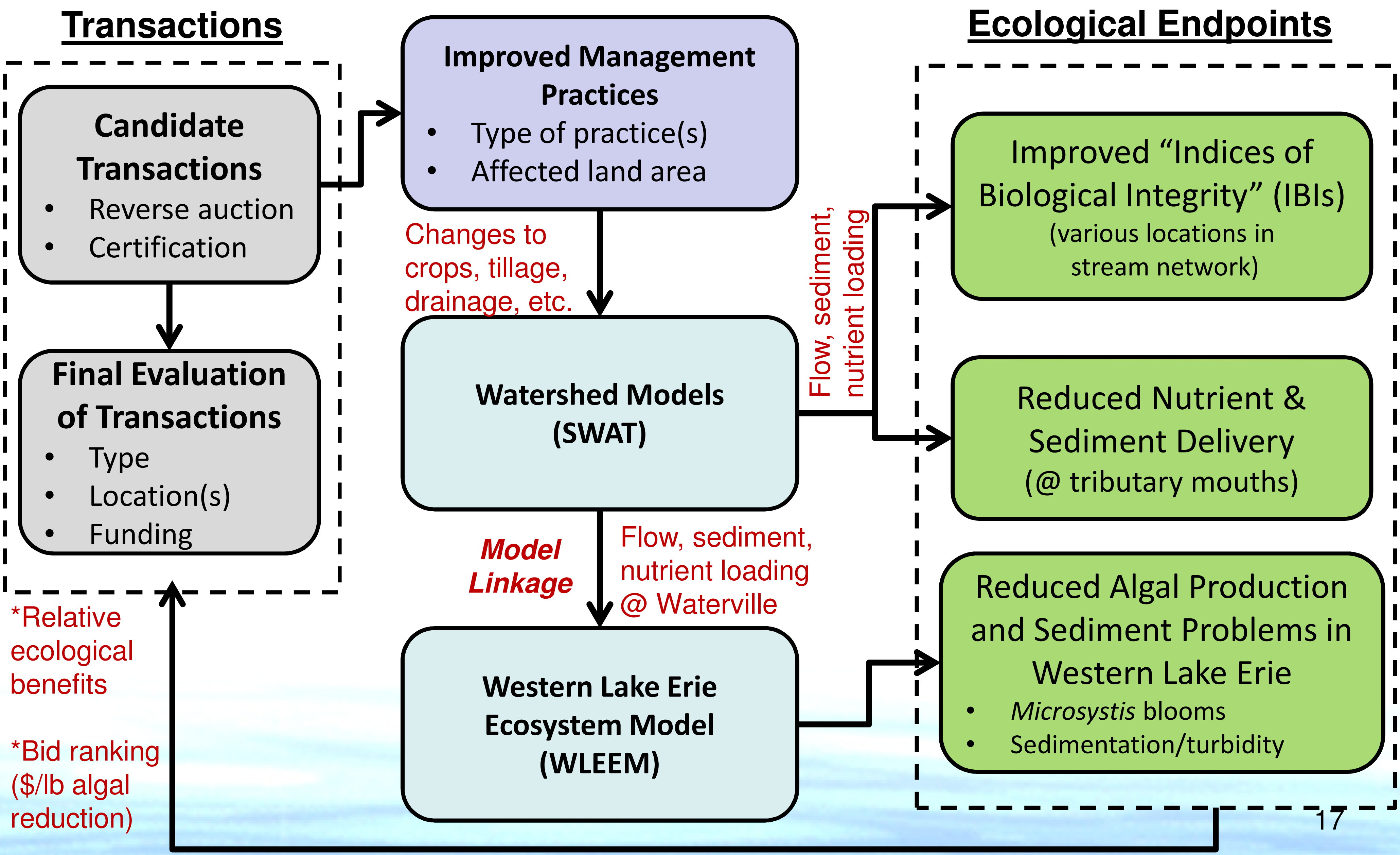
  - Harmful algal blooms (HABs)
  - Nuisance benthic algae in WLEB
  - High sedimentation rates in Federal navigation channel

The Tools: Great Lakes Watershed Ecological Sustainability Strategy (GLWESS)

- Link ecosystem improvement outcomes to type, placement and number of BMPs applied in watershed
- Test transaction framework that will pay for water stewardship practices based on how well nutrient and sediment loads are reduced from farmlands
- Models used to support transactions
  - SWAT watershed models
  - Western Lake Erie Ecosystem Model (WLEEM)
- Agricultural community will be ultimate end user



