# Staying the course: Collaborative modeling as an adaptive process over time

Allyson Beall King
School of the Environment
Washington State University
Freshwater.org Water Summit
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WASHINGTON STATE UNIVERSITY

# Building towards sustainable water resource futures

Increased efficiency and conservation?

Improved quality?

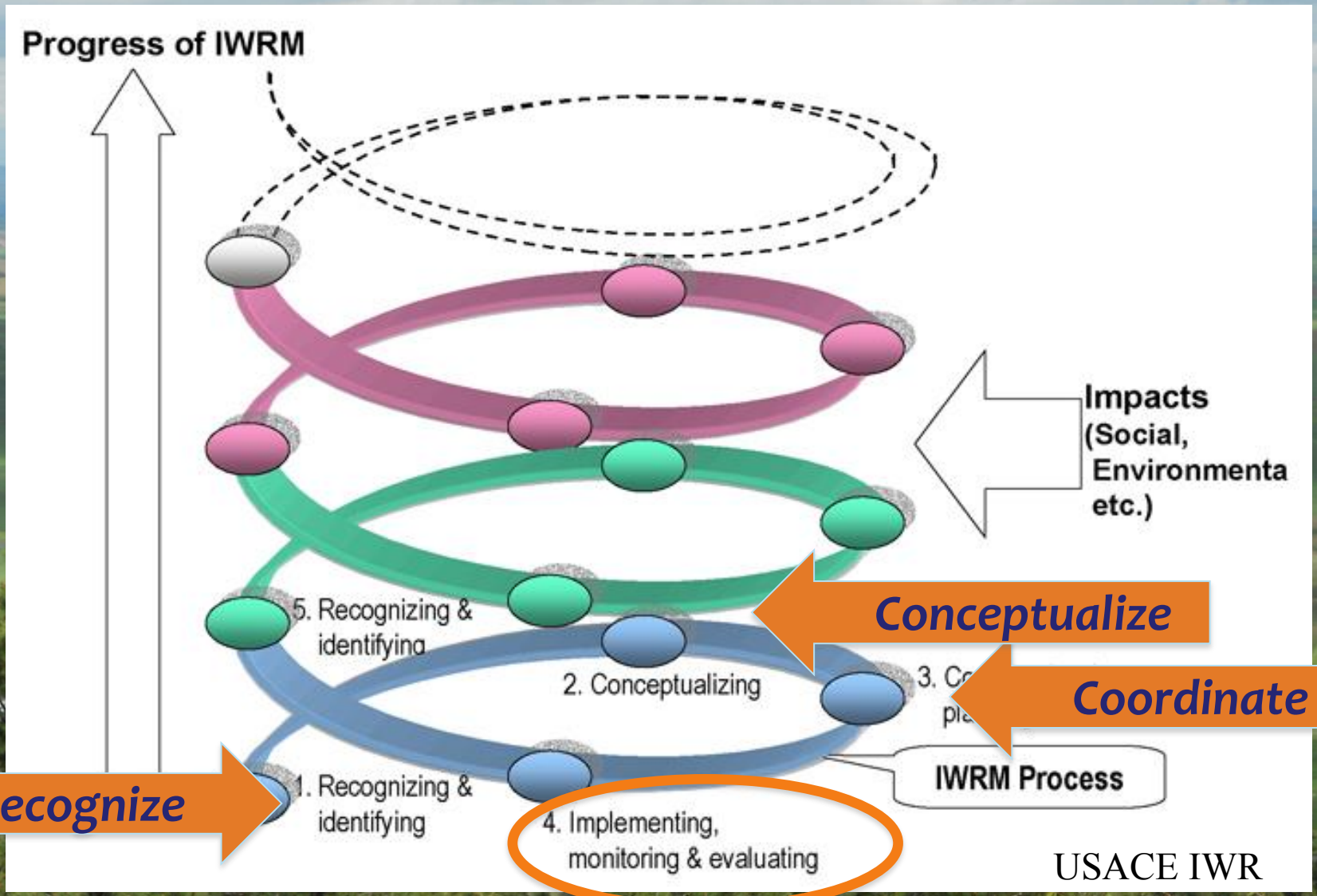
Ecosystem resilience?

# Building towards sustainable water resource futures

How far can engineering take us?

What role does individual and institutional behavior play?

# Integrated Water Resource Management an ongoing adaptive process



# Collaborative Modeling in Water Planning and Management

- Potomac River Basin
- Lake Ontario – St. Lawrence River Study
- Roanoke River Basin Hydropower Re-License
- Solomon's Harbor Watershed
- St. Albans Bay Watershed
- Upper Mississippi River
- ACT-ACF Basin
- Cedar and Green Rivers
- Gila River
- James River
- Kanawha River
- Pacific Northwest Climate Change
- Rappahannock River
- Snake Plan Aquifer
- Lake Powell/Lake Mead
- Los Angeles
- Marais des Cygnes – Osage
- Middle Rio Grande
- Mississippi Headwaters
- Susquehanna River
- Upper Rio Grande River
- Willamette River


Collaborative modeling
Professional Science
Experiential Knowledge
Problem solving space
Social concerns

# Collaborative Modeling in support of IWRM

- Builds a shared language across disciplines, entities and users
- Clarifies assumptions and facts
- Embraces whole system analysis
- Objectively addresses uncertainty
  - Moves us away from extremes/polarization
- Evaluate cumulative impacts & mitigation measures

# Collaborative Modeling tools for IWRM

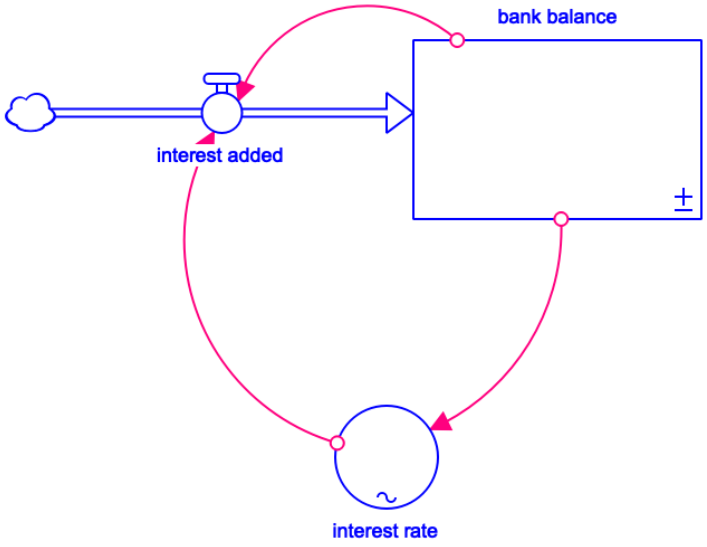
- Multiple types of hydrologic models
  - MODFLOW, Riverware, OASIS, etc….
- Facilitation
- Systems Thinking
- System Dynamics Modeling
  - Transparent
  - Embraces scientific and social uncertainty
  - Captures dynamic complexity - feedback and delay

