

# PURPOSE OF MEETING



Solve California's Water  
problems

# VISION

The WRPI envisions a long-term, sustainable water supply for California, made possible through education, research and policy development, serving urban, agricultural and environmental needs and interests.

# KEY GOALS

## WATER RESOURCES AND POLICY INITIATIVE

The WRPI will be a leading resource for:

*Partnerships with the water industry and government*

*Education, training and professional capacity building*

*Technology and economic development*

Solve Problems with a WRPI rain dance routine?





**A New York Times best seller**

# **SMELT RECIPES**

**A REALLY VERSATILE FISH**  
**Bake, stew, grill or puree**





# HYDROLOGIC SYSTEM





## Hydrological connections – hydrologic system



## Vectors of system inputs, outputs and changes in storage





Stream to ground water or ground water to stream?





# Size mixture in sedimentary deposits



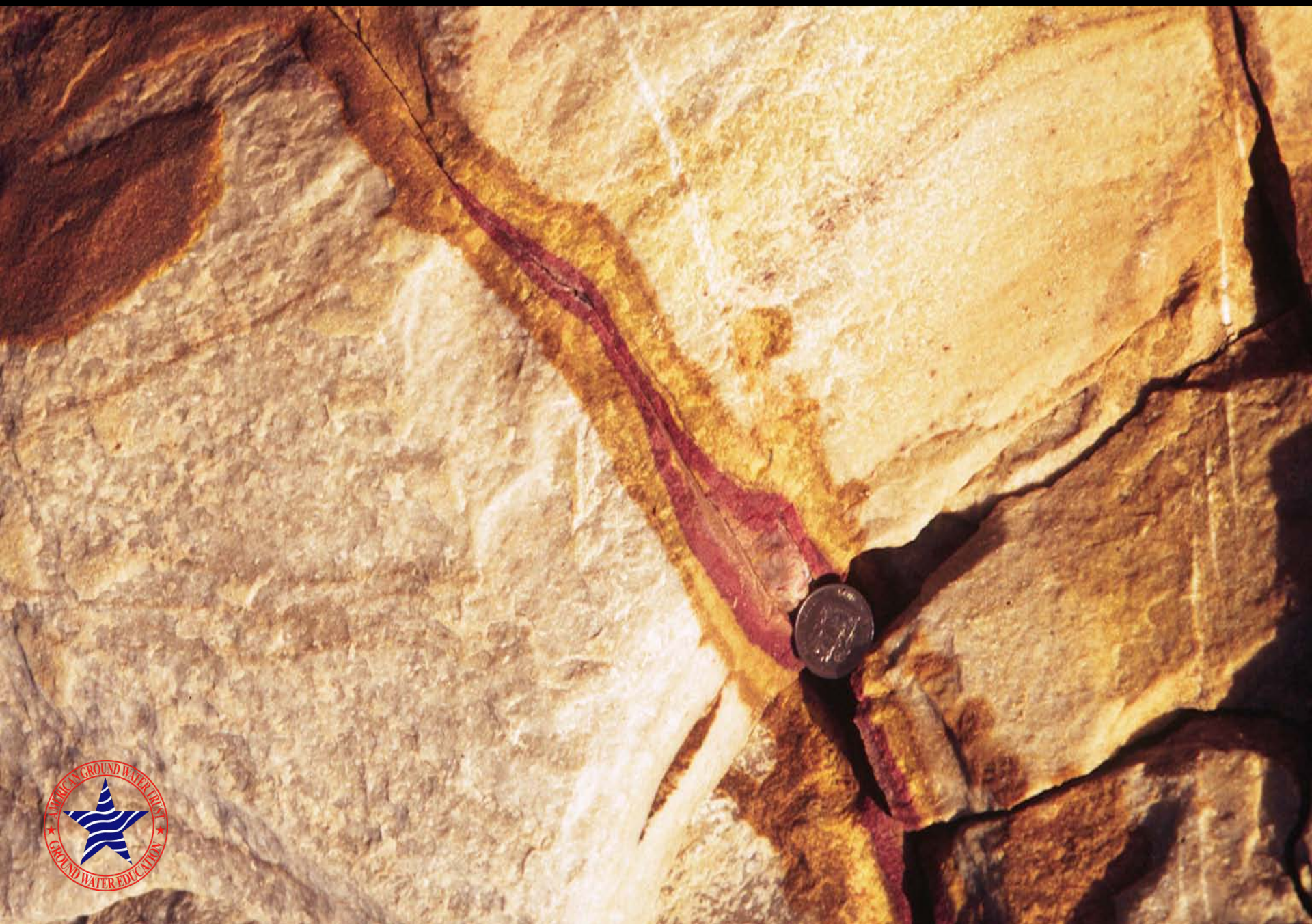


# Igneous and sedimentary





# Fractures (secondary permeability) as flow conduits







The Hydrologic system is global



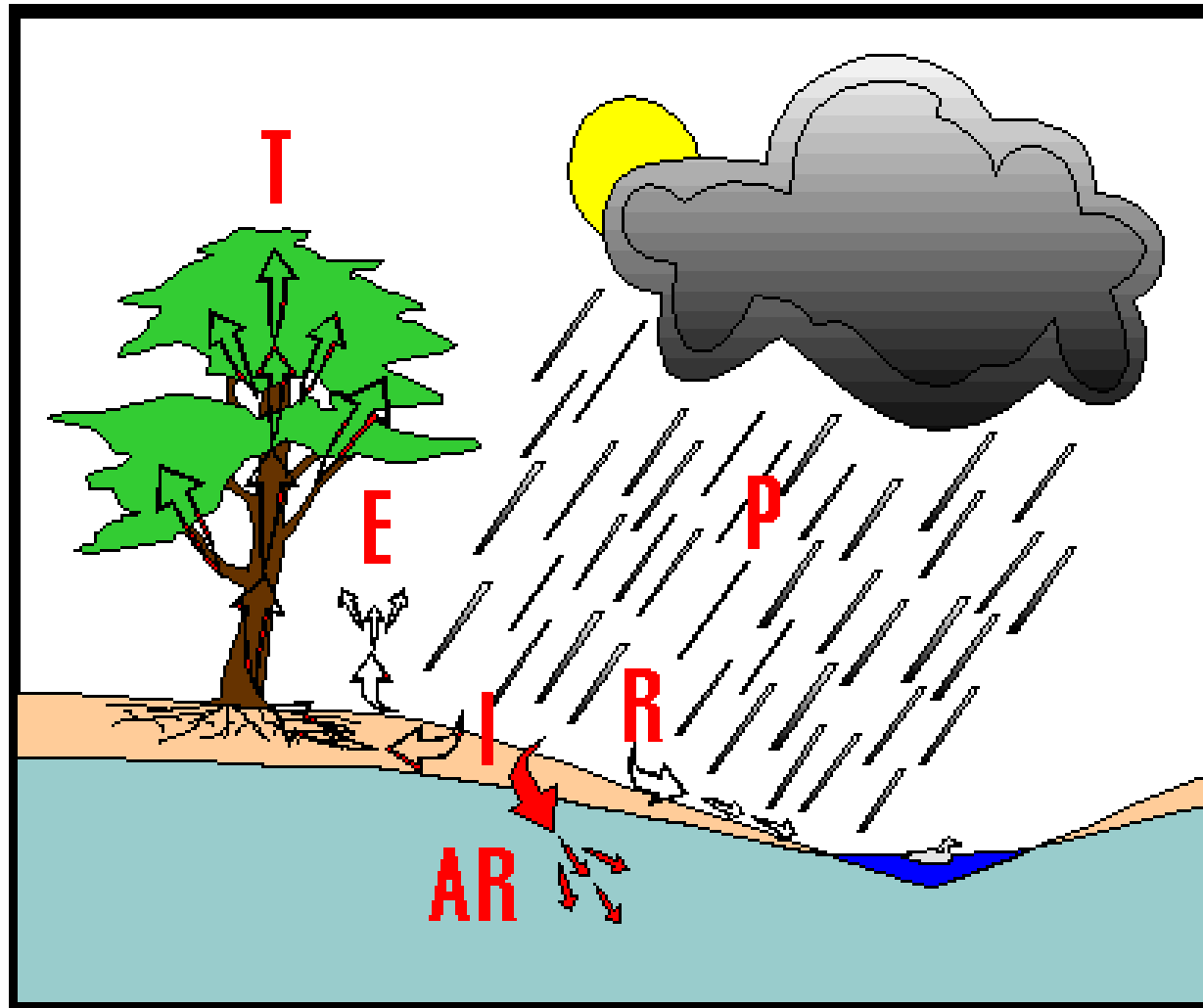


Canadian  
coin carries  
hydrologic  
message

“Natural  
Legacy”