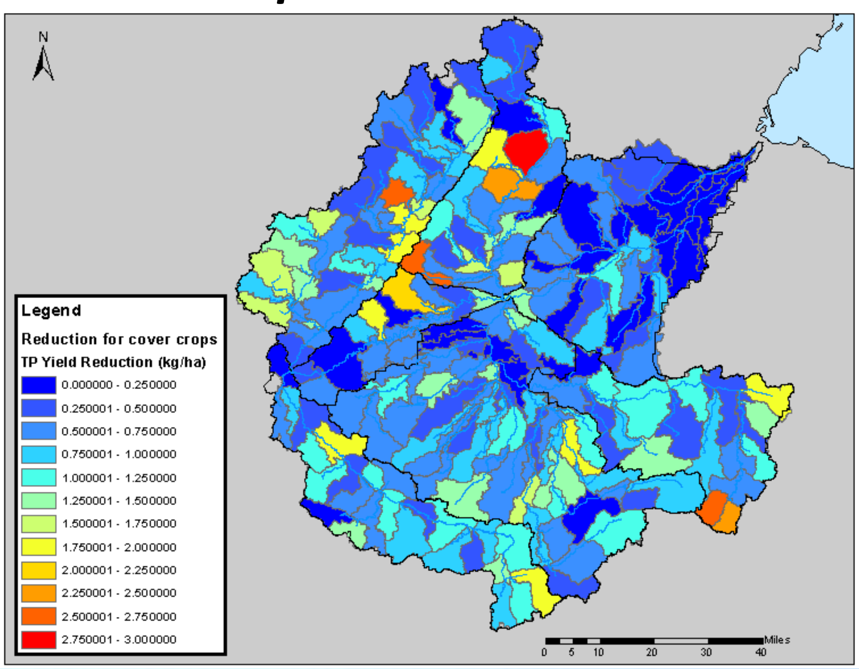
Transactions ←→ Ecological Endpoints



Linked Watershed-Lake Models Support Transactions

- Physically-based tool estimates ecological benefits of candidate agricultural management actions
- Provide guidance on "target" areas for transactions
- Evaluate and rank candidate transactions & associated management actions
- Work with stakeholders to get the best possible return on investment - ideally, enough to ultimately solve the HAB problem

Total Phosphorus Yield Reduction

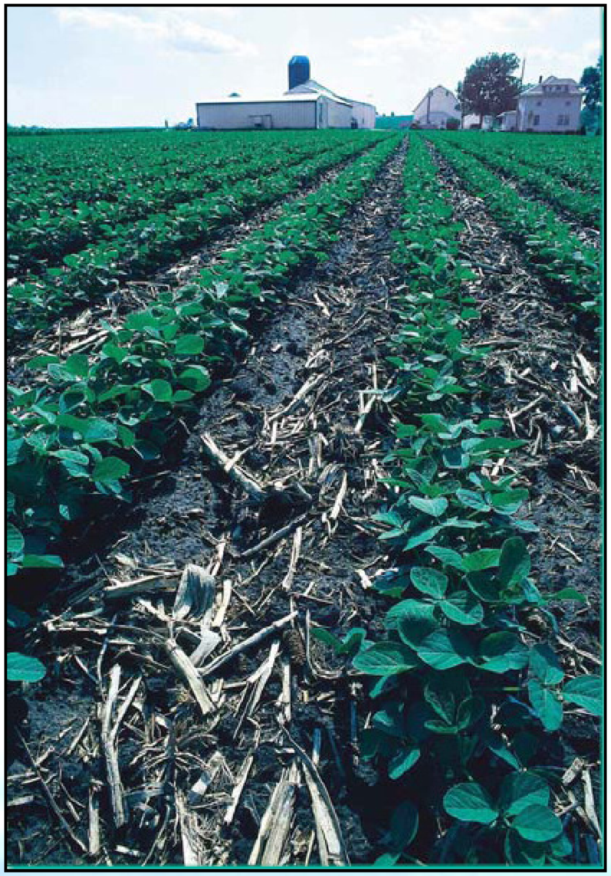


Concept for Reverse Auction Approach

Auction Bid	Total Cost	Estimated Algal Biomass Reduction (lbs)	Cost-Effectiveness ($/lb)	Final Bid Ranking
Bid #1	$20,000	1,000	$20	2
Bid #2	$30,000	2,000	$15	1
Bid #3	$25,000	1,000	$25	3