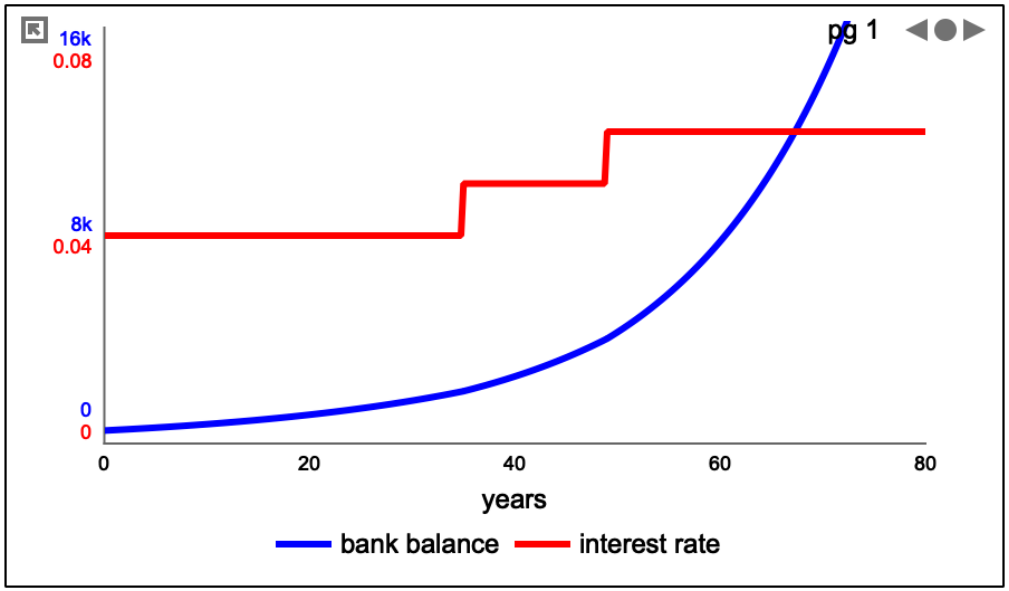
# System Dynamics

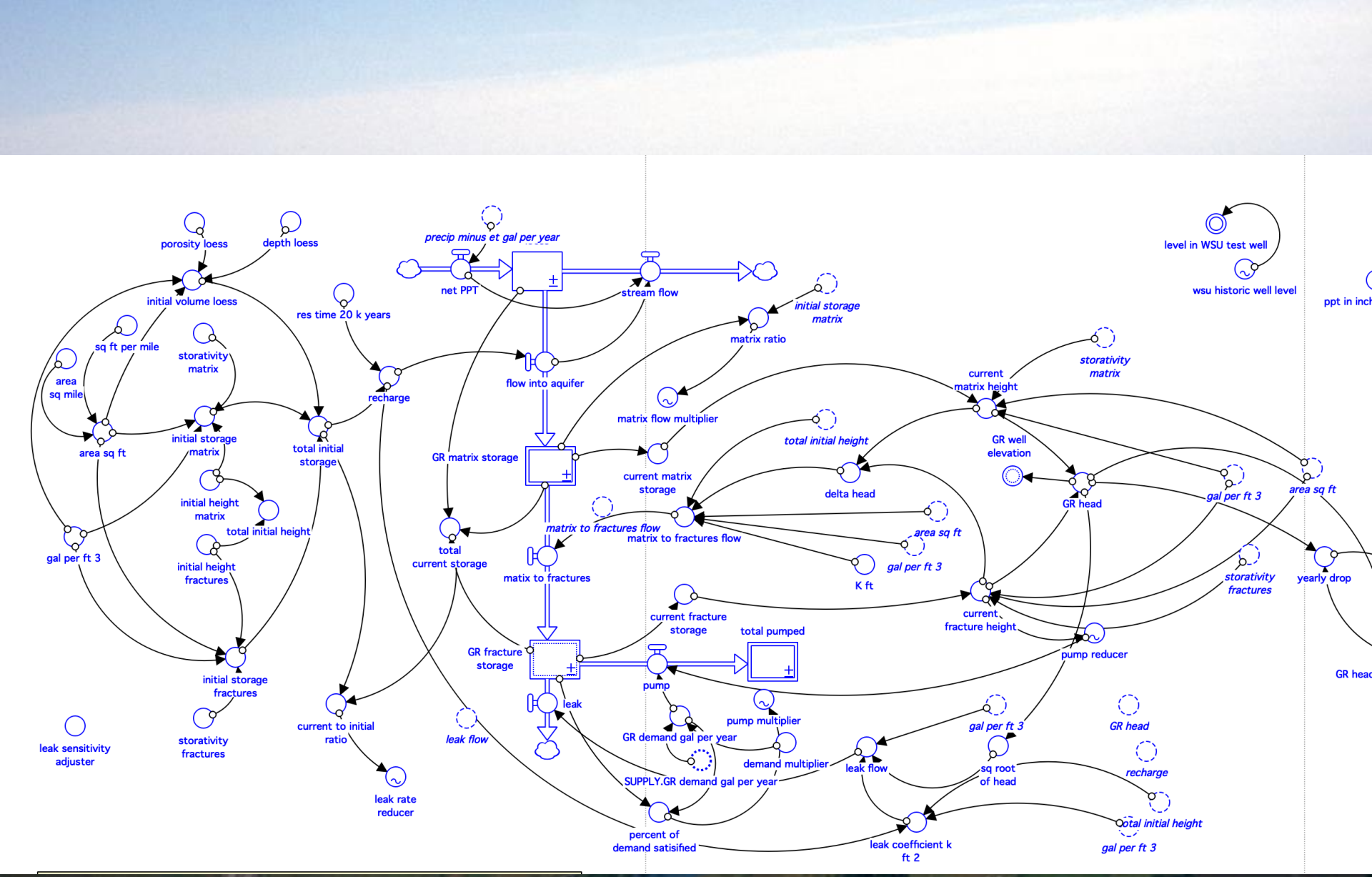
System Dynamics is a computer-aided approach to policy analysis and design. It applies to dynamic problems arising in complex social, managerial, economic, or ecological systems—literally any dynamic systems characterized by interdependence, mutual interaction, information feedback, and circular causality.

https://www.systemdynamics.org/what-is-sd

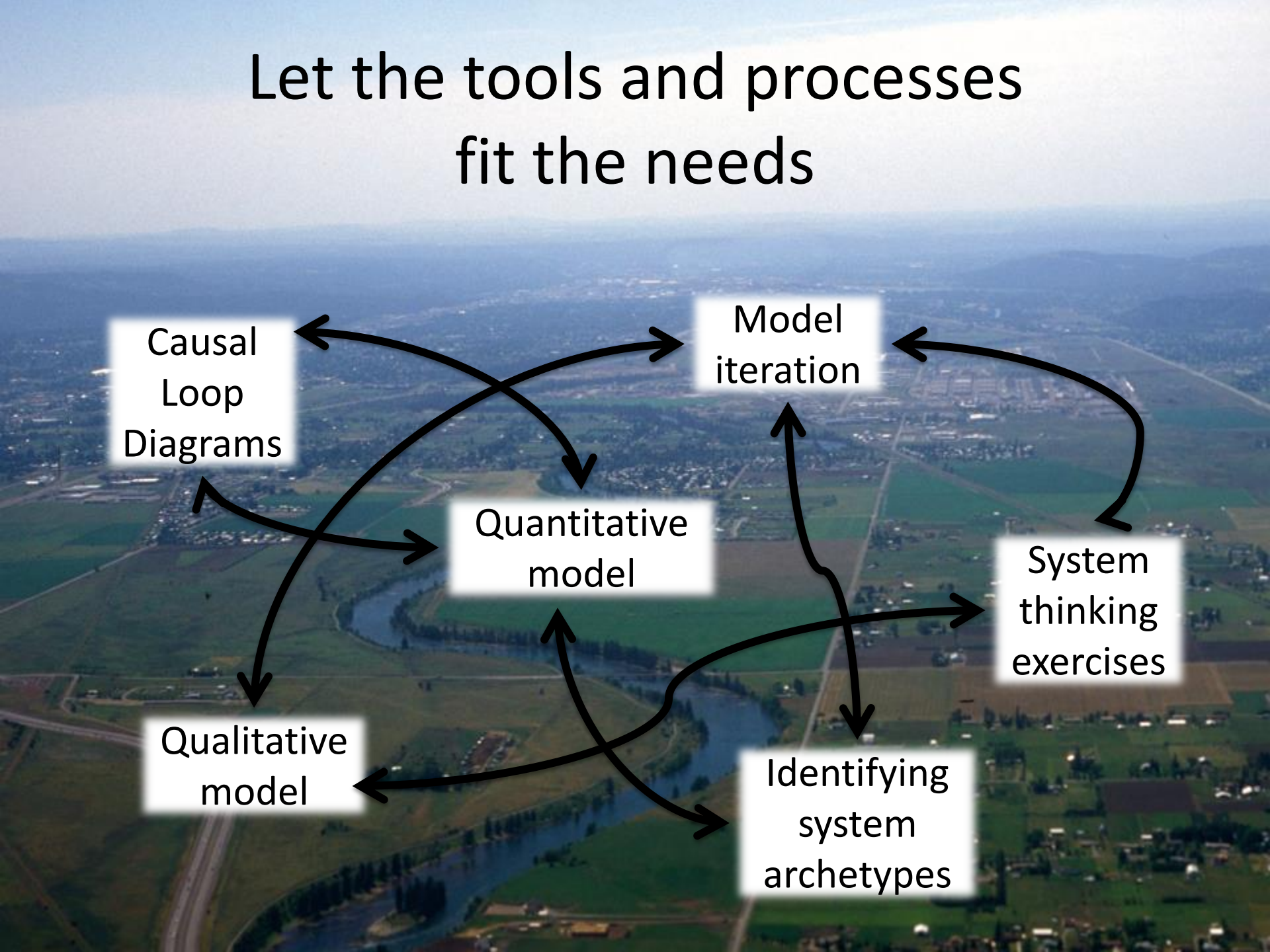
# System Dynamics
# Icon based stock and flow modeling



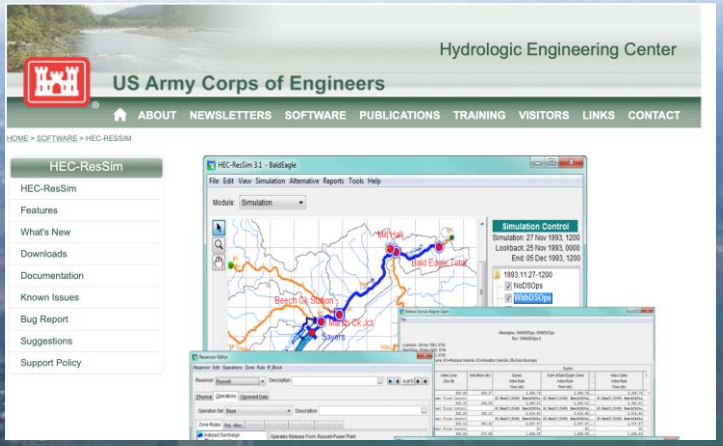

porosity loess
depth loess
initial volume loess
sq ft per mile
storativity matrix
area sq mile
area sq ft
initial storage matrix
initial height matrix
total initial height
initial height fractures
gal per ft 3
initial storage fractures
storativity fractures
leak sensitivity adjuster
res time 20 k years
recharge
total initial storage
current to initial ratio
leak rate reducer
precip minus et gal per year
net PPT
stream flow
flow into aquifer
GR matrix storage
total current storage
matrix to fractures
matrix to fractures flow
leak flow
leak
GR fracture storage
current fracture storage
total pumped
pump
pump multiplier
GR demand gal per year
demand multiplier
SUPPLY.GR demand gal per year
percent of demand satisified
initial storage matrix
matrix ratio
matrix flow multiplier
current matrix storage
total initial height
delta head
area sq ft
gal per ft 3
K ft
leak flow
leak coefficient k ft 2
level in WSU test well
wsu historic well level
storativity matrix
current matrix height
GR well elevation
GR head
gal per ft 3
area sq ft
storativity fractures
yearly drop
current fracture height
pump reducer
gal per ft 3
GR head
sq root of head
recharge
total initial height
gal per ft 3

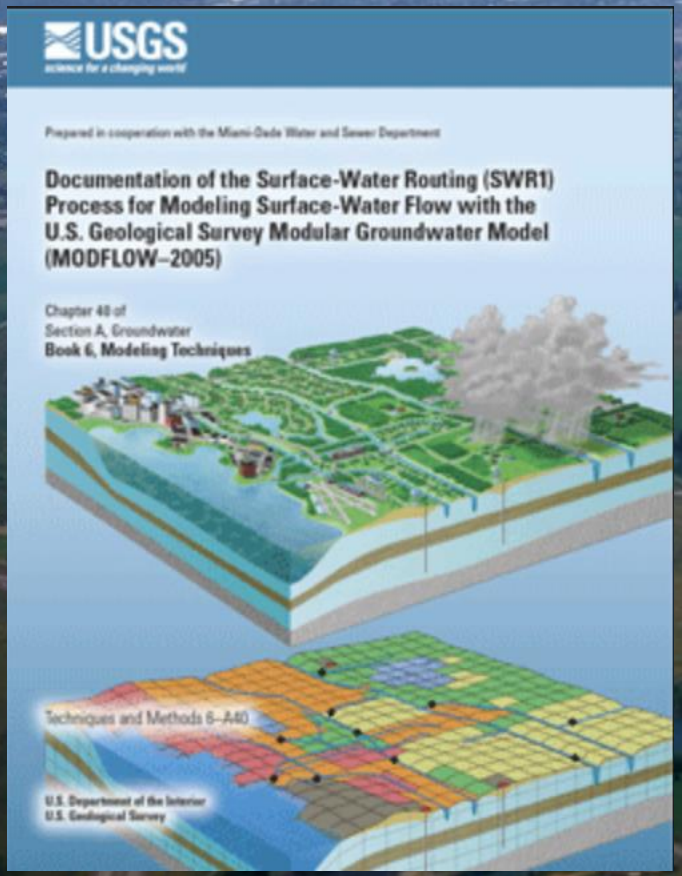
# Let the tools and processes fit the needs

