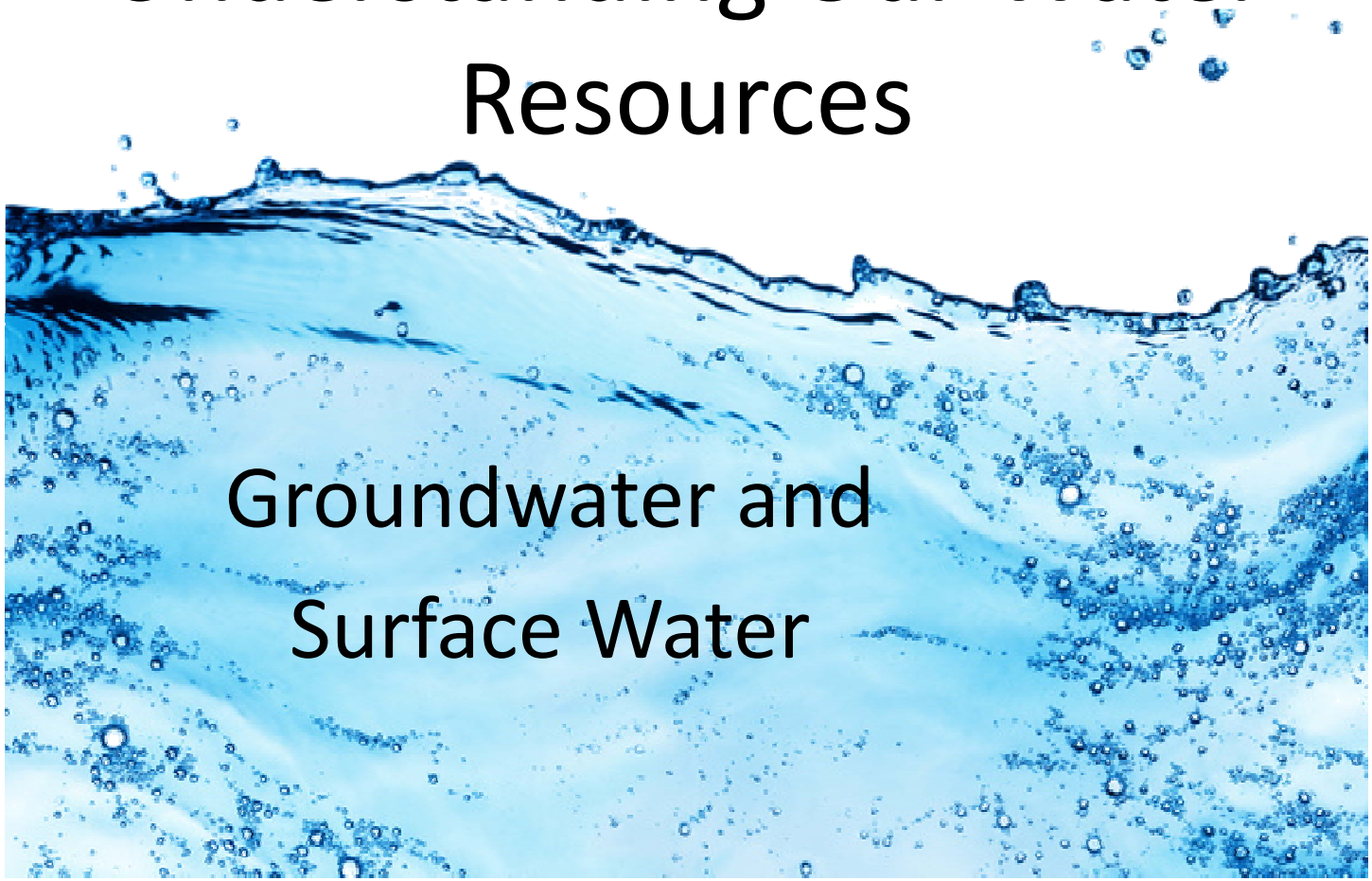
Understanding Our Water Resources



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