The Stakeholders

- Funded by Great Lakes Protection Fund (GLPF)
- Project team: The Nature Conservancy, LimnoTech and Michigan State University
- Partners:
  - NRCS-CEAP (Natural Resources Conservation Service-Conservation Effects Assessment Program)
  - Conservation districts
  - Farm owners/operators
  - Soil and water conservation districts
  - Drain commissioners
  - Agribusiness
  - Municipal and county planning agencies
  - State and federal resource agencies
  - Universities
  - Non-governmental organizations



Stakeholder Input

- Sharing site-specific data for watershed characteristics
- Visits to farms and farmer interviews
  - Understand willingness and values
  - Provide a "reality check" on reasonable land management practices and BMPs
  - Survey farmers regarding crops, management practices, soils – feedback to SWAT model

- Plan to conduct stakeholder workshops to pilot test reverse auction approach
  - Determine how best to implement the concept to maximize acceptance, participation, and return on investment
  - Need to build trust and confidence in the tools
- Meetings with retailers and agribusiness leaders

Value Gained / Lessons Learned

- Stakeholders input and feedback has helped modelers understand needs up front
  - Must have strong communication to successfully relate model results and limitations to non-technical audience
- Improved model parameterization and scenario development
- Overarching Goal→ Successful pilot transactions will lead to expanded marketing and implementation of achievable BMPs
  - Share tools with a farmer to provide him/her with estimates of benefits that his/her conservation actions can have on the watershed
  - Will need to be practical and realistic in eyes of stakeholders
  - Will need to have strong business case
- Stay tuned for success stories…..

GREEN RIVER BASIN, KY

The Watershed: Green River

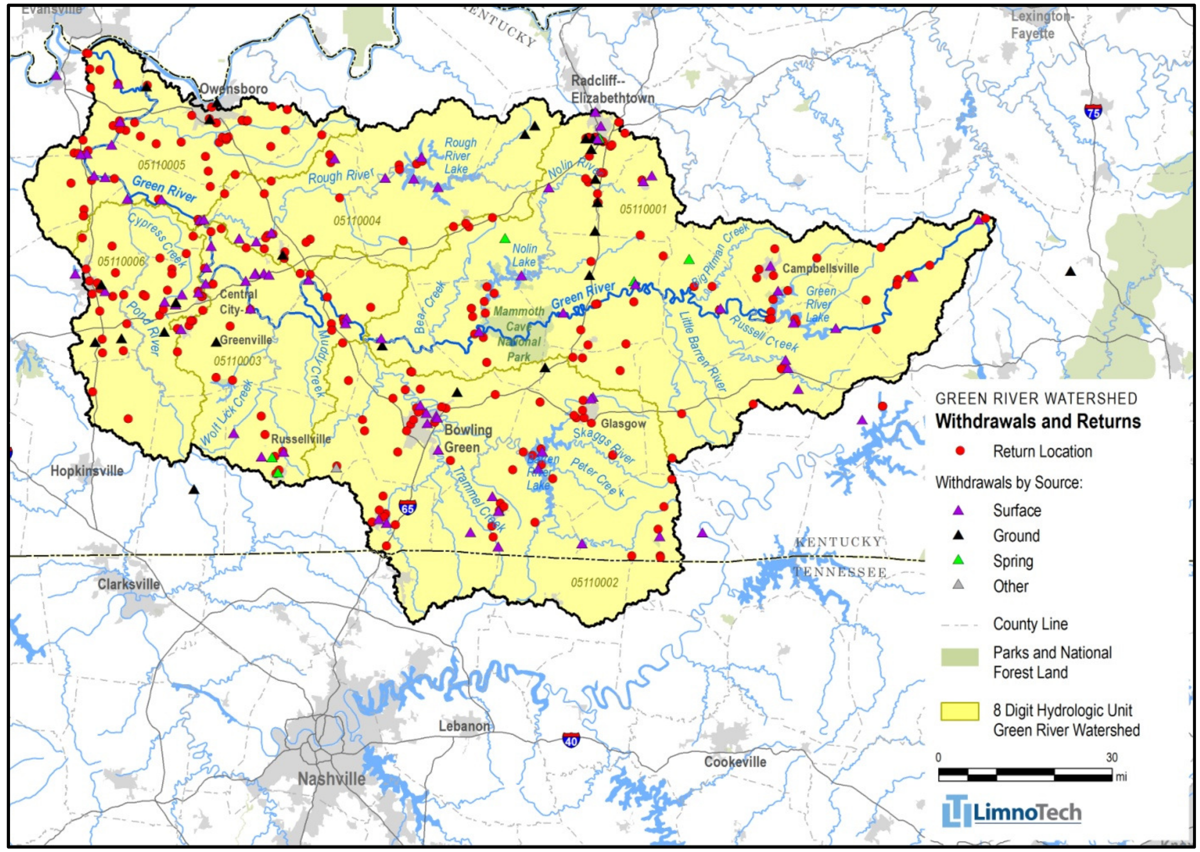
Area: ~9,220 mi^2

Water Use:

- 167 surface withdrawals
- 26 groundwater withdrawals
- 302 point sources

Power Plants:

- 4 coal-fired – once-through and closed cycle cooling
- 2 planned IGCC plants
- 2 small biofuel plants



Four flood control reservoirs operated by USACE

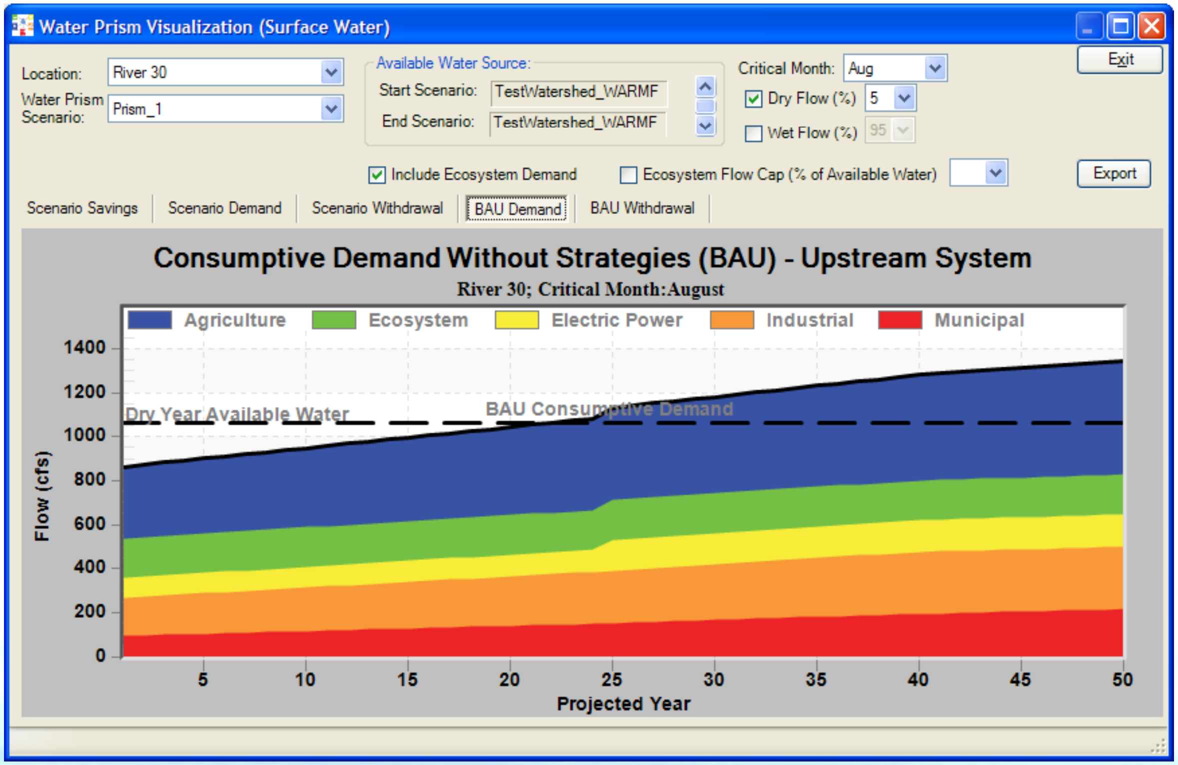
The Issue: Water Availability Planning for Power Plant

- 2500 MW; once-through and closed-cycle cooling
- Water source is Green River, KY
- Considering power plant changes
  - Conversion of two once-through units to closed-cycle cooling
  - Conversion to dry ash handling

- Limited understanding of impacts of change in water use on water risk in the context of available water and competing demands with other water use sectors