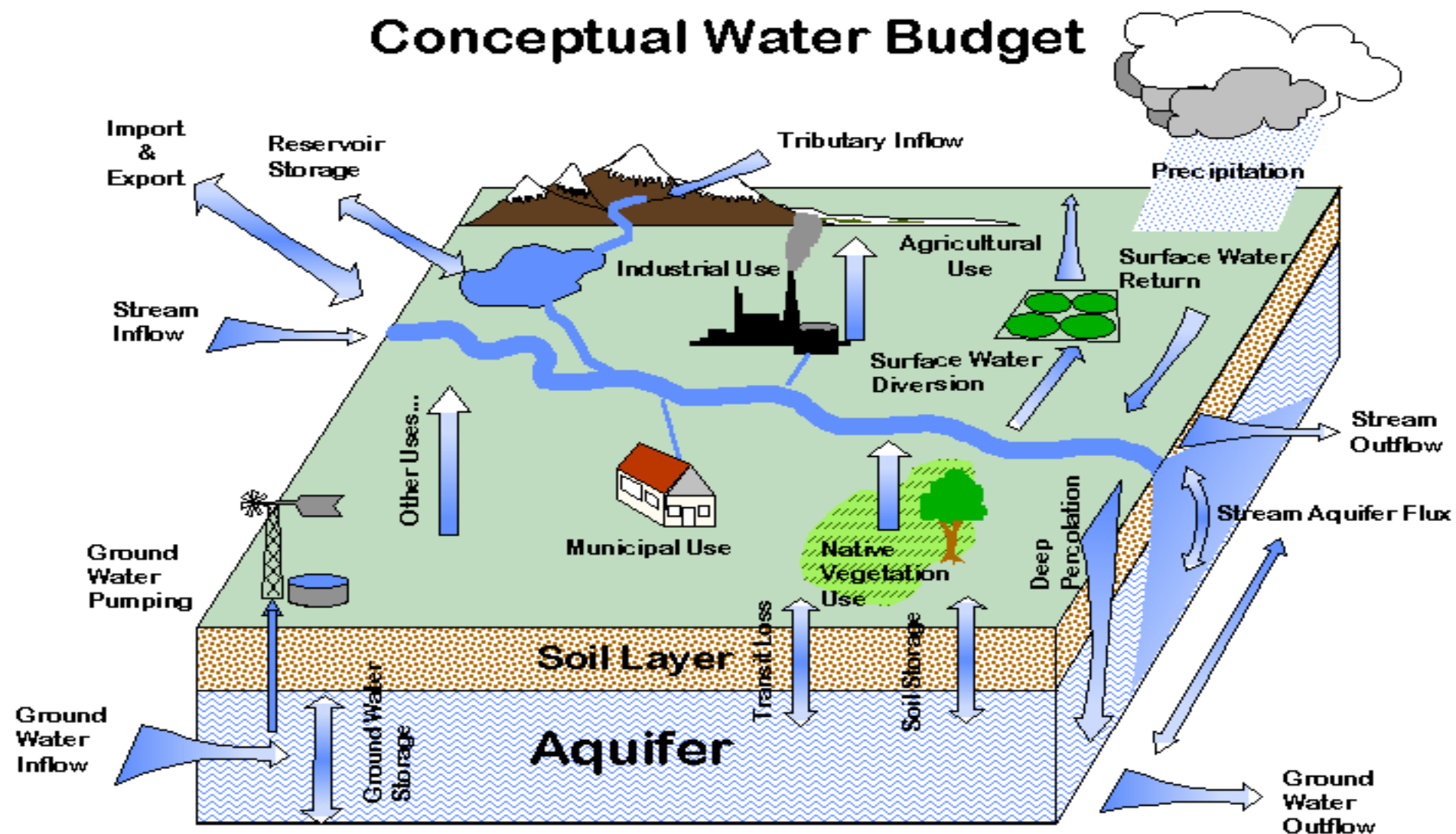


# AQUIFER RECHARGE



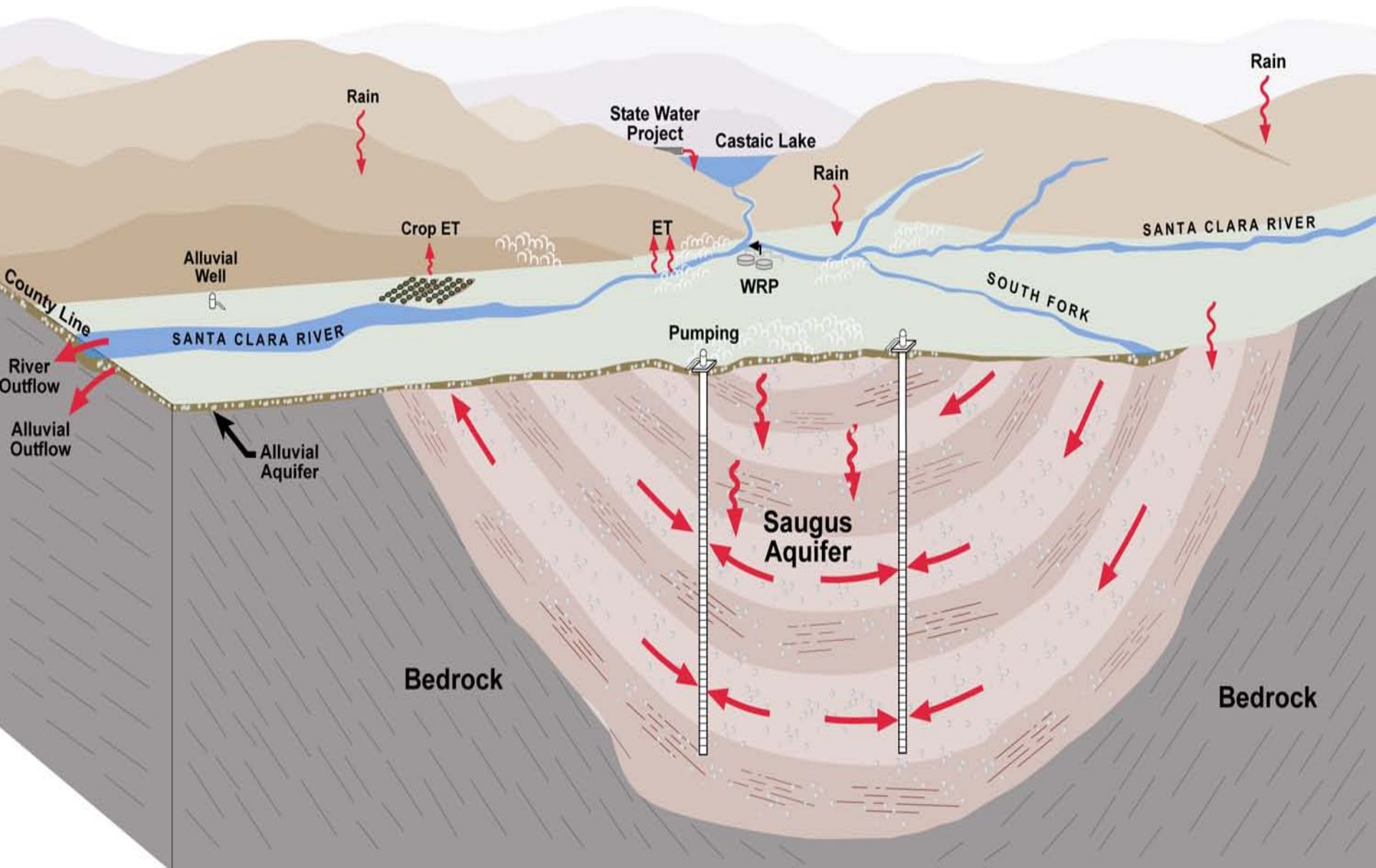
# Hydrologic system - geologic environment

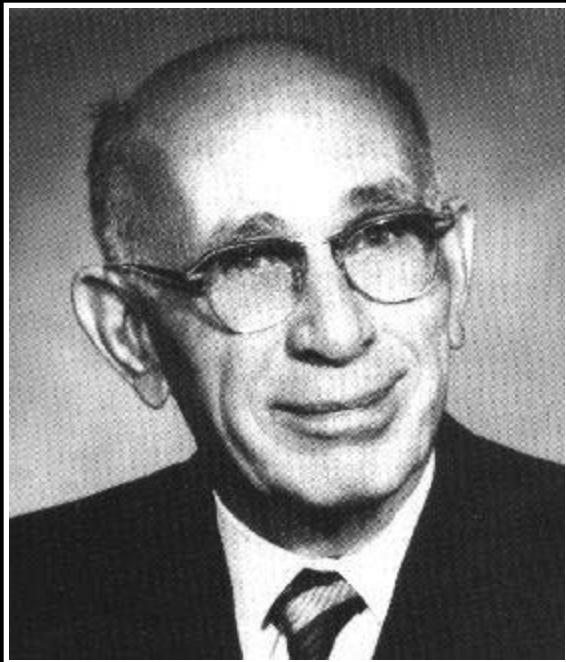
## Conceptual Water Budget





# Conceptual model of specific hydrologic system





**Under natural conditions ....  
Previous to development by wells,  
aquifers are in a state of  
approximate dynamic equilibrium.  
Discharge by wells is thus a new  
discharge superimposed upon a  
previously stable system, and it**

**must be balanced by an increase in the recharge  
of the aquifer, or by a decrease in the old natural  
discharge, or by loss of storage in the aquifer, or  
by a combination of these”**

**C.V. Theis 1940**

# WATER RESOURCES PROBLEMS



Town of Santa Margarita off US 101 and near junction of Hwy 58, San Luis Obispo County.

Drinking water status sign in March 2008.



March 2008 storms produced 0-10% of the average rainfall for the month, in central and southern California





San Luis Obispo County, March 2008,  
creeks and rivers completely dried up

Salmon conservation is in conflict with other policy objectives that are more longstanding and deeply entrenched



2,000 square feet of roof or driveway,  
produces 1200-1400 gallons of water  
from a one-inch rainfall event











# WASTEWATER CONTENT

University of Minnesota Water Resources Center  
(06/03/2009)

16 households for one year in FL MN & CO

Caffeine in all samples, Salicylic acid in about three quarters, Ibuprofen in half

Detergent additives and plasticizers in three quarters

Decrease in the amount of oil and grease and phosphates

Younger households using 2x water

Nitrogen levels remained the same



# Perchlorate





Land  
subsidence 30  
feet in western  
San Joaquin  
valley near  
Mendota







Mark Watte, farmer  
Tulare, CA

I don't want the government to come in and dictate .... 'This is all the water you can use on your own land,' ... we would resist that to our dying day