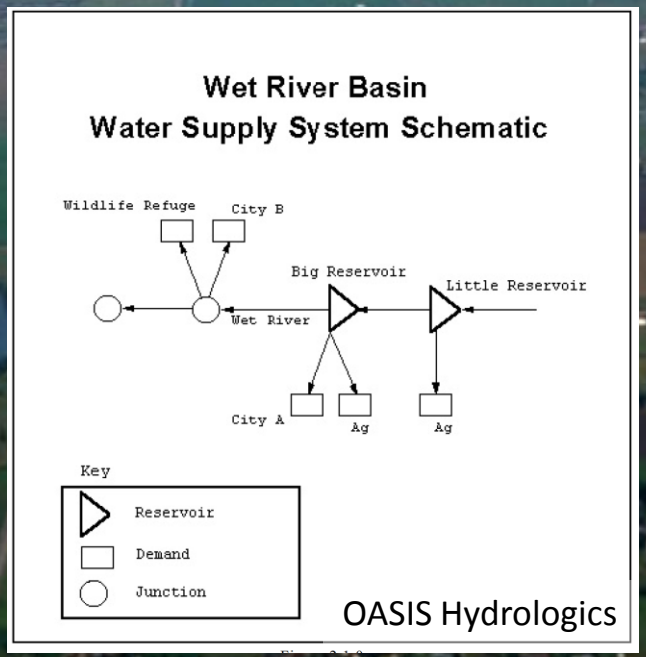


# Need basic science?
# Hydrologic process models

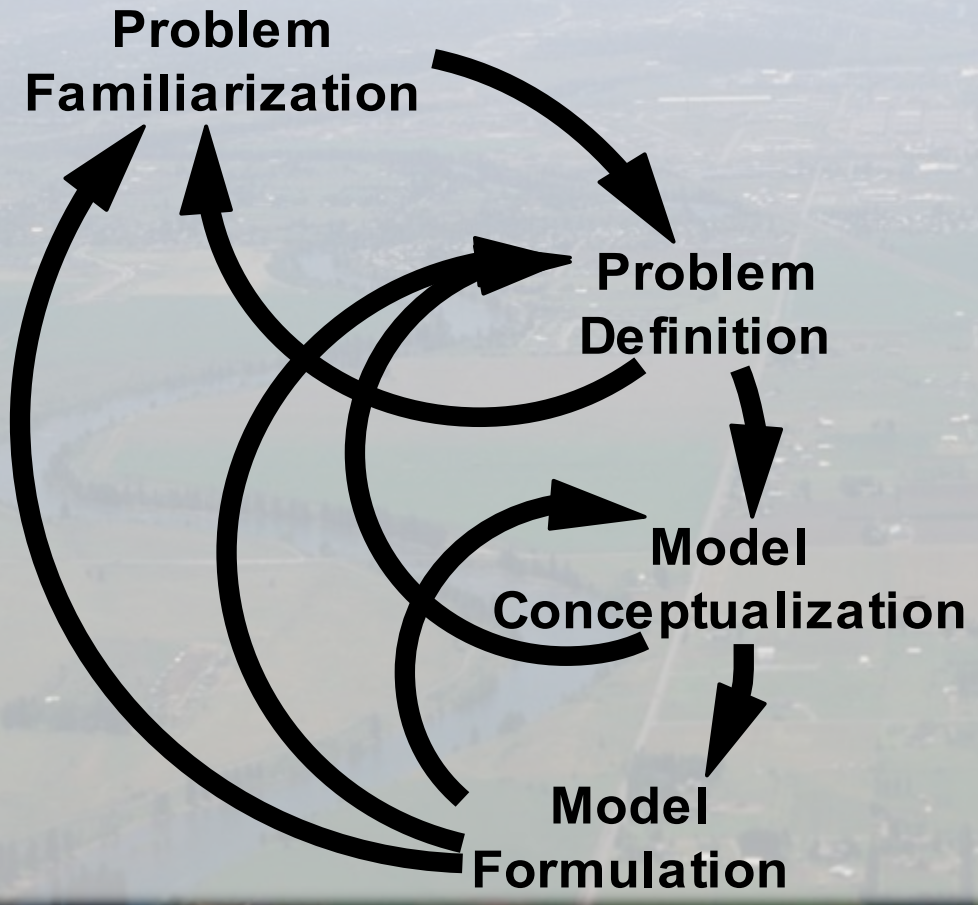
RiverWare



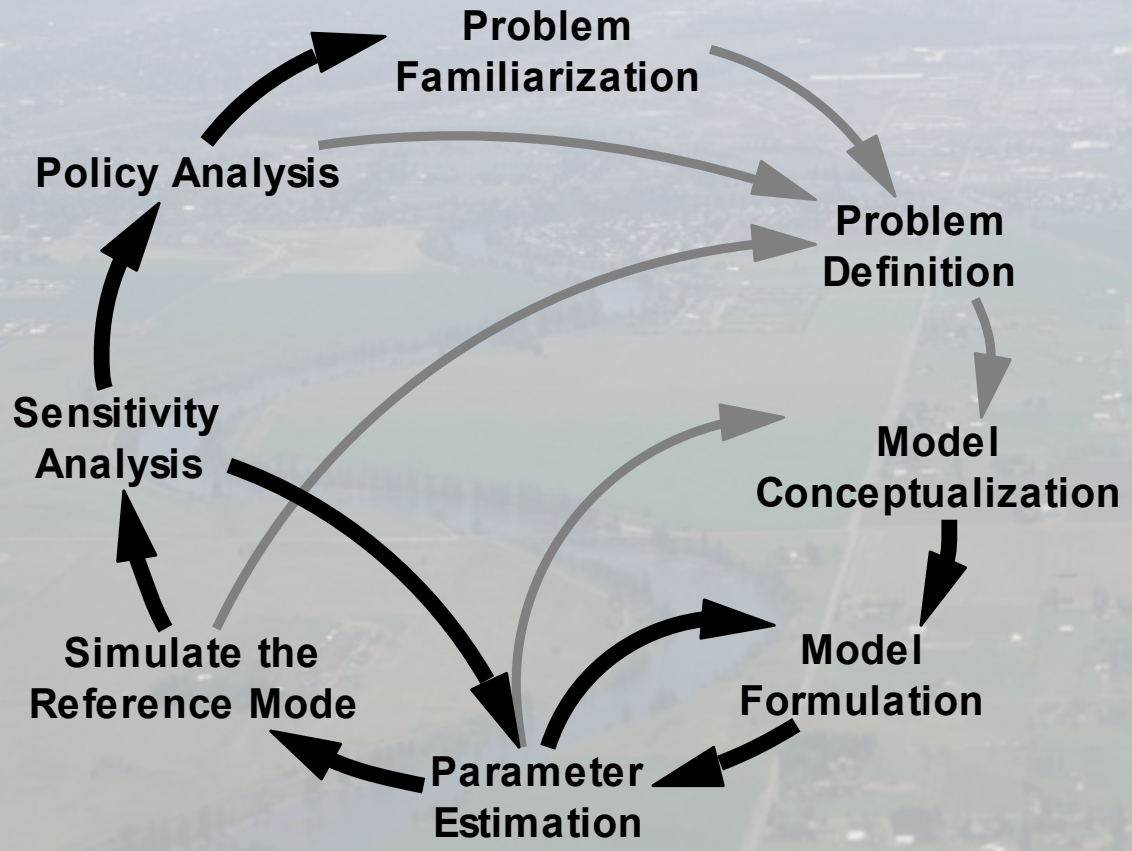



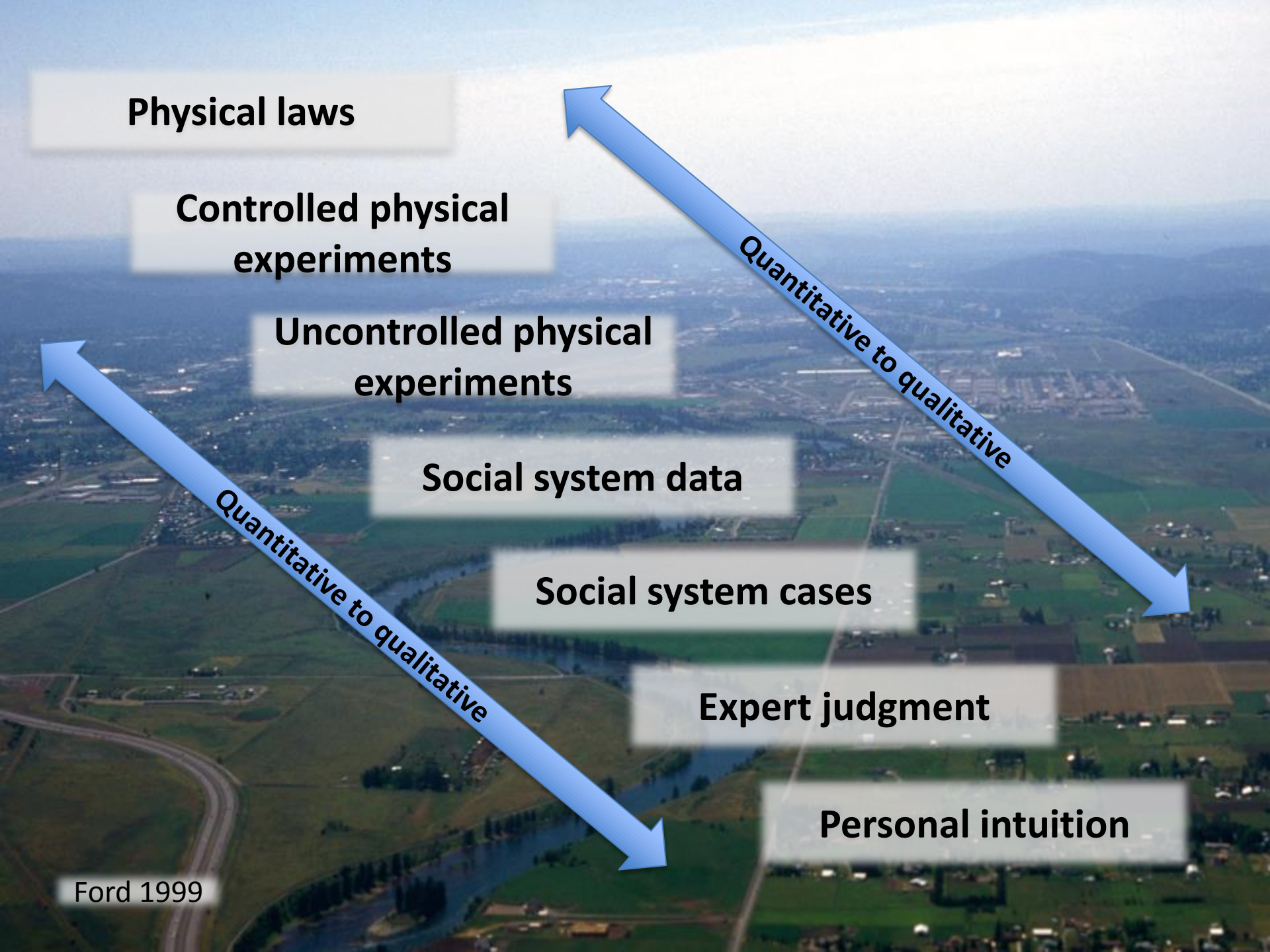



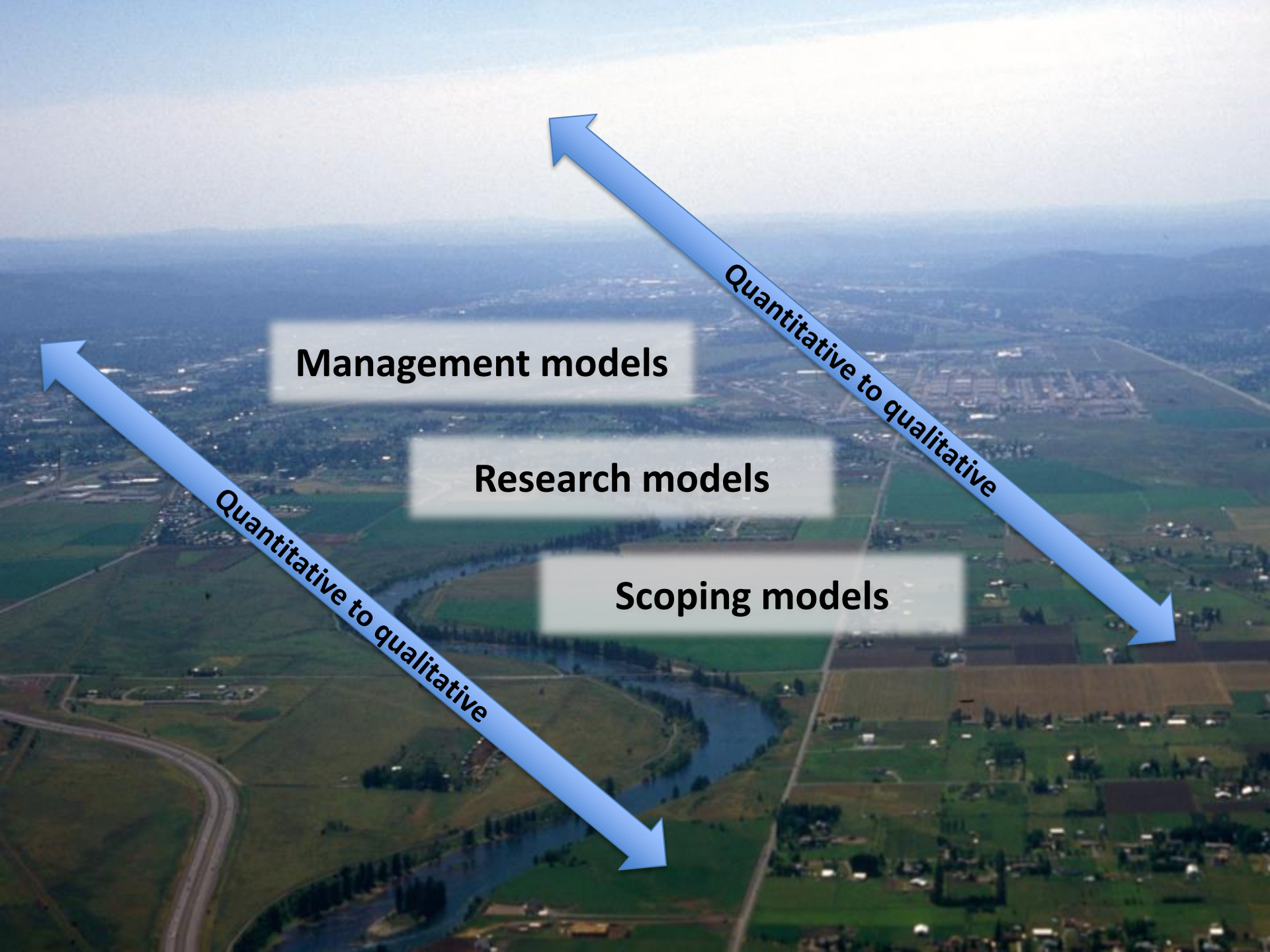
# Need problem identification? System thinking exercises

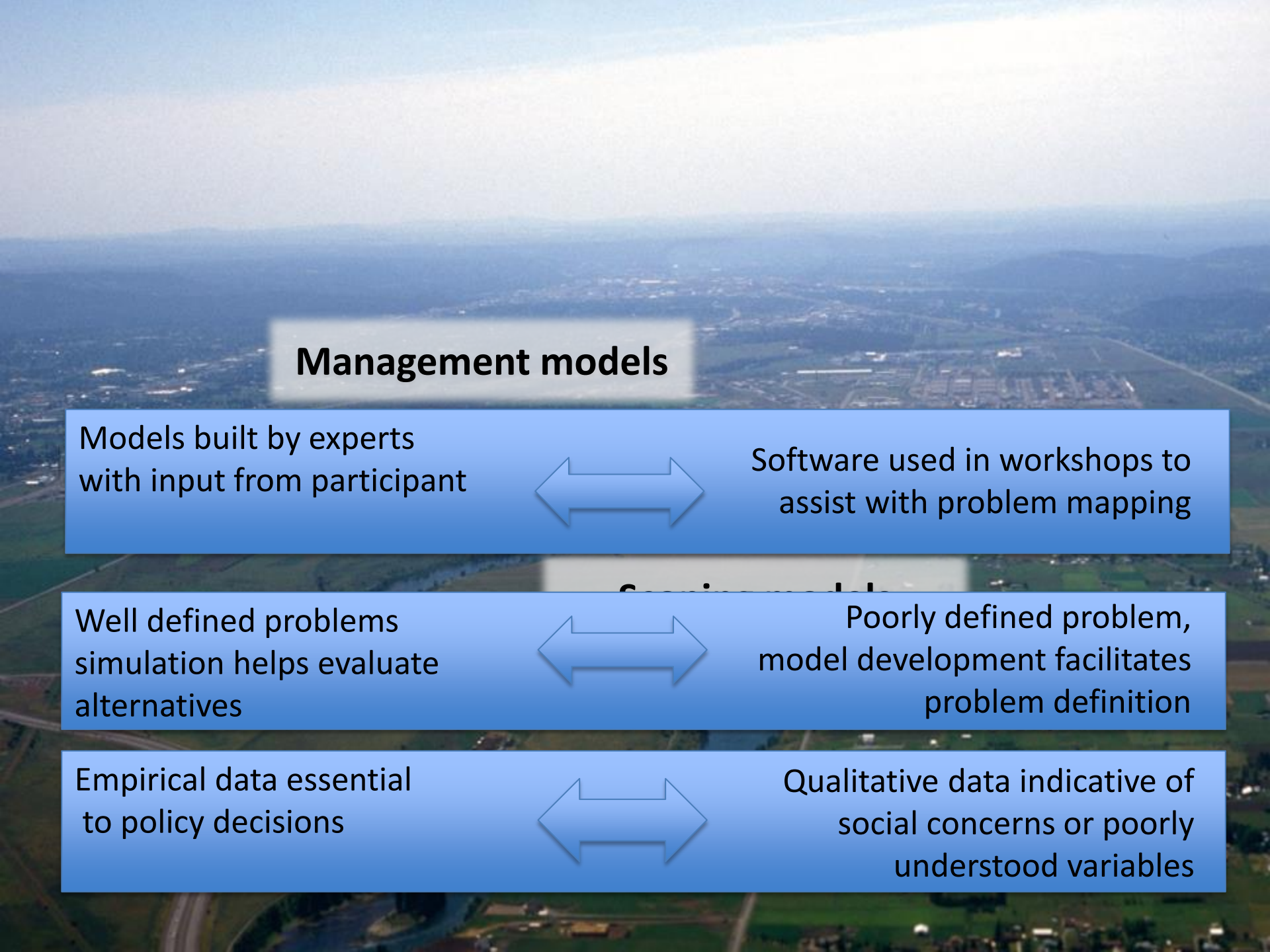


# Need to integrate with social systems? System Dynamics simulation




Physical laws
Controlled physical experiments
Uncontrolled physical experiments
Social system data
Social system cases
Expert judgment
Personal intuition
Quantitative to qualitative
Quantitative to qualitative