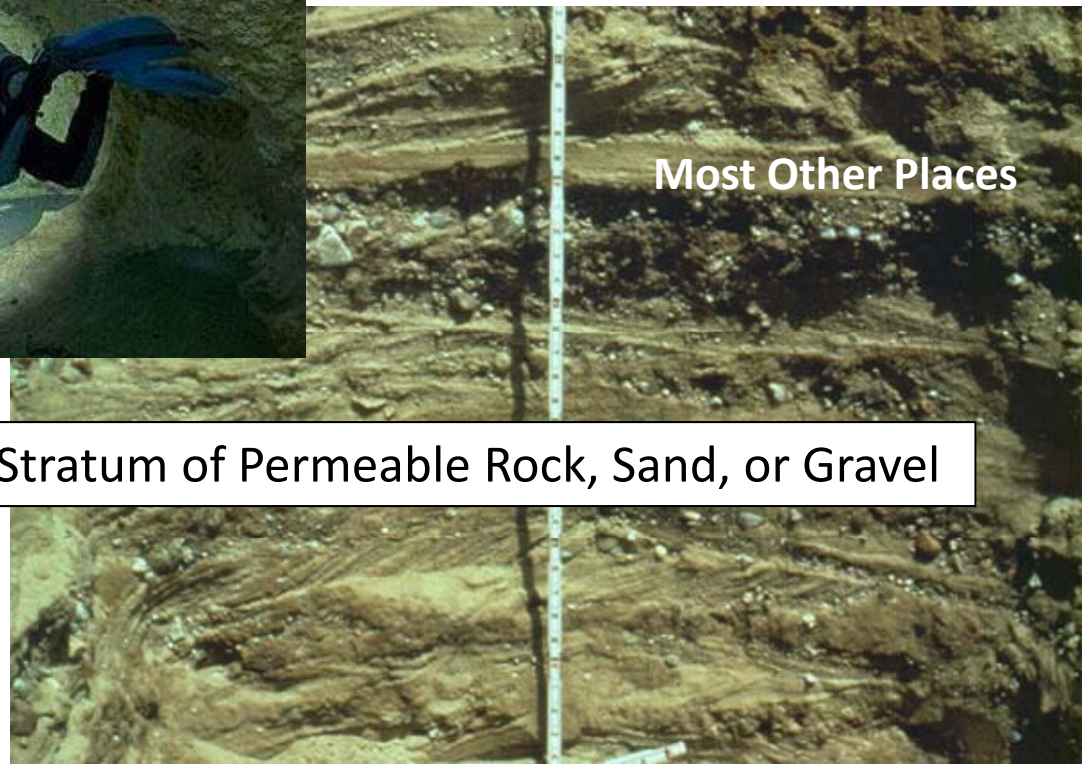
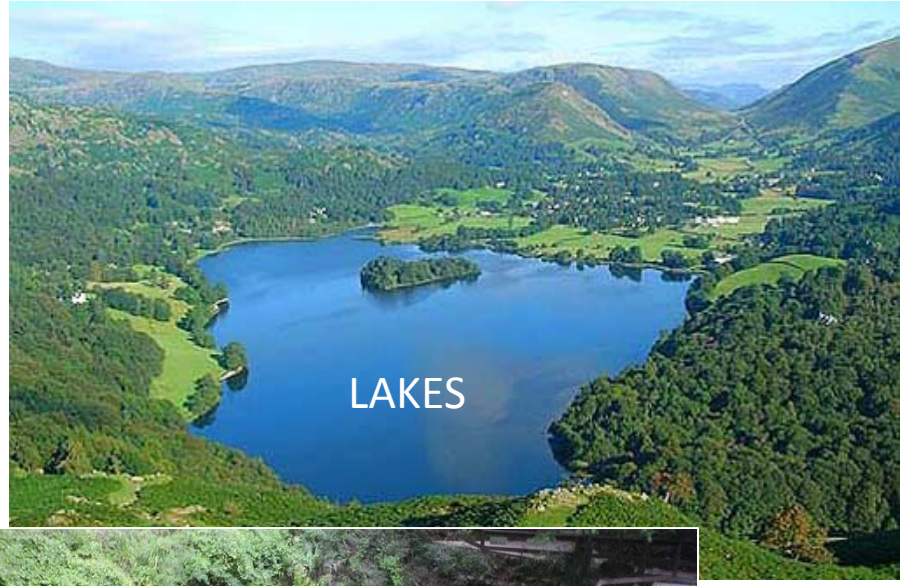
GROUNDWATER:
Water Below Ground Surface