The Tool: Water Prism

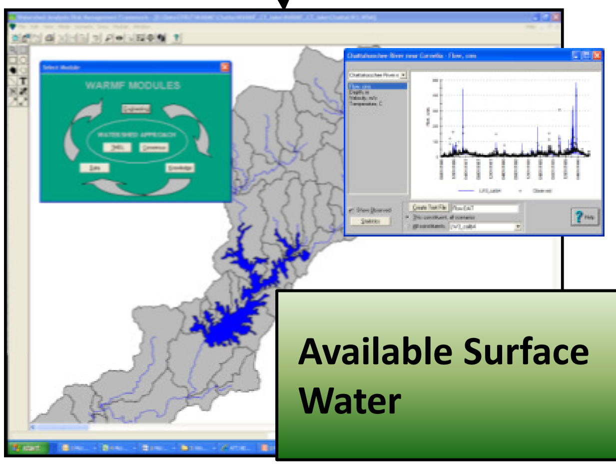
- Watershed-scale decision support system for:
  - Understanding and verifying water risks
  - Exploring water saving benefits across sectors
  - Encouraging stakeholder collaboration
- Computes system water balance on regional scale
- Projects consumptive and withdrawal demands for 40- to 50-year horizon
- Explores water saving strategies through scenarios



Water Prism Design Overview

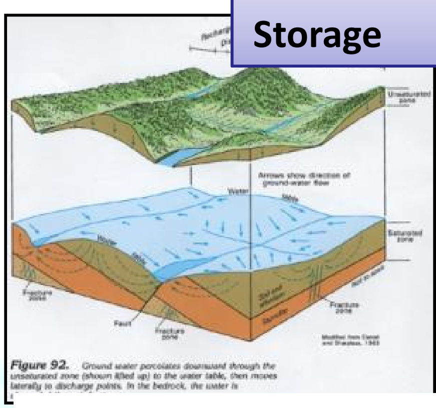
Land Use, Climate, Topography, etc.

Watershed Model (WARMF, TWLF)



Available Surface Water

Groundwater Storage



Ground Water Data

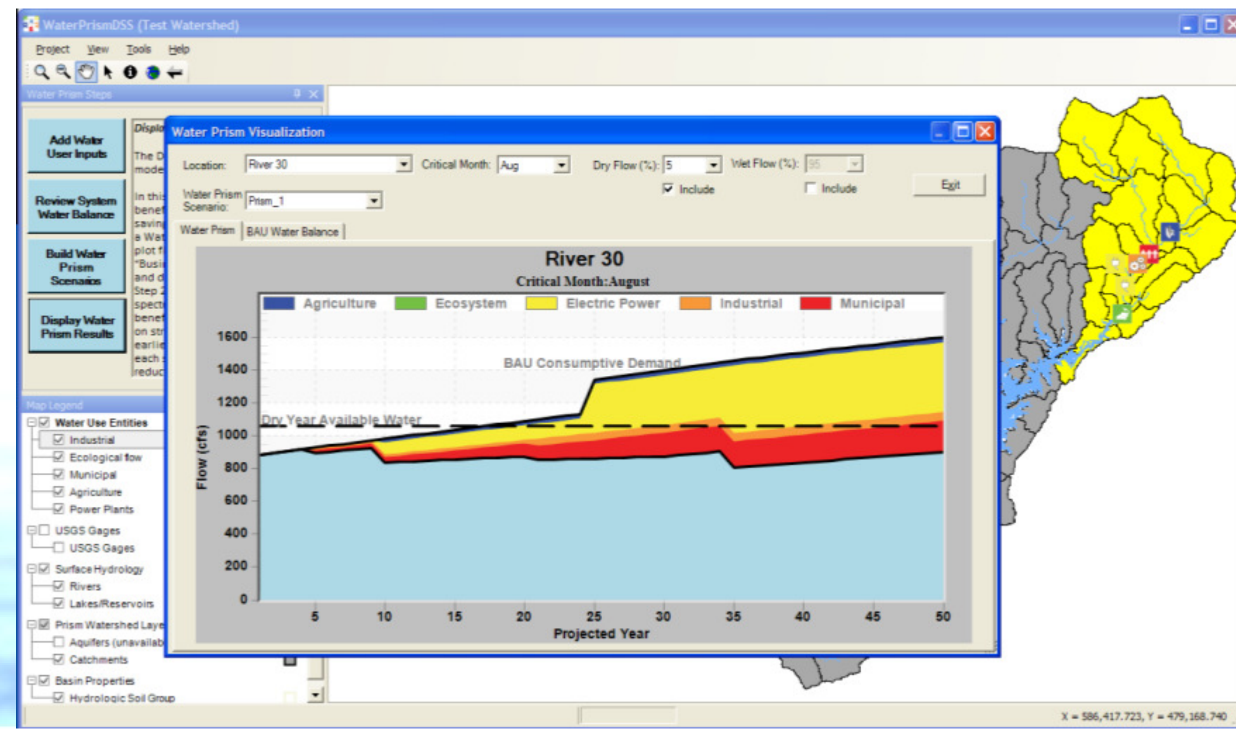
Population, Energy Demand, Irrigated Land Use