Ford 1999


Quantitative to qualitative
Management models
Research models
Scoping models
Quantitative to qualitative


Management models
Models built by experts with input from participant
Software used in workshops to assist with problem mapping
Well defined problems simulation helps evaluate alternatives
Poorly defined problem, model development facilitates problem definition
Empirical data essential to policy decisions
Qualitative data indicative of social concerns or poorly understood variables

# How can you model that?

## If you don't understand this?

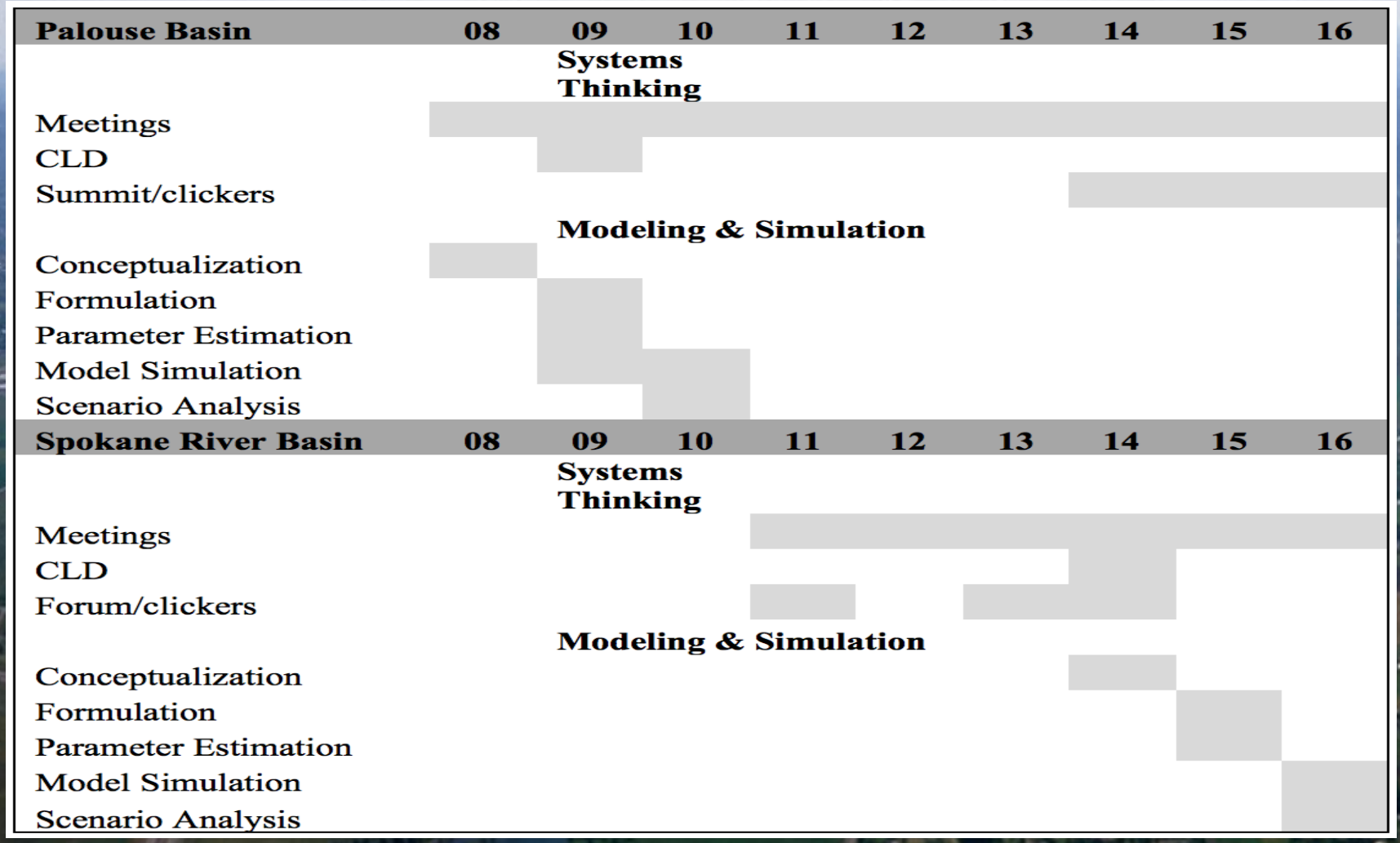
# How can you manage that?