New York Times

# Climate Change



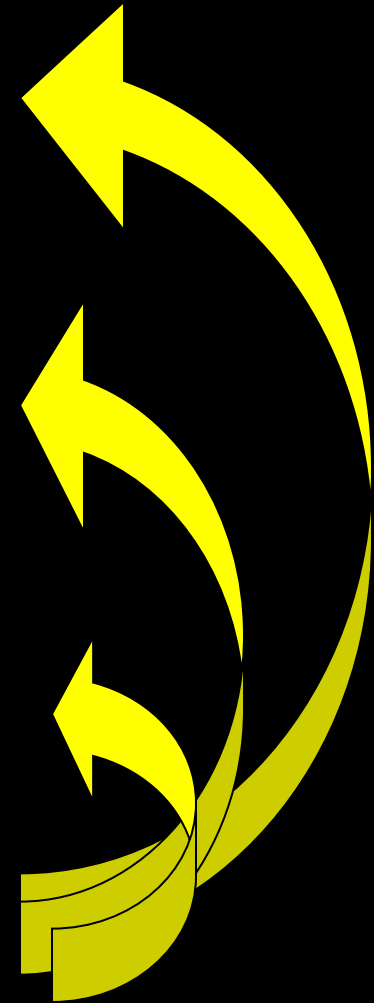


# WATER MANAGEMENT



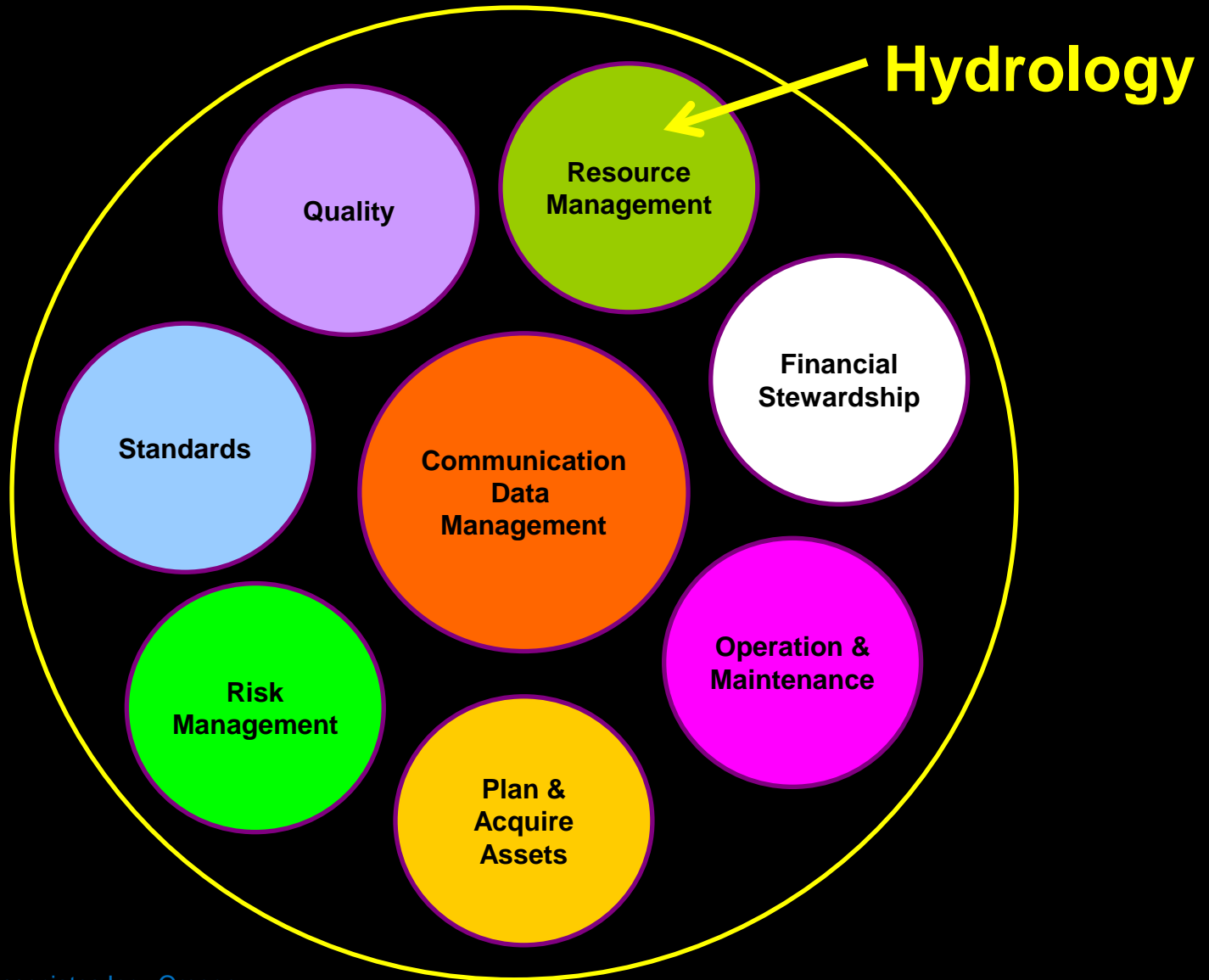
# Adaptive Management

- Document what you want to do
  - “Quality Assurance”
- Do what you document
  - “Quality Action”
- Document what you did (Monitor and Report)
  - “Quality Control”
- Review and improve everything
  - “Adaptive Management”