AQUIFER: A Water-Bearing Stratum of Permeable Rock, Sand, or Gravel

SURFACE WATER: Water Above Ground Surface



Effects of Pumping on Baseflow

SURFACE WATER AND GROUNDWATER – ONE SYSTEM

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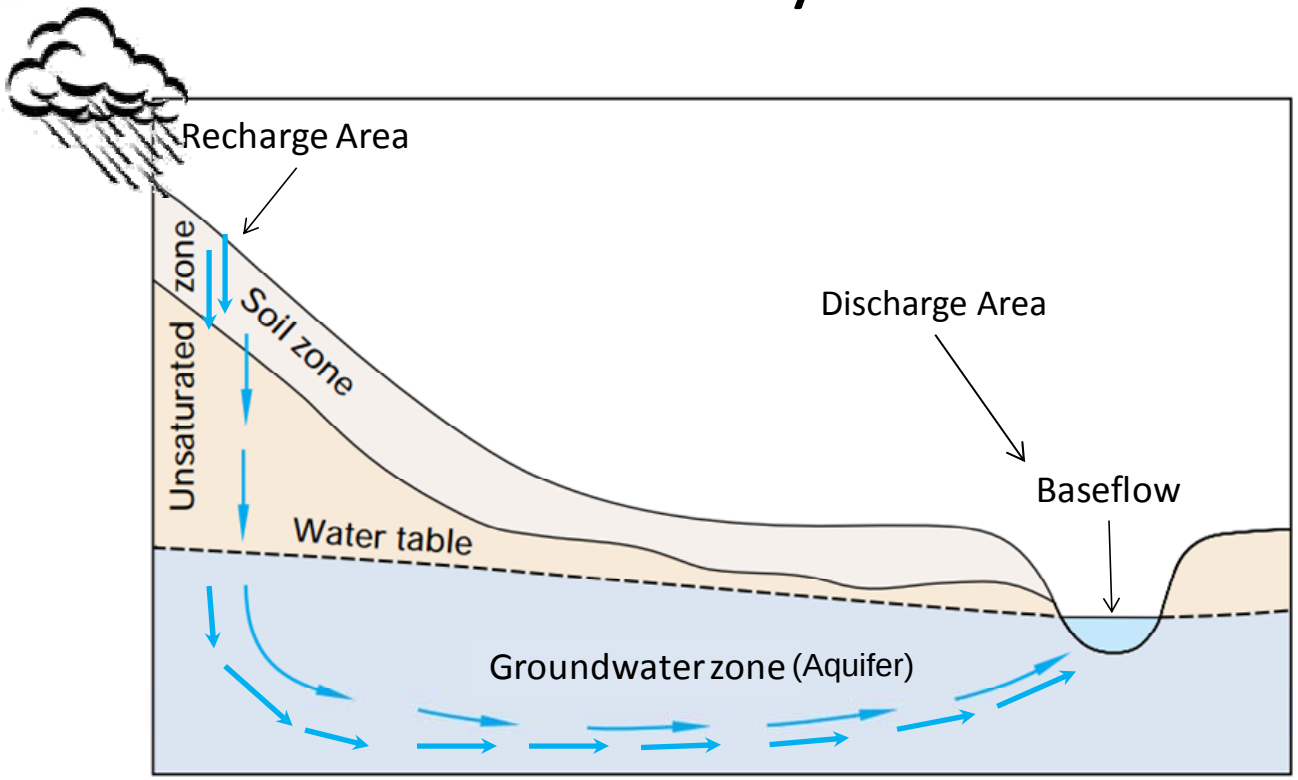
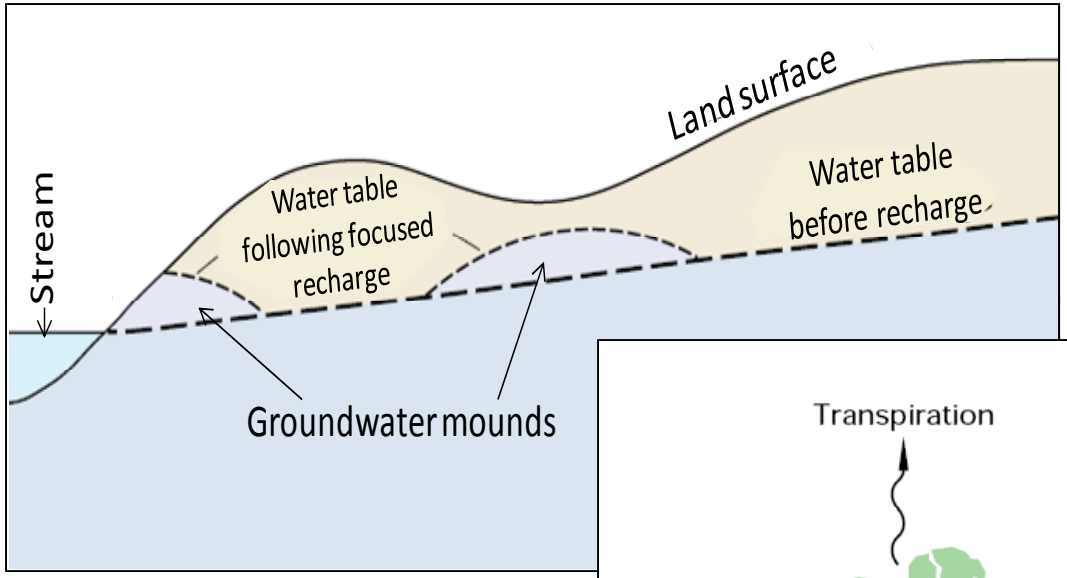
Groundwater and Surface Water: How Are They Related?