## If you don’t understand this?

# Collaborative modeling for water resources management benefits from long term engagement

- Water resource issues are never “fixed” but rather managed in their current state until the state changes.
- Long-term engagement is an iterative process of education and empowerment that builds relationships, engenders trust, and facilitates collaboration and institutional change.

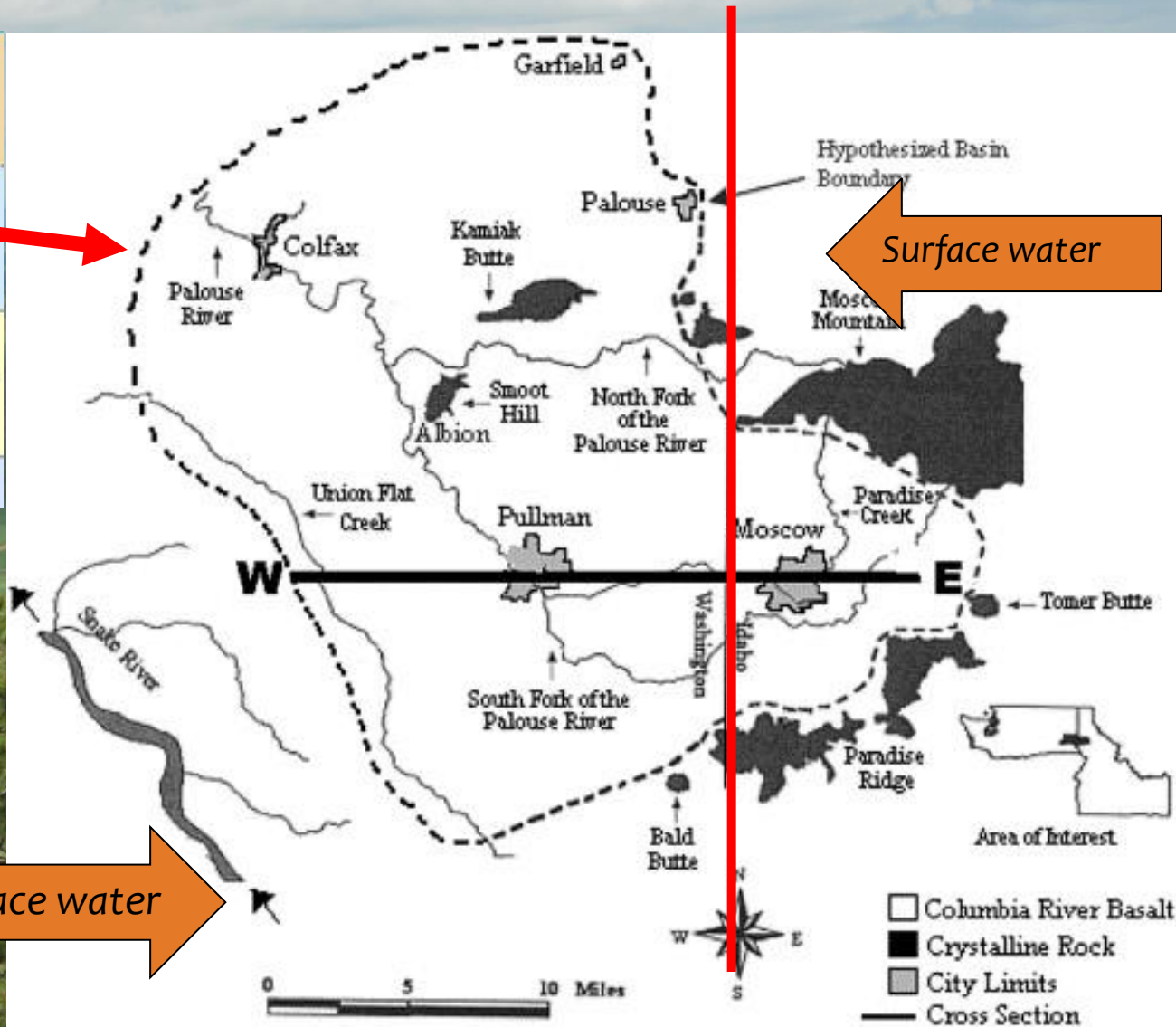
# The Palouse and Spokane Basins




- Staying the Course: Collaborative Modeling to Support Adaptive and Resilient Water Resource Management. *Water: Special Issue "Water Governance, Stakeholder Engagement, and Sustainable Water Resources Management"*. Beall King and Thornton. *Water* **2016**, *8*, 232; doi:10.3390/w8060232

# Palouse Basin Bi-State Aquifer


Courtesy of http://commons.wikimedia.org/wiki/Image:US_map_-_states-fr.png



# Palouse Basin
# sole source, confined, fossil water, significant public concern


# Palouse Basin Challenges: sole source, confined, fossil water, recharge has not been determined

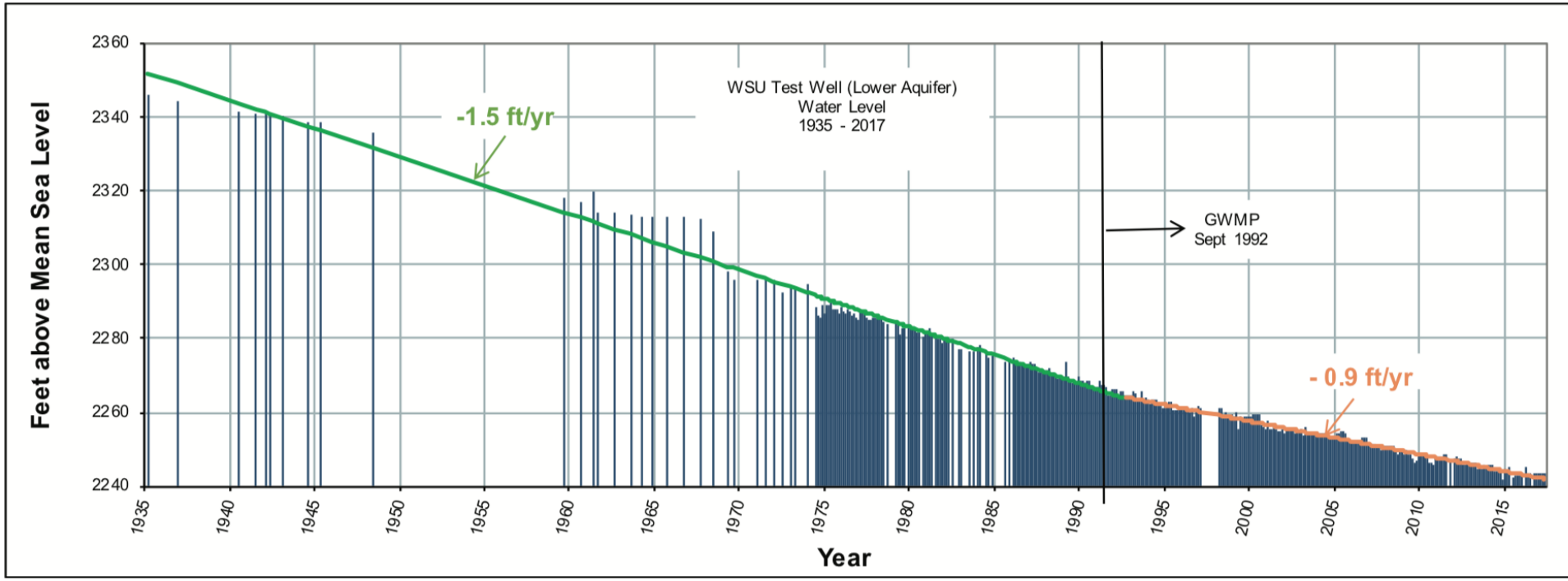



*Figure 4: Static water level, WSU test well (lower aquifer), 1935-2017*

http://palousebasin.org/wp-content/uploads/2018/10/101718_PBAC_2017AnnualReport_Final.pdf