Water Prism Database

Date	City of Cumming (MGD)	Forsyth County (MGD)	Gwinnett County (MGD)	City of Buford (MGD)	City of Gainesville (MGD)
	Permitted Water Withdrawals				
1/1/2008	18	14	150	2	30
1/2/2008	16.2	12.6	135	1.8	27
1/3/2008	12.6	9.8	105	1.4	21
1/4/2008	19.8	15.4	165	2.2	33
1/5/2008	14.4	11.2	120	1.6	24
1/6/2008	18	14	150	2	30
1/7/2008	16.2	12.6	135	1.8	27
1/8/2008	21.6	16.8	180	2.4	36
1/9/2008	16.2	12.6	135	1.8	27
1/10/2008	12.6	9.8	105	1.4	21
1/11/2008	19.8	15.4	165	2.2	33
1/12/2008	14.4	11.2	120	1.6	24
1/13/2008	18	14	150	2	30
1/14/2008	16.2	12.6	135	1.8	27
1/15/2008	21.6	16.8	180	2.4	36

Water Prism Access Database

Water Prism DSS



The Stakeholders and Water Saving Strategies

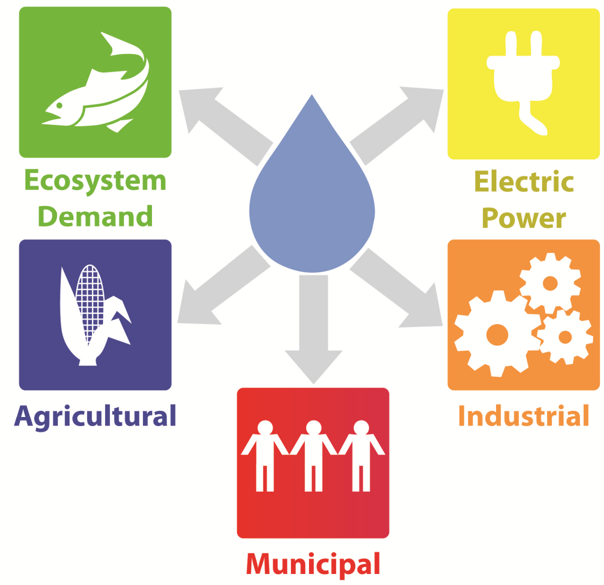
Agricultural
- Retirement of agricultural land
- Low water crops
- Water efficient irrigation

Ecosystem Demand
- Sensitivity to range of ecosystem constraints

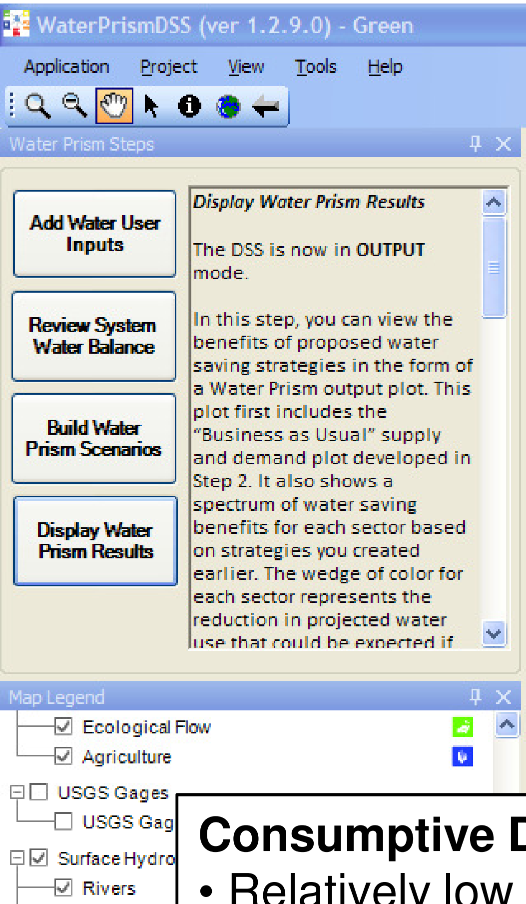
Electric Power
- Plant decommissioning
- Retrofit to advanced cooling technologies
- Non-traditional water sources
- In plant water reuse
- Low water renewable generation (wind, solar PV)