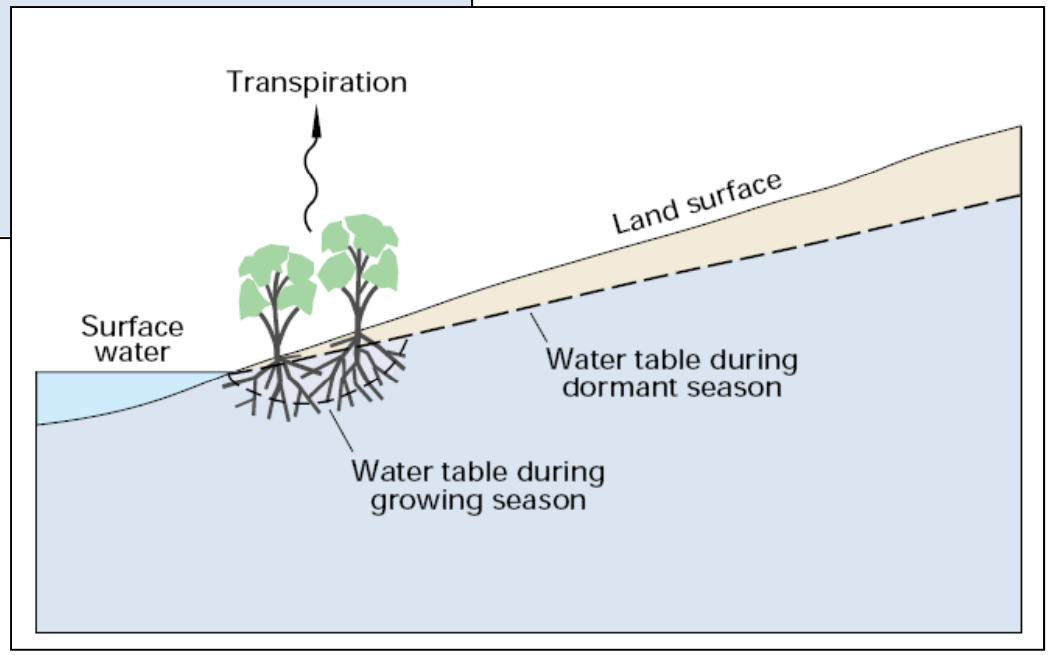
Source: Winter, T.C., J.W. Harvey, Franke, O.L., and W.M. Alley, 1998, Ground Water and Surface Water – A Single Resource, U.S. Geological Survey Circular 1139, Denver, CO.