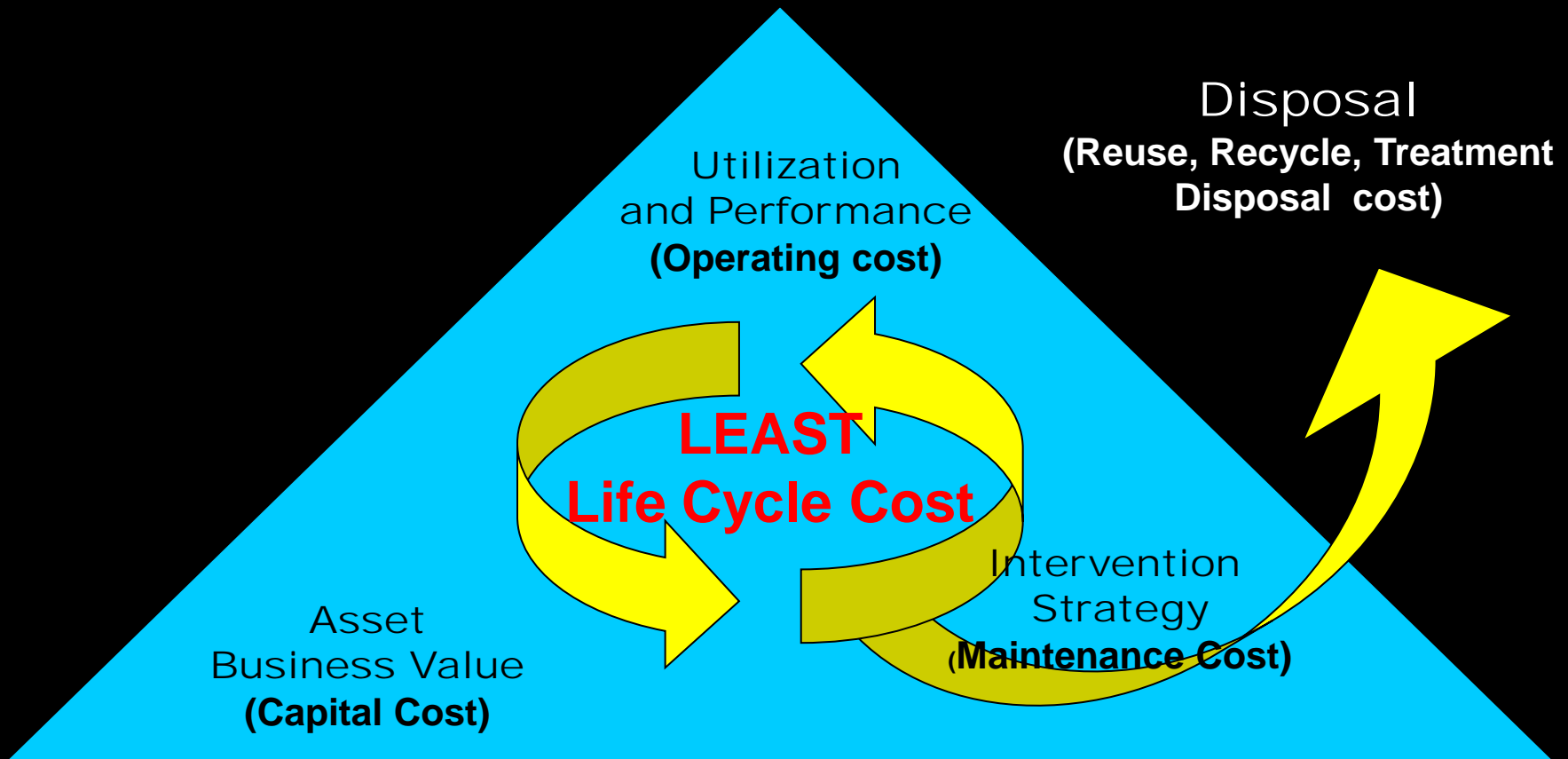




# Management Elements

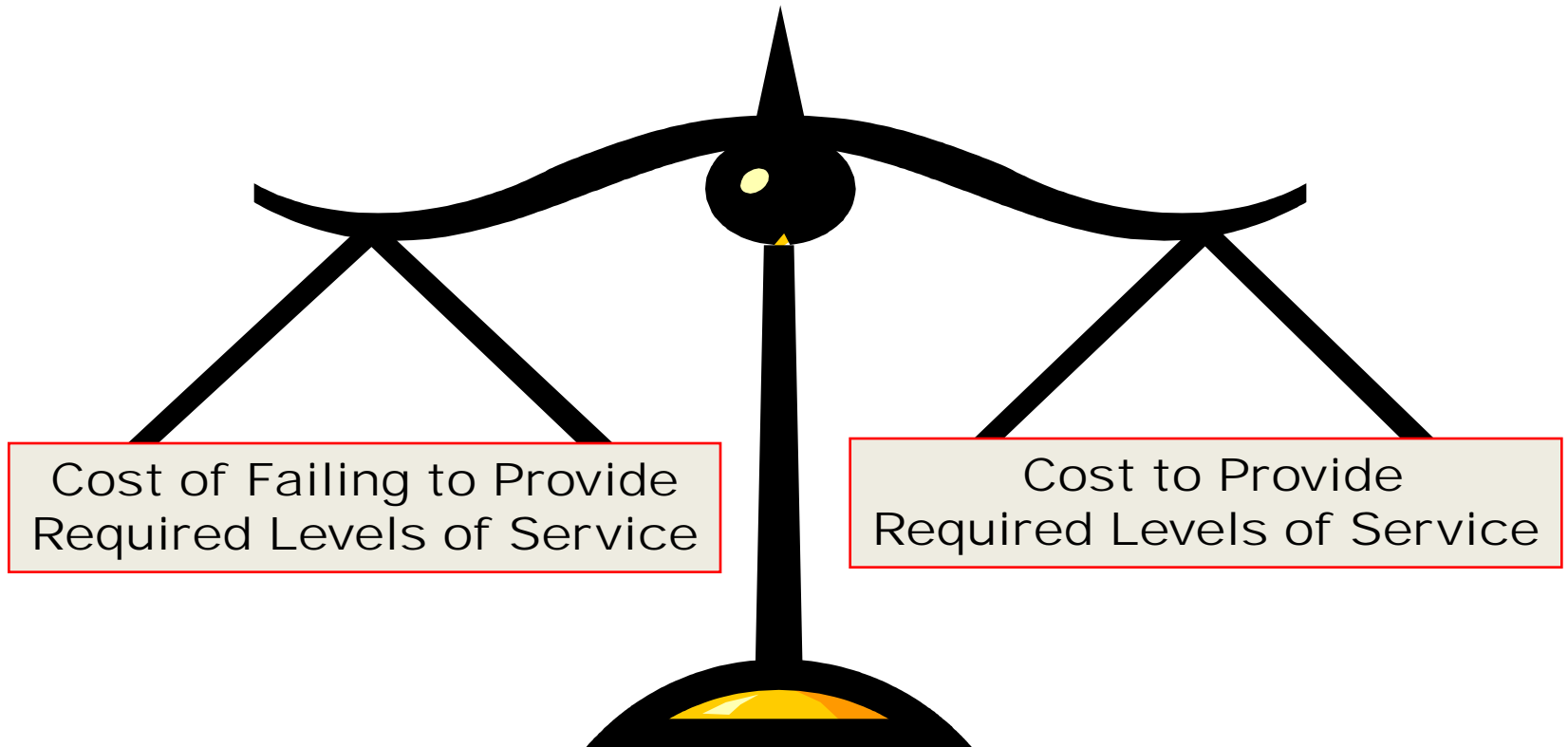


# Asset Management Evaluation



# BALANCE THE RISK

**RISK**





# SCIENCE EDUCATION

## EARTH SCIENCE LITERACY PRINCIPLES



The Big Ideas and Supporting Concepts of Earth Science

[www.earthscienceliteracy.org](http://www.earthscienceliteracy.org)

An Earth-science-literate public, informed by a current and accurate understanding of the Earth, is critical to the promotion of good stewardship and sound policy

NSF Report - principle 9.9



DARK UNDERGROUND  
THE WATER FLOWS  
IN HIDDEN VEINS THAT  
NO ONE KNOWS  
UNTIL THE FORKED STICK  
BENDS AND SHOWS.

Despite all the evidence of geologic science... misunderstandings about ground water are an issue with regard to public perception and water policy ....

... at all levels of education

*Tragically the enactment of  
**No Child Left Behind** has  
greatly diminished the time  
spent on teaching science  
in many elementary schools*

Page Keeley, President, National Science Teachers Association



*All the parts of the system that should include the K-6 years of knowledge and skill building are not there to support the cumulative steps that contribute to high levels of learning*

Page Keeley, President, National Science Teachers Association

## CAREERS IN HYDROLOGY

*Water-related studies and projects are leading to a need for people with knowledge in various related specialties*

*Employment for hydrologists is expected to grow much faster than the average through the year 2014*

*Hydrologists are needed to help companies comply with the growing number of environmental laws and regulations*