Industrial
- Non-traditional water sources
- In plant reuse
- Low water landscaping; rainwater capture

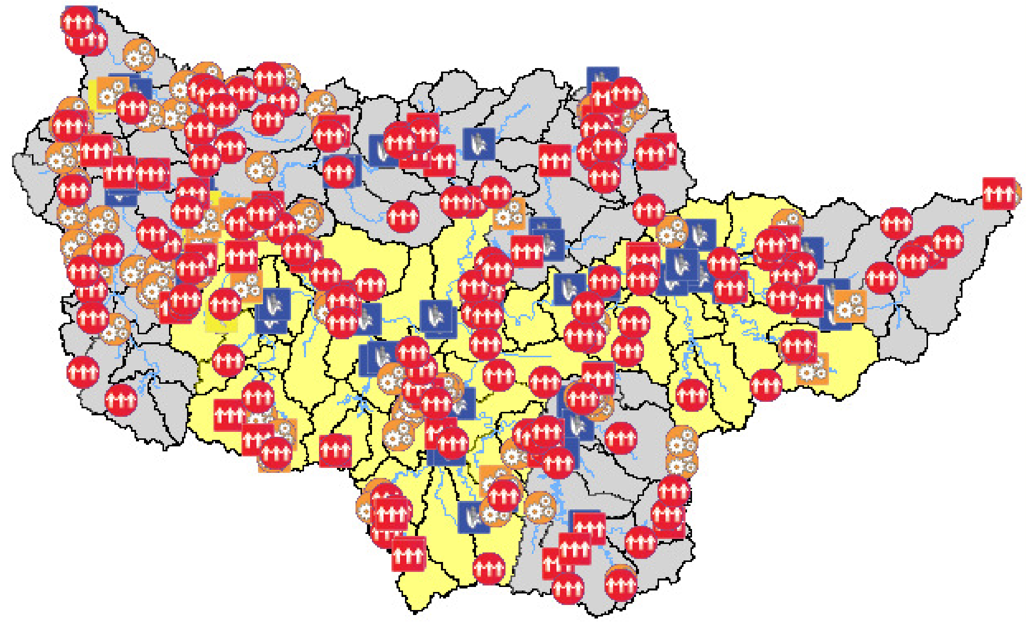
Municipal
- Low water landscaping; Rainwater capture
- Greywater recycling
- Water efficient appliances and fixtures
- Distribution system maintenance, leak detection