Natural Changes to Groundwater System

Recharge

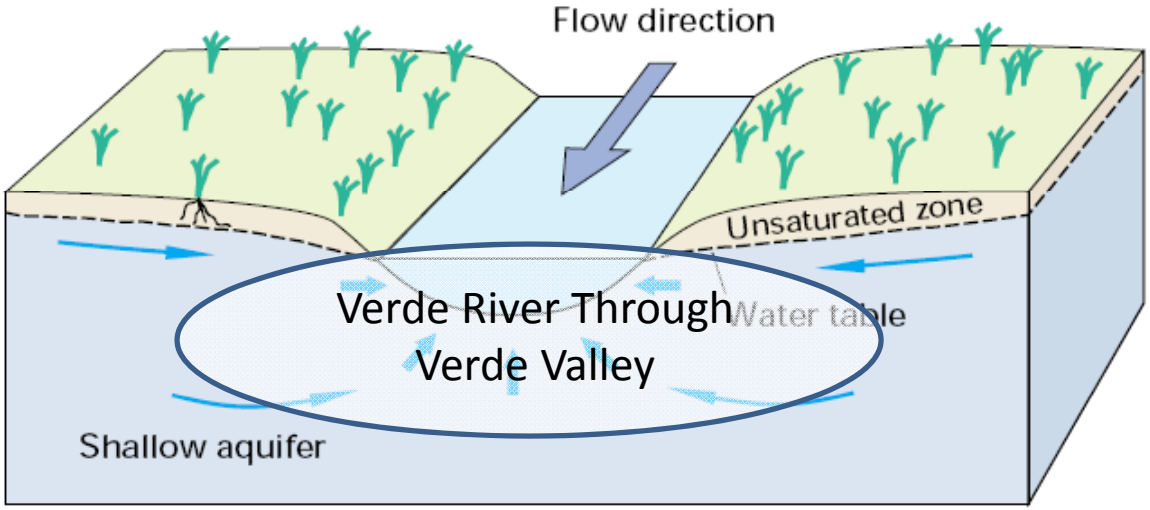


Discharge

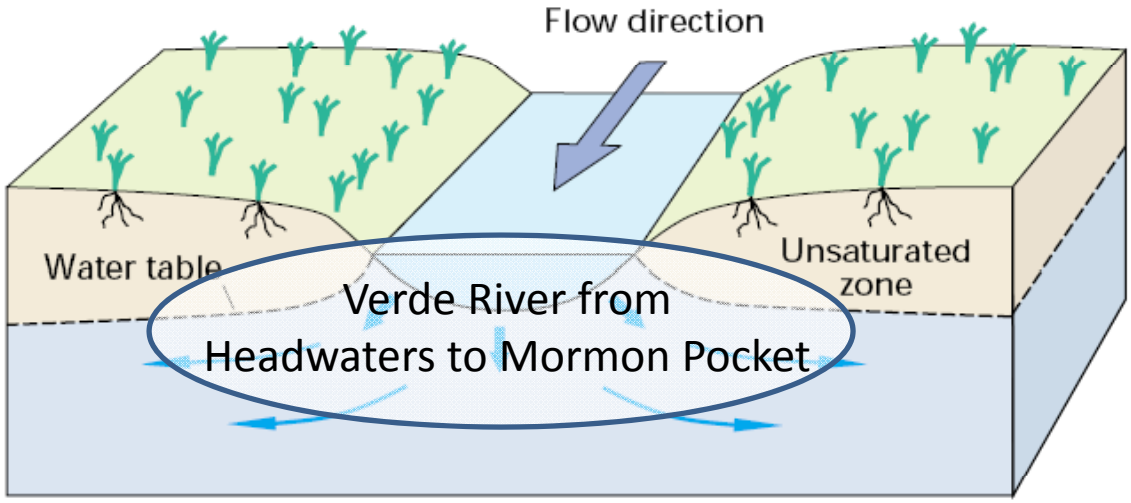


Two Different Types of Streams

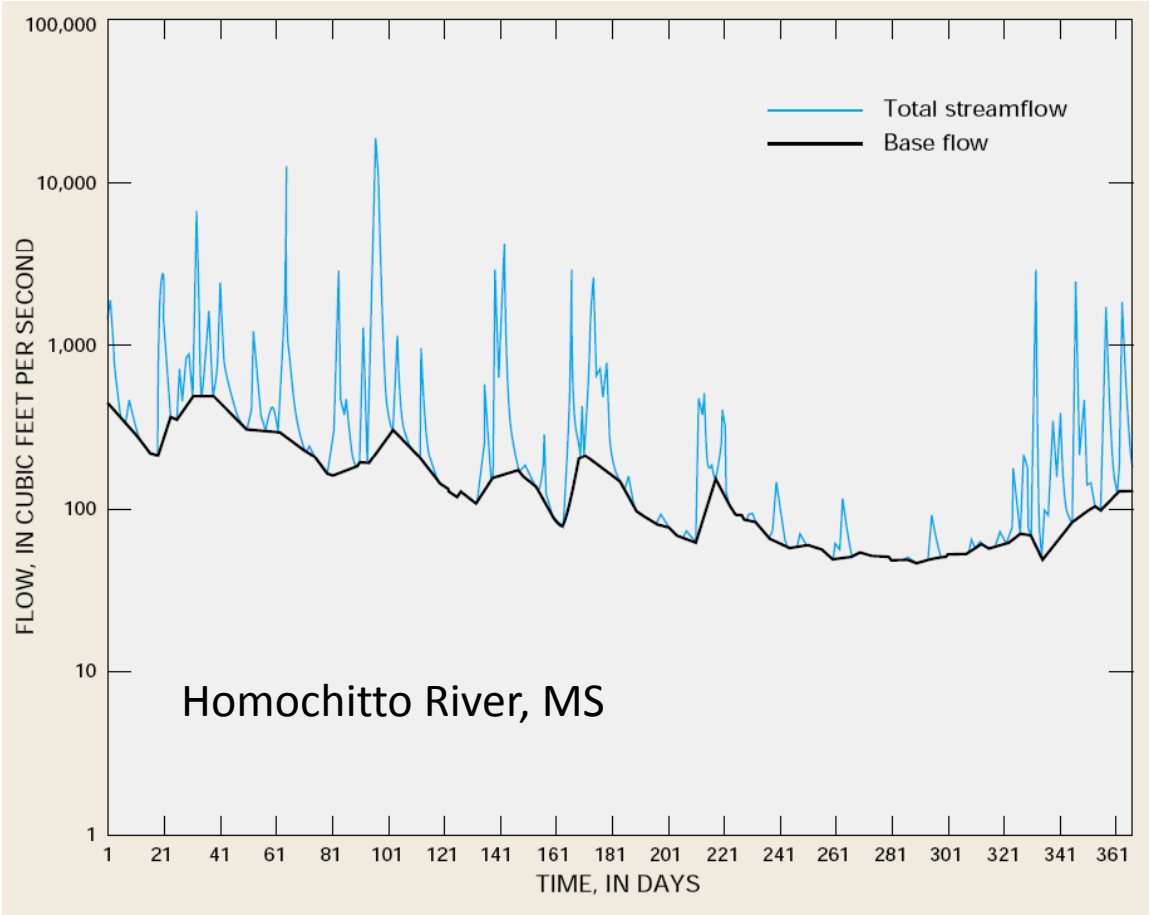
Gaining Stream