Pasadena Star-News (AP) 05/29/2009

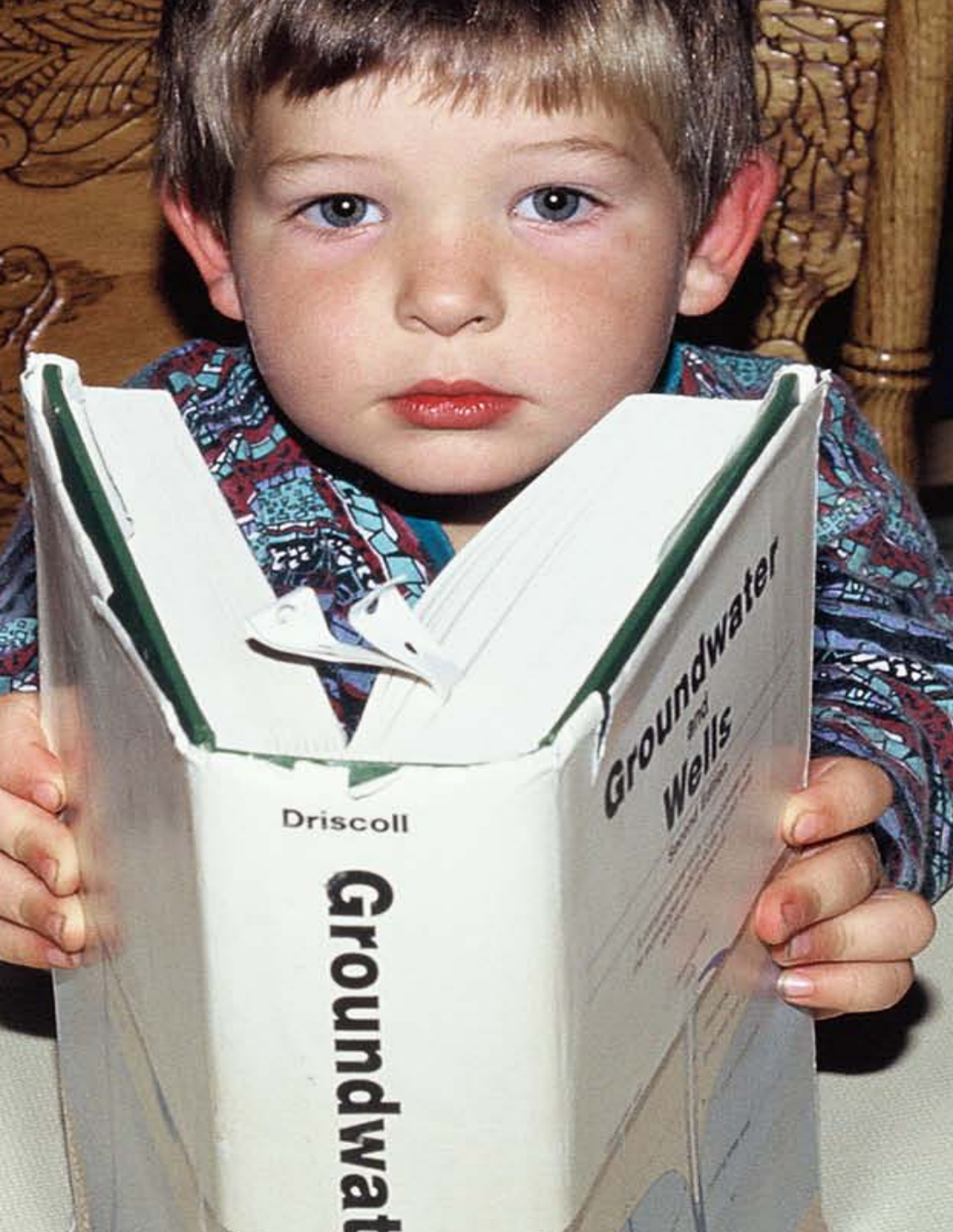
# *Santa Fe Irrigation District Survey Finds 70% Very Concerned About Water Supply*

“We have received our marching orders”

“We now know that to have a successful outreach program and achieve our water conservation goals, **we must broaden the base of residents who understand the urgency and long-term nature of our water shortage.**”

Michael Bardin, SFID general manager





# GROUND WATER EDUCATION STRATEGY

Compulsory  
ground water  
study for  
all California 1<sup>st</sup>  
grade  
students?



# Chino Valley Ground Water Model



# RECYCLE ISSUES





From Shower  
to Flower  
"Indirect potable reuse"



# IMPLEMENTATION DELAYS

2003 REPORT from California Department of Water Resources, State Water Resources Control Board and the California Department of Health made **26** specific recommendations on water recycling

Margaret Mellor's NWRI White paper (2009) shows that so far only **2** recommendations have been implemented  
**9** have been partly addressed

*There is a need to have an agenda of achievable short term strategies*

Do no harm

Solve at point of implementation

Leave long term options open

Move in desired direction

- Interconnections (eg Hayward pipeline – East Bay and San Francisco)
- Low hanging conservation opportunities
- Pricing structures (10% On price 6% less demand)
- Changes to water codes
- Assured water supply (AWS) before development



# AQUIFER STORAGE



# Recharging Aquifers (1)

What needs to be done?

1. Capture the imagination of water managers
2. Convince regulatory authorities
3. Satisfy legal issues
4. Answer environmental concerns

# Recharging Aquifers (2)

What need to be done?

5. Compare other supply options
6. Be prepared for hybrid solutions
7. DO THE MATH [Hydrologic and economic]
8. Educate the public and elected officials
9. Make science the basis for policy



# Recharging Aquifers (3)

## Economics

- Typically less than half the capital cost of alternative water supply sources
- Phased implementation