# Palouse Basin successes: Collaboration and engineering has resulted in reduced pumping

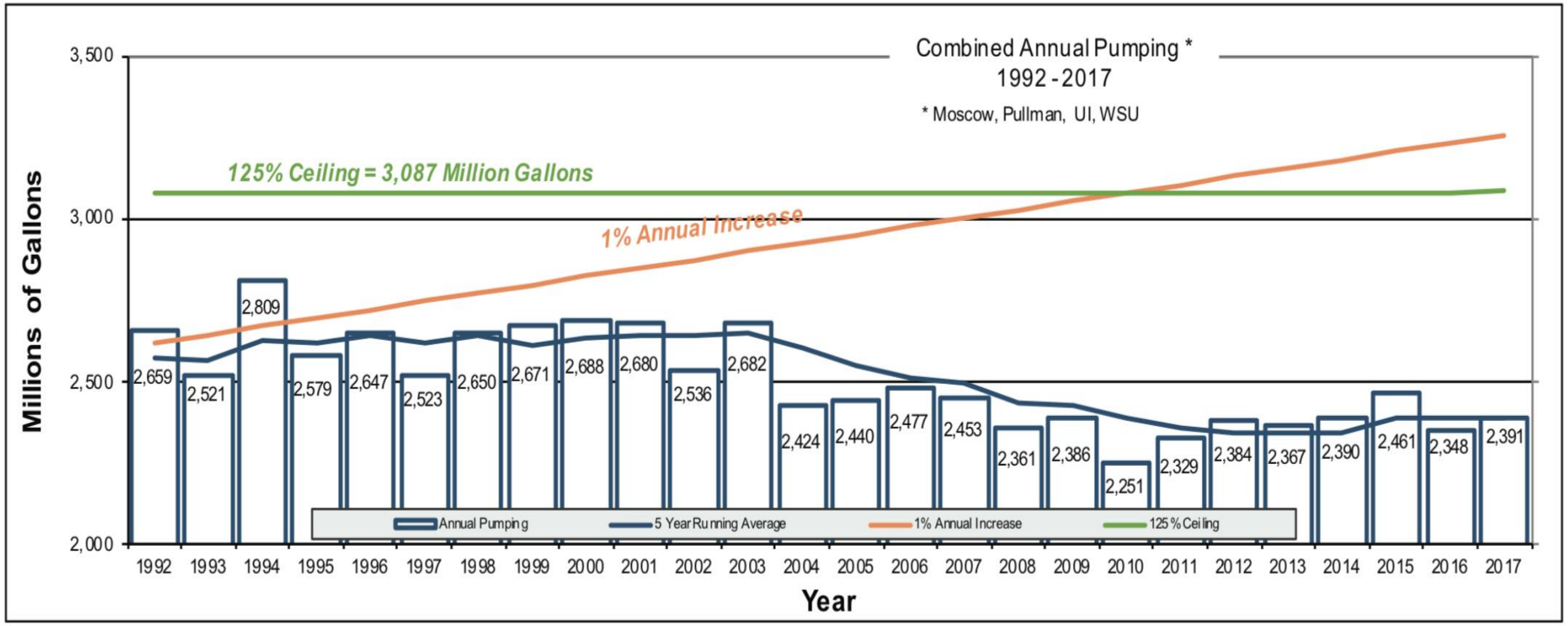
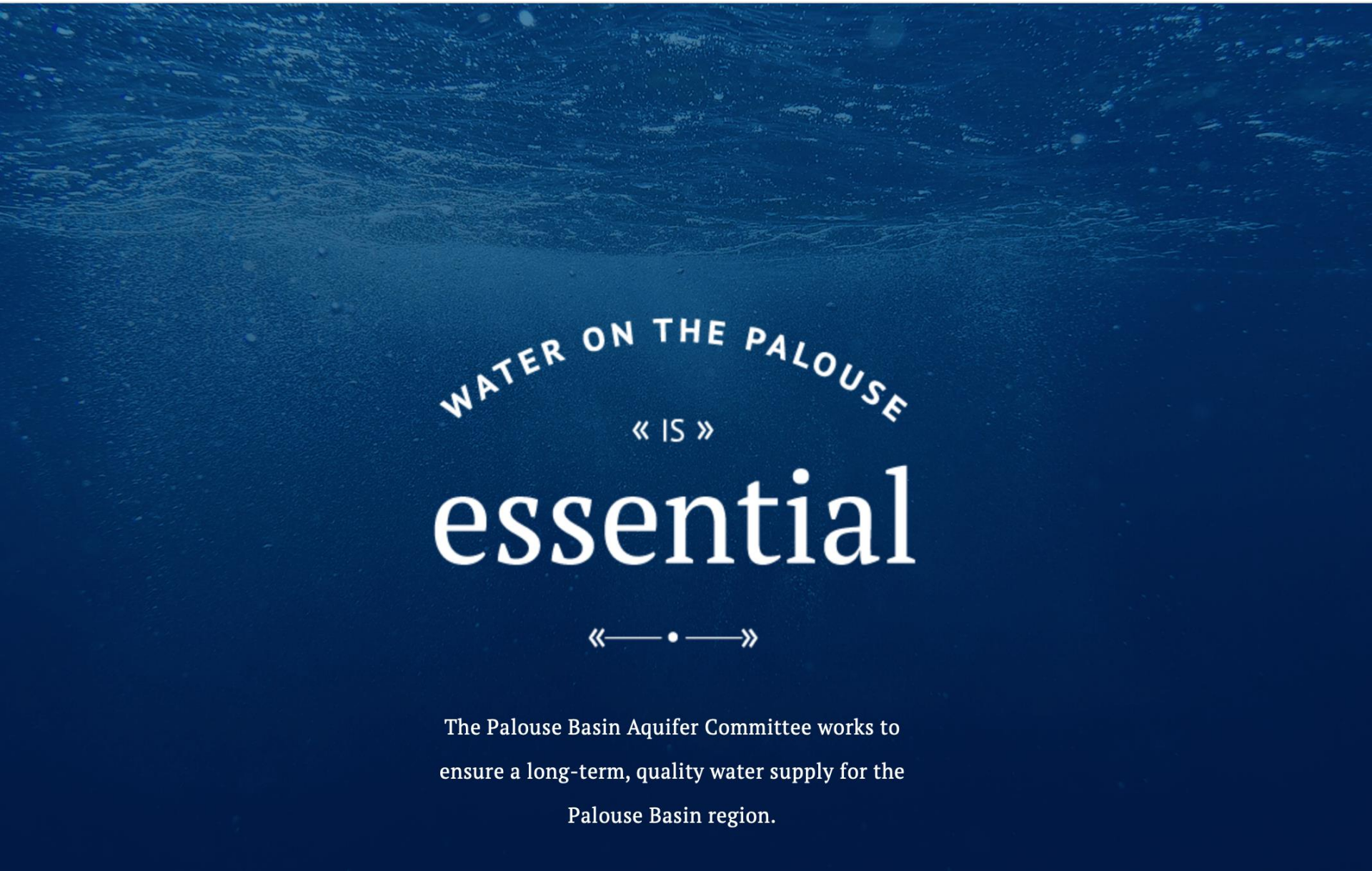



*Figure 10: Combined Annual Pumping*

http://palousebasin.org/wp-content/uploads/2018/10/101718_PBAC_2017AnnualReport_Final.pdf

PALOUSE BASIN AQUIFER committee






The Palouse Basin Aquifer Committee works to ensure a long-term, quality water supply for the Palouse Basin region.

Palouse Basin Aquifer Committee

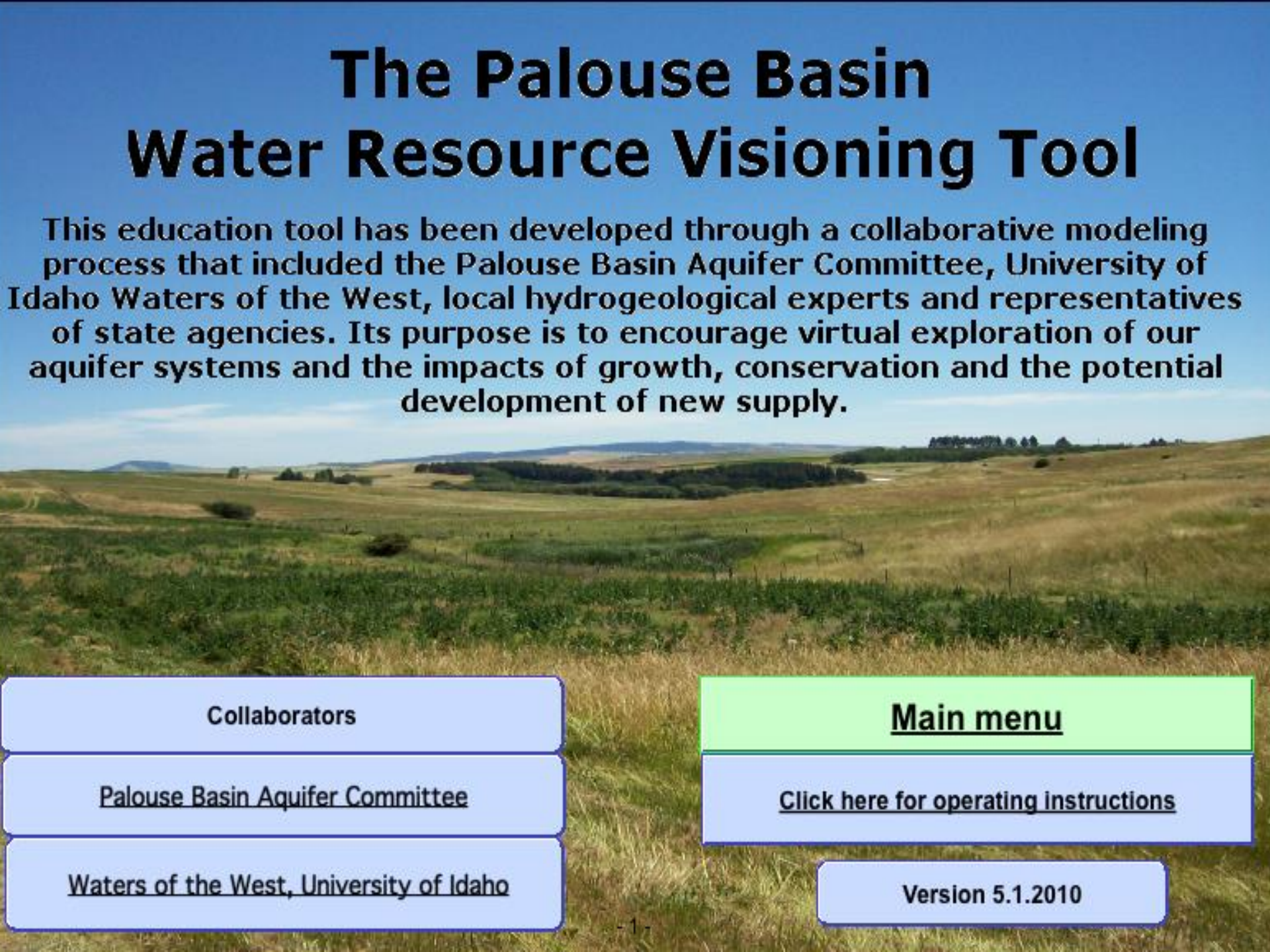
# The Palouse Basin Participatory Model

PBAC Citizens Advisory Group


University of Idaho
A LEGACY OF LEADING

# The Palouse Basin Water Resource Visioning Tool

This education tool has been developed through a collaborative modeling process that included the Palouse Basin Aquifer Committee, University of Idaho Waters of the West, local hydrogeological experts and representatives of state agencies. Its purpose is to encourage virtual exploration of our aquifer systems and the impacts of growth, conservation and the potential development of new supply.