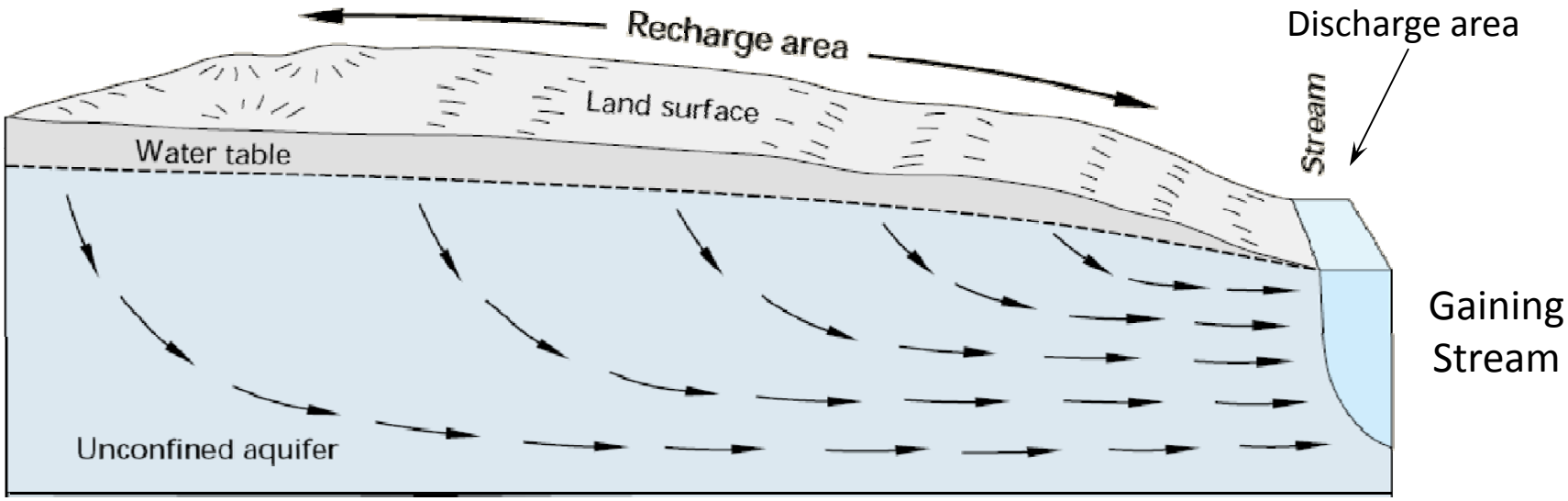
Losing Stream



BASEFLOW: Groundwater Component of Streamflow

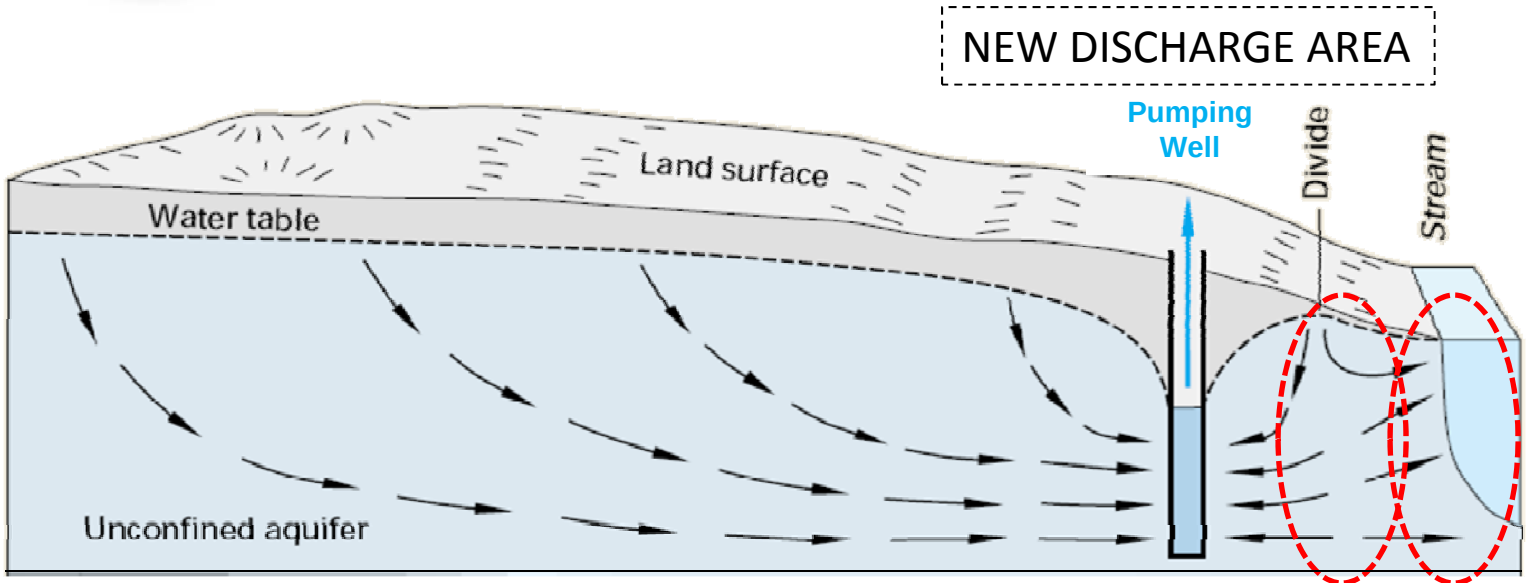


How Do Pumping Wells Affect the Natural Hydrologic System?