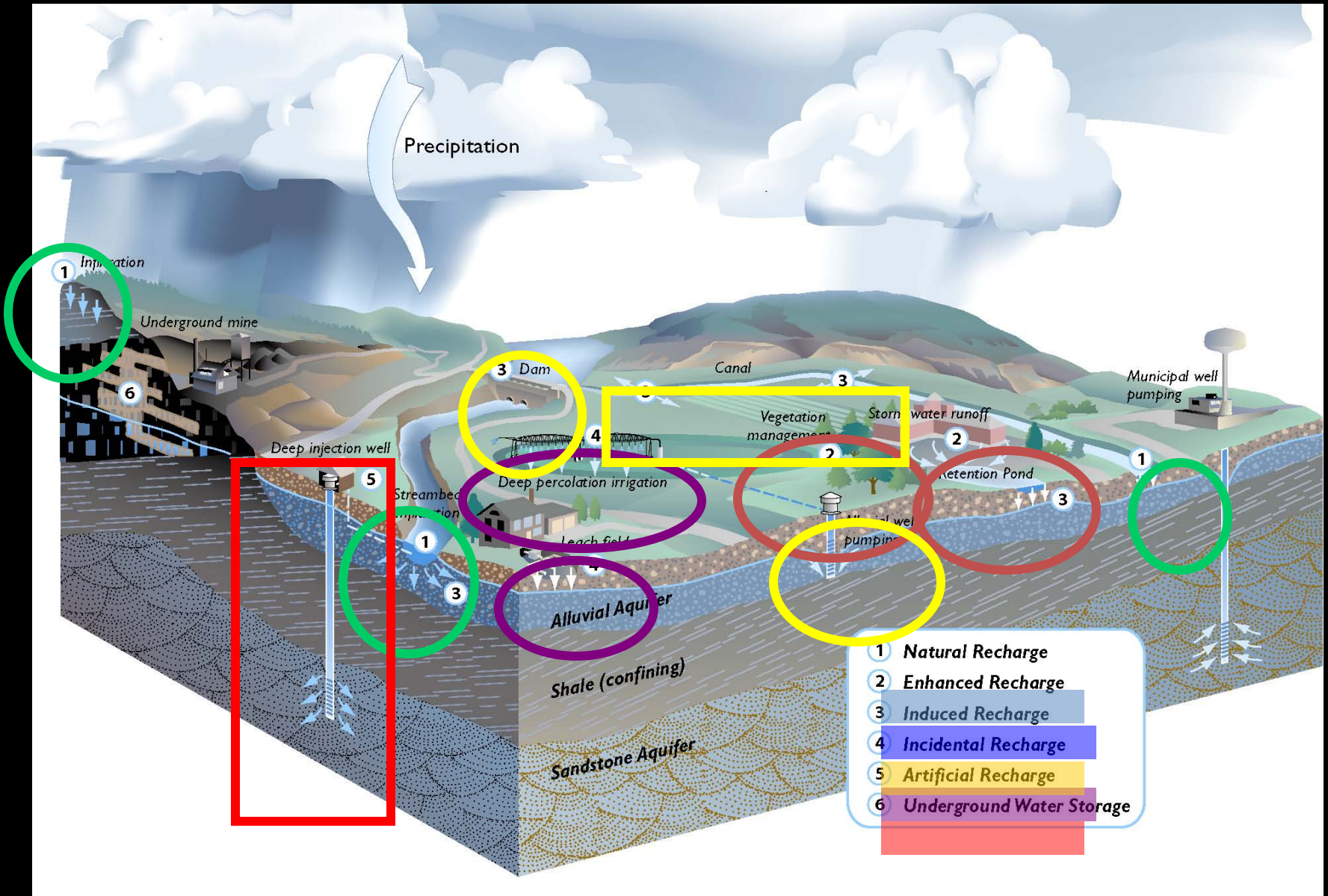
## Proven Success

- Over 84 well fields in 20 states
- 400 operating, fully permitted ASR wells

# Recharging Aquifers (4)

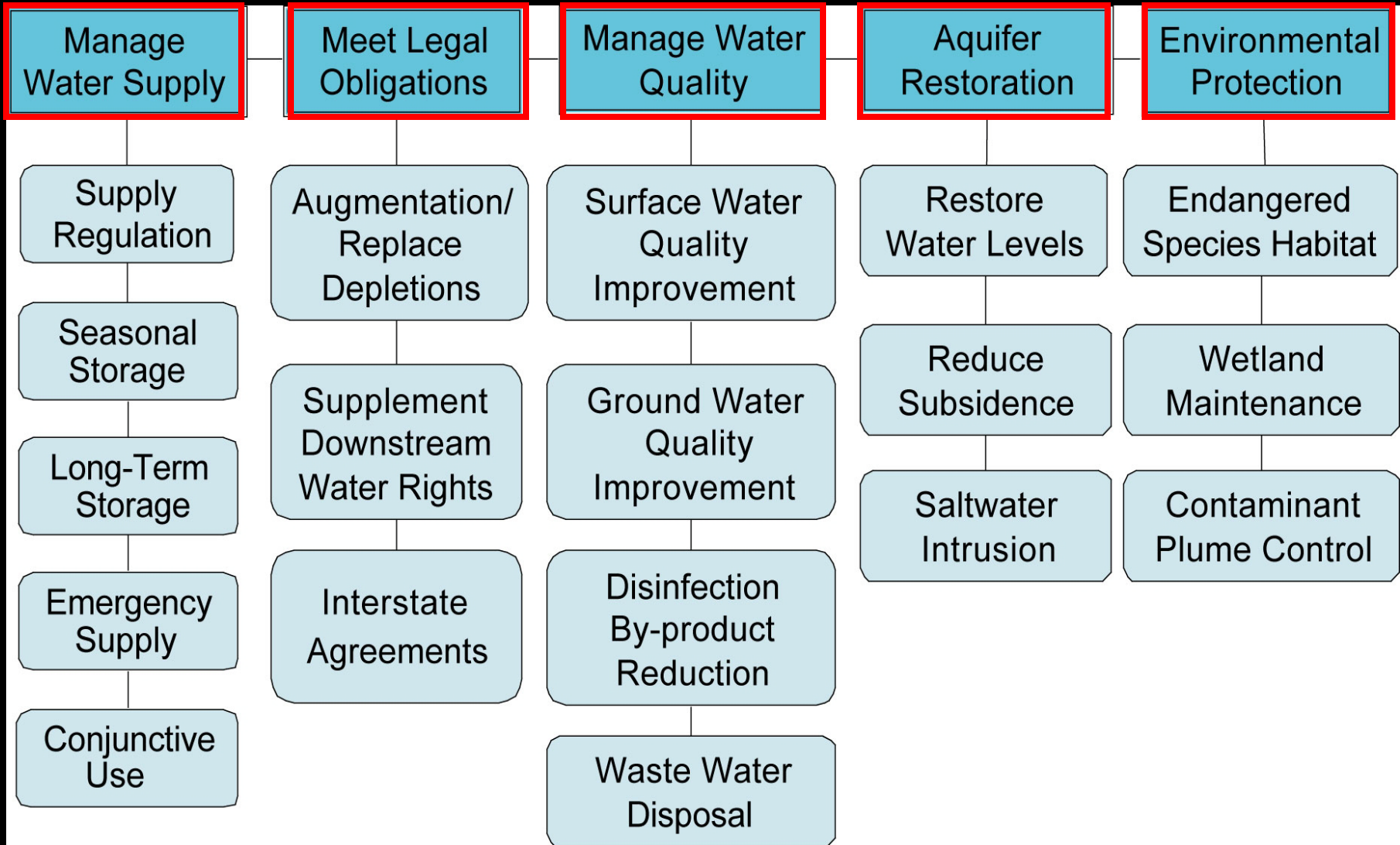
- Environmental and Water Quality Benefits
  - Maintain minimum flows
  - Small storage footprint compared to surface reservoirs
- Adaptability to Different Situations
  - Fresh, brackish or saline storage aquifers
  - Drinking water, reclaimed water, storm water or groundwater storage
  - Over 26 different applications (David Pyne, ASR Systems)