Collaborators

Palouse Basin Aquifer Committee

Waters of the West, University of Idaho

Main menu

Click here for operating instructions

Version 5.1.2010

March 2017
Palouse Basin Aquifer Committee

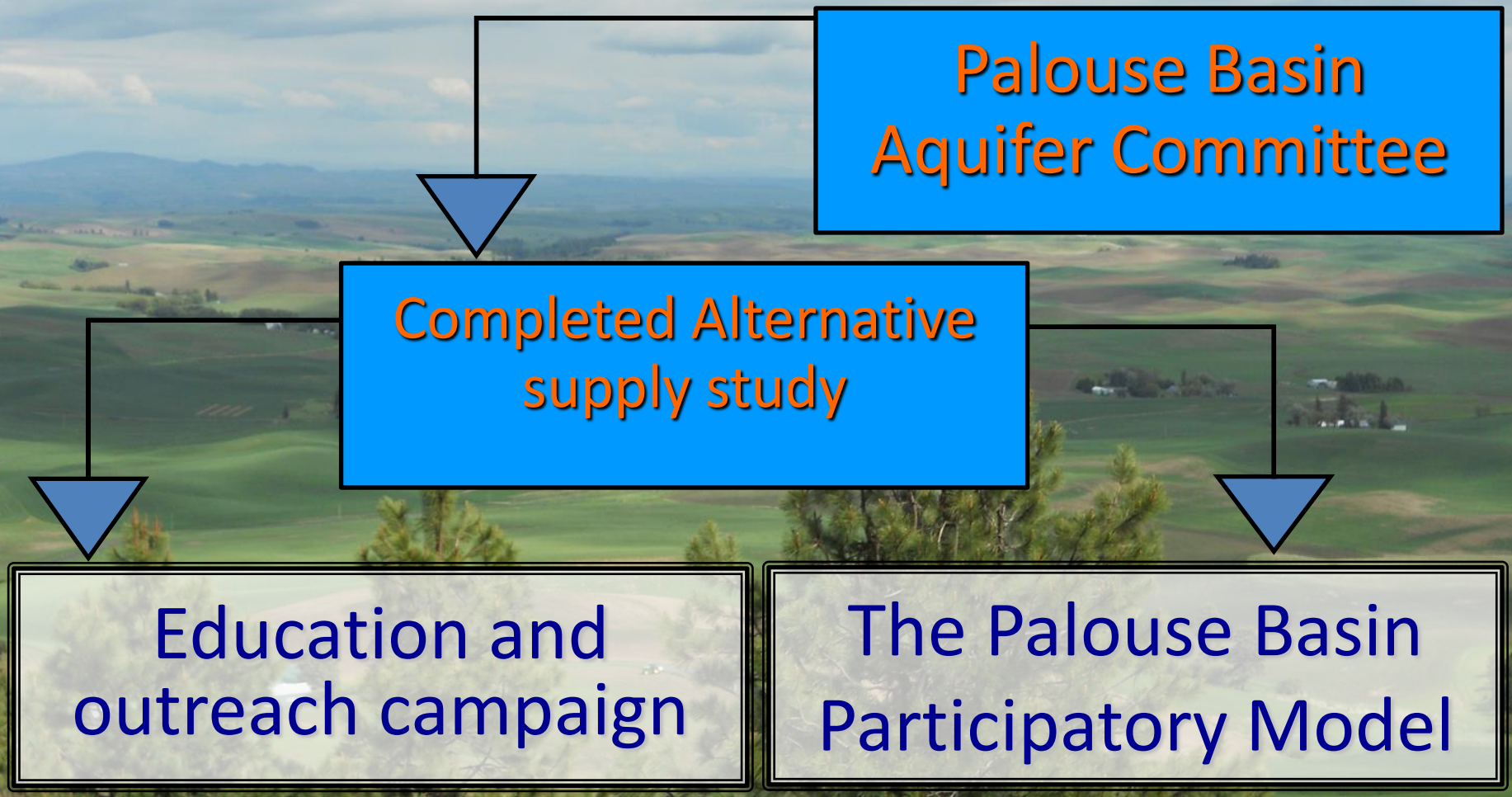
EA Engineering, Science, and Technology, Inc., PBC

HDR ANCHOR QEA

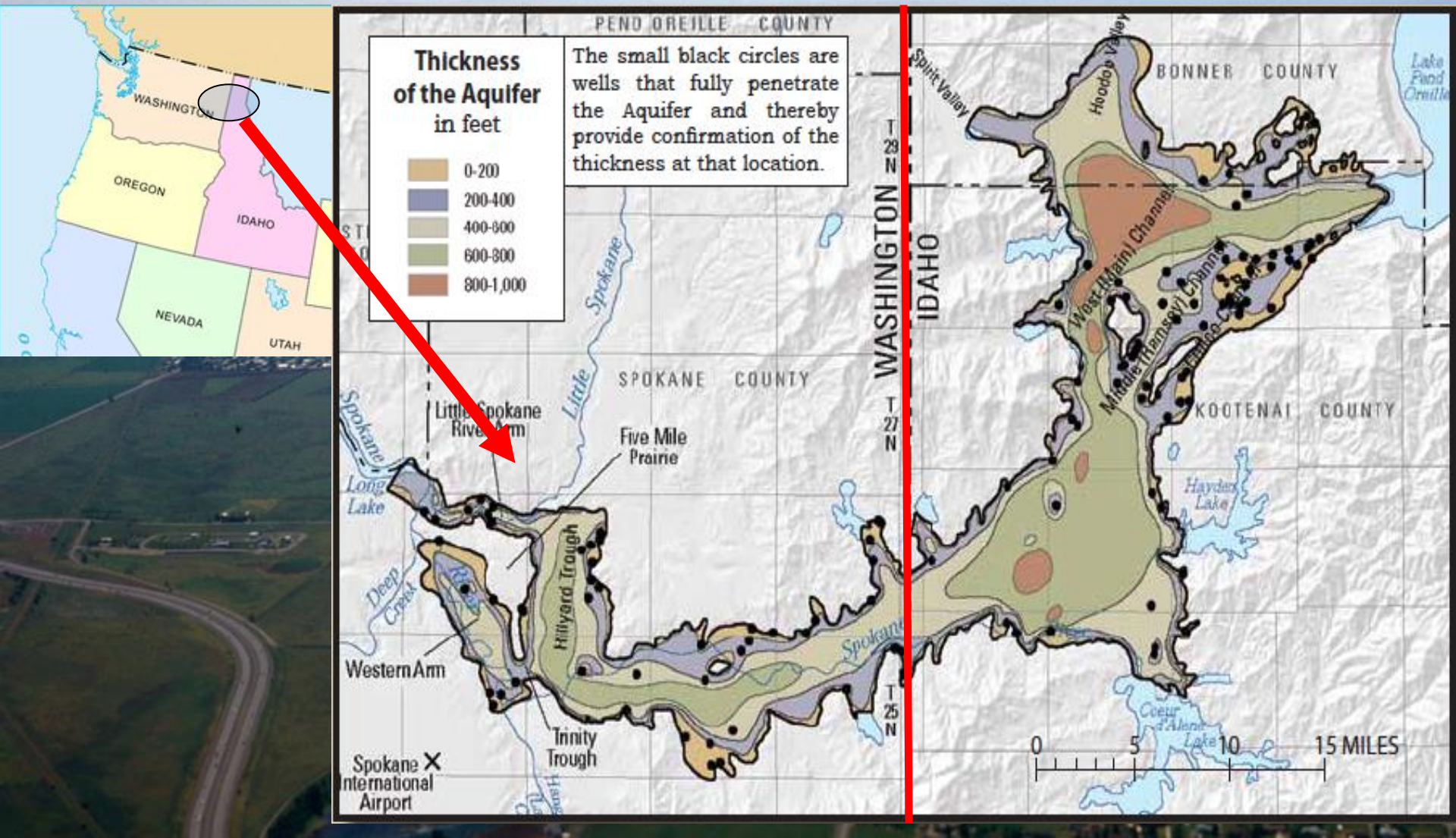
# Palouse Groundwater Basin Water Supply Alternatives Analysis Report – Summary

Prepared for Palouse Basin Aquifer Committee/University of Idaho

# Next steps on the Palouse



# Spokane Valley Rathdrum Prairie bi-state Aquifer and Spokane River



# Spokane Valley Rathdrum Prairie Aquifer

sole source – unconfined

perception that area is “water rich”

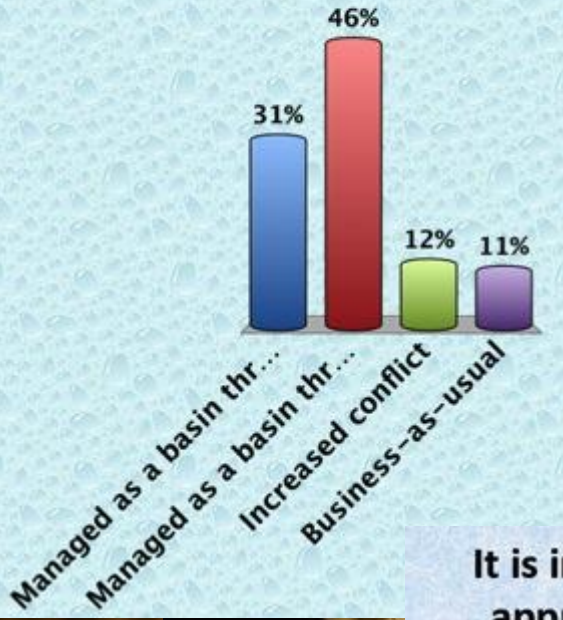
SVRP Atlas 2009

# Spokane River - SVRP Aquifer Challenges

- Phosphorous – Dissolved Oxygen TMDL
- Low flows in river ← Climate Change!
  - Collaborative SD modeling, MODFLOW, and others
- Spokane River Toxics
  - PCB plan or TMDL?
  - Fish advisories
  - NPDES permit challenges
- Lake Coeur d'Alene mine waste (CERCLA) and phosphorous loading

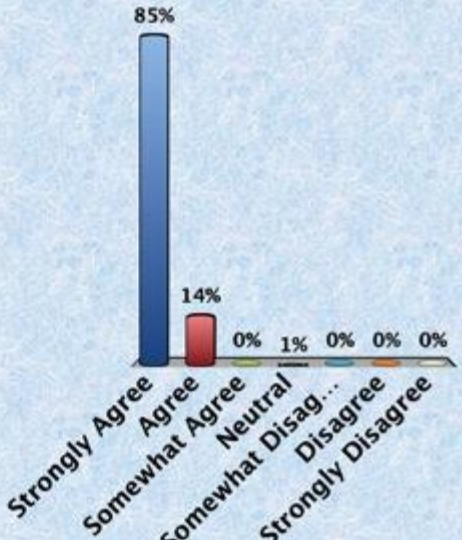
## Where do you see management of water resources in the Spokane River Basin in 2034 (20 years)?

A. Managed as a basin through regulation
B. Managed as a basin through collaboration
C. Increased conflict
D. Business-as-usual




## It is important to take a regional, collaborative approach among governments, agencies and stakeholders to meet water quality needs?