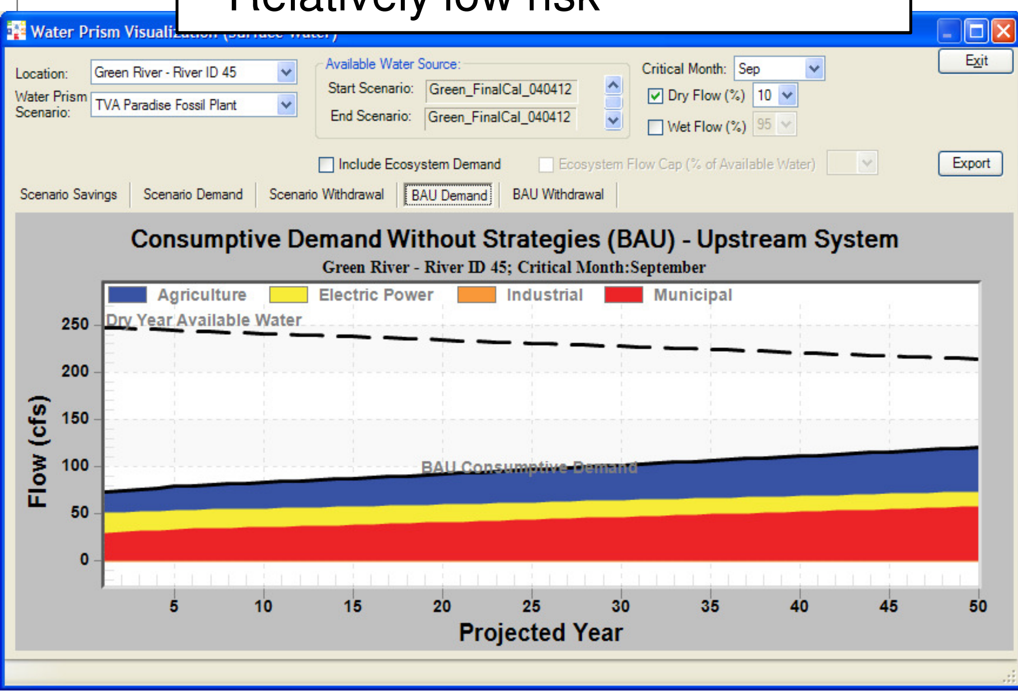
Electric Power Sector Example



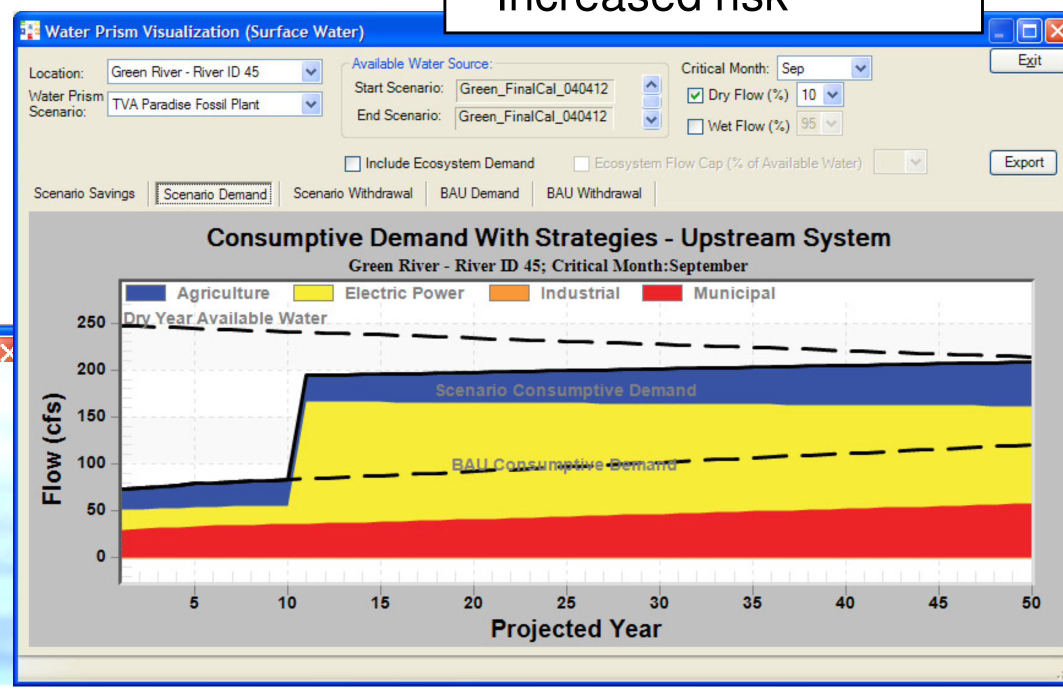
Increased consumptive demand risk with conversion of power plant to closed cycle cooling and dry ash handling



Consumptive Demand (BAU):
- Relatively low risk



Prism Scenario:
- Increased risk



Stakeholder Input

- Phase 1: Two prototype applications; focus on electric power industry
- Verified accuracy of water use data from public sources
  - Improved model inputs
  - More accurate results
- Scoped and define reasonable and insightful management scenarios
- Feedback -- recognized Water Prism as potentially valuable tool for planning and stakeholder education of electric power water use

Value Gained / Lessons Learned

- Water Prism intended to promote stakeholder collaboration and education
  - Highly visual and intuitive output graphics
  - Identify most critical months of year for a system
  - Analyze consumption and withdrawal risks -- can differ greatly
  - Identify local water issues even if broader basin risk is low
  - Consider reasonableness of environmental flow limits
  - Consider tradeoffs with various water saving strategies
- Provides single framework to evaluate multi-sector water use at facility, sector and/or basin scale
- Phase 2 and beyond…
  - Expanding to more comprehensive risk assessments increased collaboration from other sectors

Closing Thoughts on Stakeholders and Watershed Modeling

- We are still struggling with model-stakeholder connection
- Potential benefits for all parties
  - Better data and more accurate model
  - More trust and buy-in of tools
  - All sides learn from each other
  - Open doors to leverage other efforts
  - Strengthen relationships

- Reduces chance that models will "go on the shelf"
- Important but can be resource intensive
  - Place value on the long-term benefits of the investment
  - Plan for it (budget, schedule)
  - Expect it to be a complicated but rewarding process

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