# ILLUSTRATION OF RECHARGE TYPES



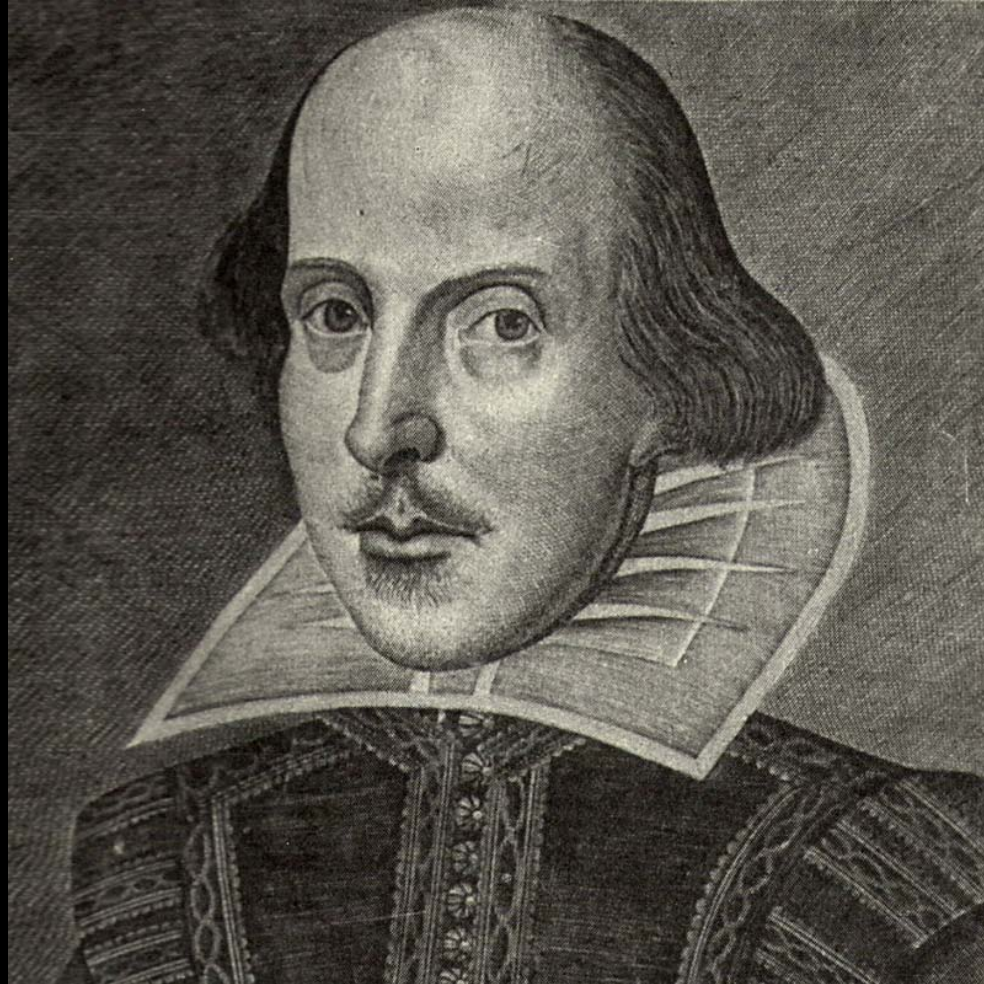


# OBJECTIVES OF ARTIFICIAL RECHARGE



# SHAKESPEARE'S HYDROLOGY

Get creative – hydrology learning opportunities are everywhere!



# Romeo & Juliet

## Water & hydrology imagery





# HYDROLOGY

## Key-word references in Romeo and Juliet

Clouds (4)

Conduit (1)

Dew (4)

Drizzle (1)

Mist (1)

Rain (1)

Sea (1)

Shower (1)

Spring (1)

Storm (1)

Well (1)

## Act 3 Scene 5

### CAPULET

When the sun sets, the air doth drizzle dew;  
But for the sunset of my brother's son  
It rains downright.

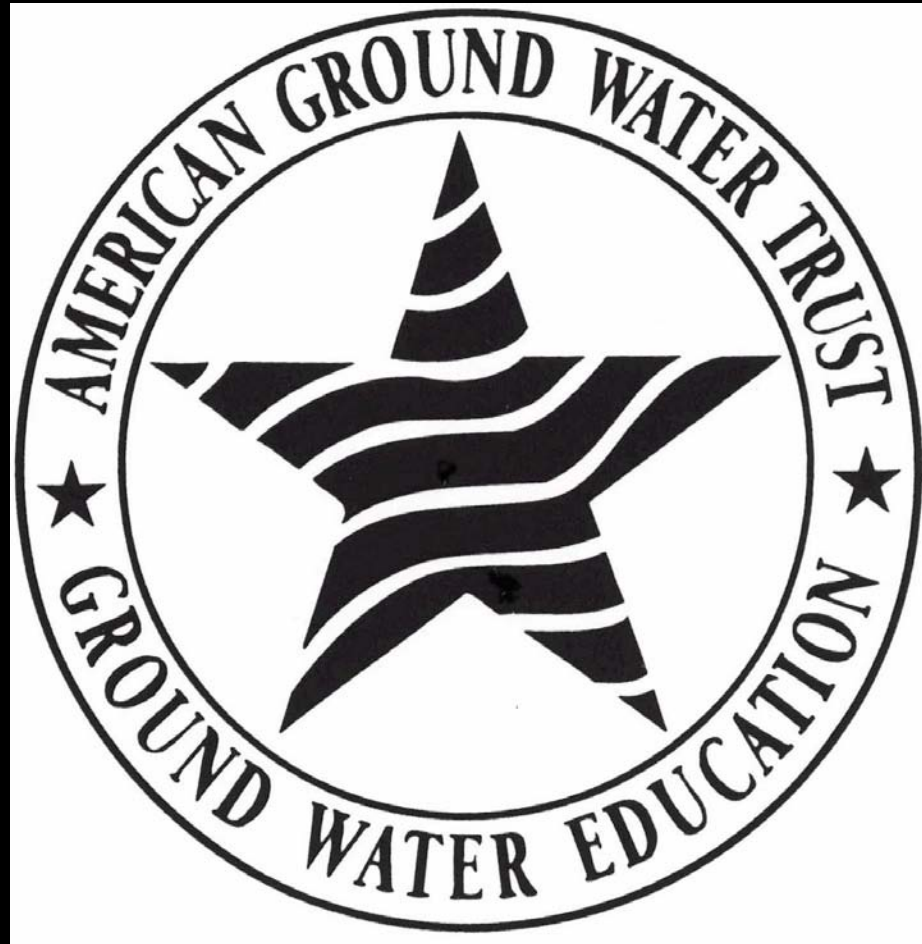
How now! a conduit, girl? what, still in tears?  
Evermore showering? In one little body  
Thou counterfeit'st a bark, a sea, a wind;  
For still thy eyes, which I may call the sea,  
Do ebb and flow with tears; the bark thy body is,  
Sailing in this salt flood; the winds, thy sighs;  
Who, raging with thy tears, and they with them,  
Without a sudden calm, will overset  
Thy tempest-tossed body.

# IVORY TOWERS



BEACONS OF  
ENLIGHTENMENT





American Ground Water Trust

[astone@agwt.org](mailto:astone@agwt.org)

[www.agwt.org](http://www.agwt.org)



**The Future  
Is In  
Our Hands**