A. Strongly Agree
B. Agree
C. Somewhat Agree
D. Neutral
E. Somewhat Disagree
F. Disagree
G. Strongly Disagree



# IDAHO WASHINGTON AQUIFER COLLABORATIVE

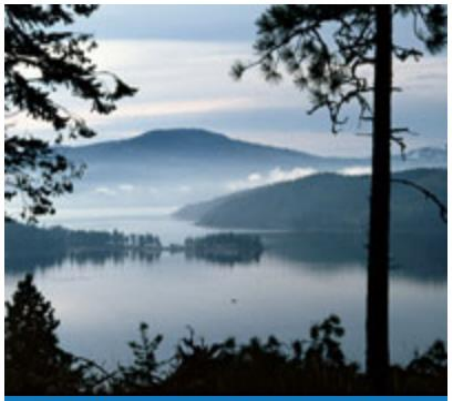
REGIONAL COLLABORATION MAINTAINING AND ENHANCING
WATER QUALITY AND QUANTITY FOR PRESENT AND FUTURE GENERATIONS

Our Water. Our Future.

protect our waters

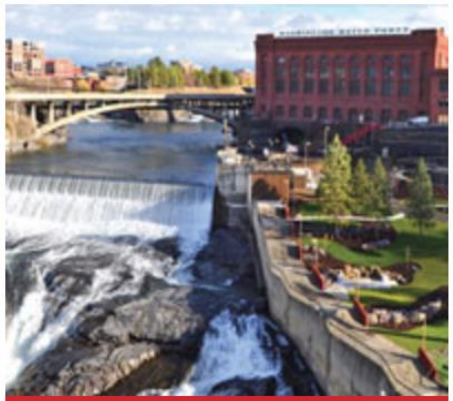
Protect and enjoy our most precious resource – clean water.

control contaminants



Together we can improve water quality in our lakes, rivers, ground and drinking water.

use water wisely



Efficient water use and conservation is good for our environment and economy.

learn more

Education and awareness are essential to protecting and preserving our waters.



WHAT'S POPULAR

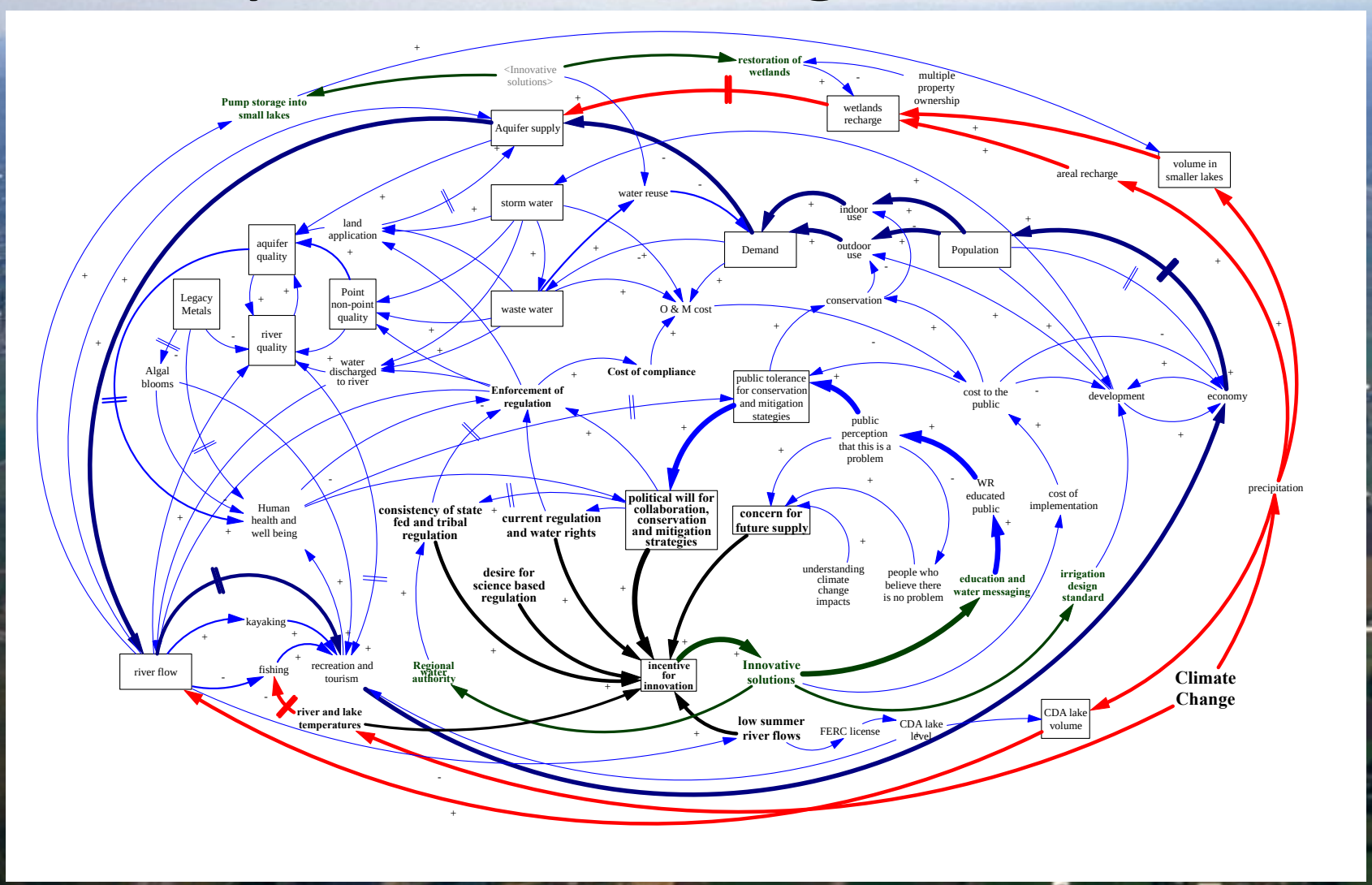
- Irrigation & Landscape Guidelines
- Aquifer Video
- Aquifer Atlas
- Find My Water Provider
- Spokane Kootenai Waste Directory

## PARTNERING IN SHARED STEWARDSHIP OF THE SPOKANE VALLEY RATHDRUM PRAIRIE AQUIFER AND SPOKANE RIVER WATERSHED

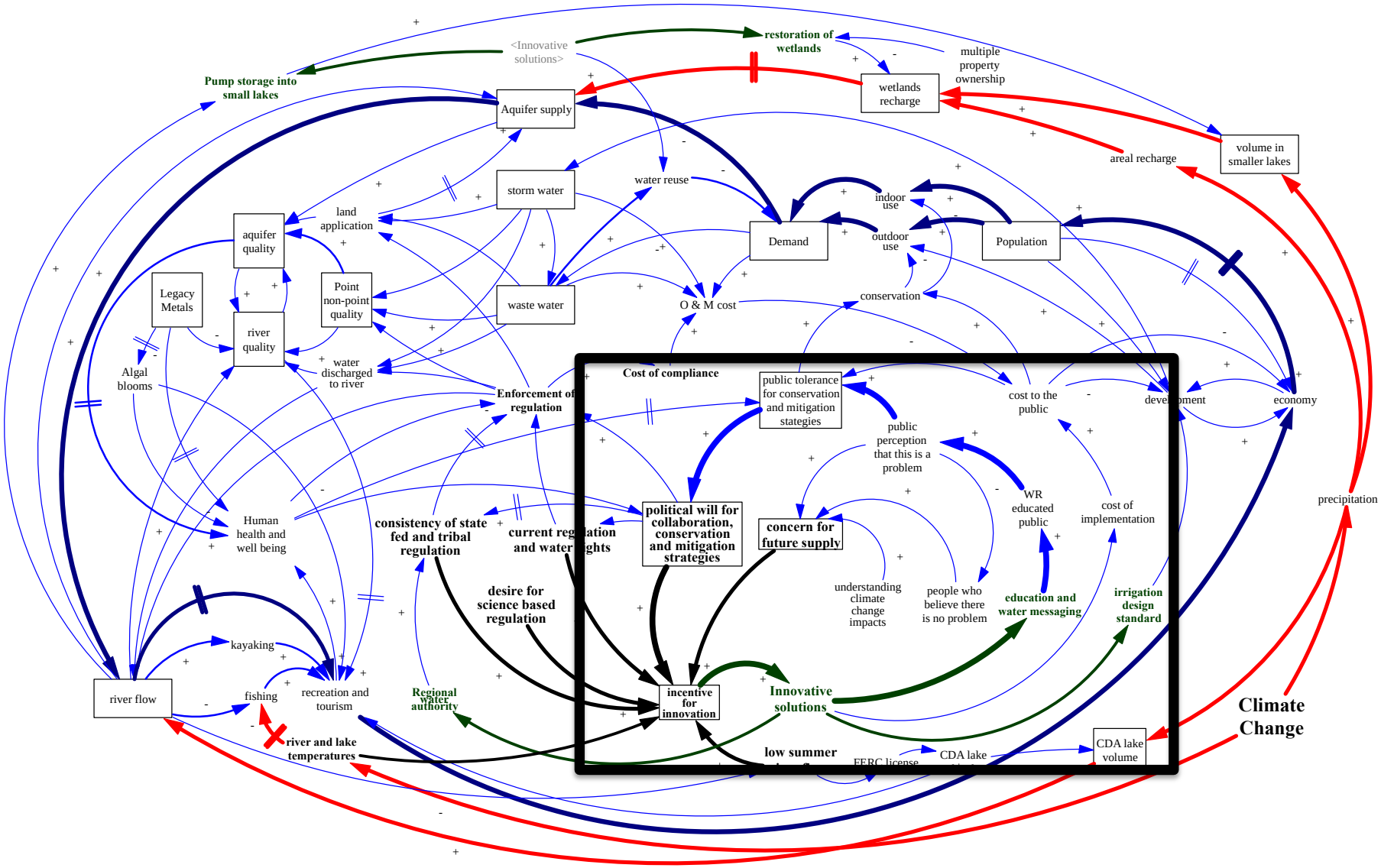

SPOKANE RIVER
REGIONAL TOXICS TASK FORCE
COLLABORATION
INNOVATION
PROGRESS



# Defining “the problem” with systems thinking exercises



# Leverage points?



# Spokane basin successes: Basin wide Public Service Videos

# K-6 Education opportunities

# MODEL EFFICIENT IRRIGATION AND LANDSCAPE DESIGN STANDARDS

*GUIDELINES FOR PREPARING AND ADOPTING YOUR ORDINANCE OR STANDARDS*

# Education and Outreach is critical

## Spokane Basin

- "Water rich" basin with ~600,000 residents
- "An educated public will increase political will for collaboration, conservation and mitigation"

## Palouse Basin

- Varying levels of perceived crisis
- "Public outreach necessary to secure funding for supply augmentation projects"

# How do we determine success?

**Long term?**

Sustainable resource use and resilient ecosystems

**To get there?**

Enduring relationships that create a culture of collaboration that supports innovative management

# Thank you!

Many thanks to Spokane River Forum, Idaho Washington Aquifer Committee, Palouse Basin Water Summit, Palouse Basin Aquifer Committee and all of the people in the Palouse and Spokane Basins from whom we have learned so much!

University of Idaho

Washington State University

USDA United States Department of Agriculture National Institute of Food and Agriculture