Source: Winter, T.C., J.W. Harvey, Franke, O.L., and W.M. Alley, 1998, Ground Water and Surface Water – A Single Resource, U.S. Geological Survey Circular 1139, Denver, CO.

Some Time After Pumping Begins



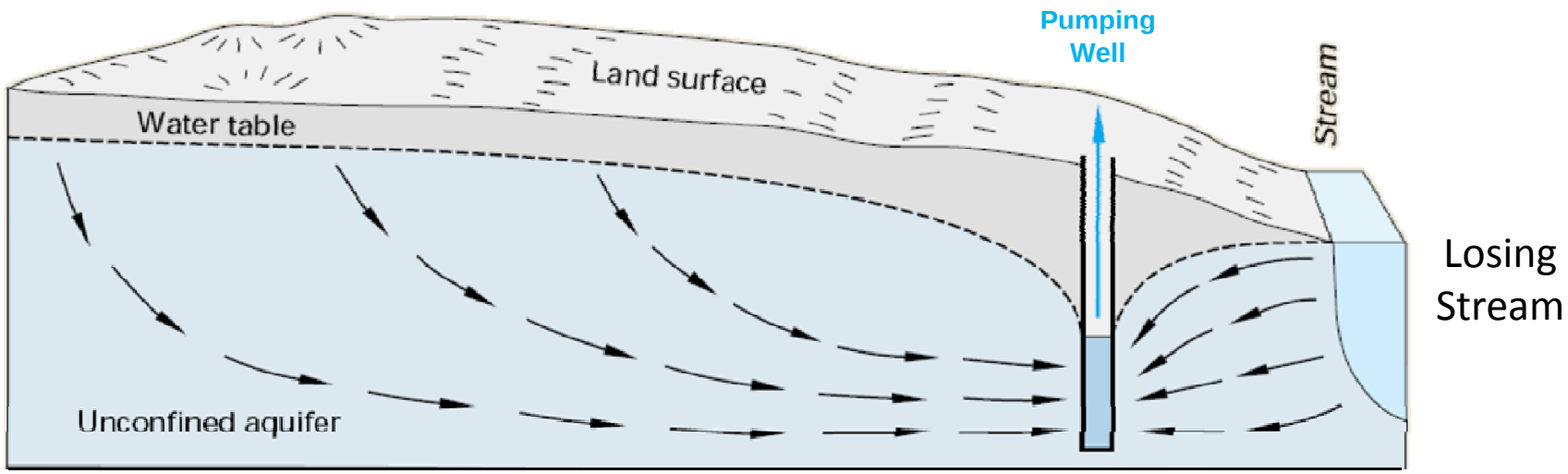
Source: Winter, T.C., J.W. Harvey, Franke, O.L., and W.M. Alley, 1998, Ground Water and Surface Water – A Single Resource, U.S. Geological Survey Circular 1139, Denver, CO.

Less Gaining Stream

Modified Groundwater Flow Direction

Reduced Groundwater to Stream

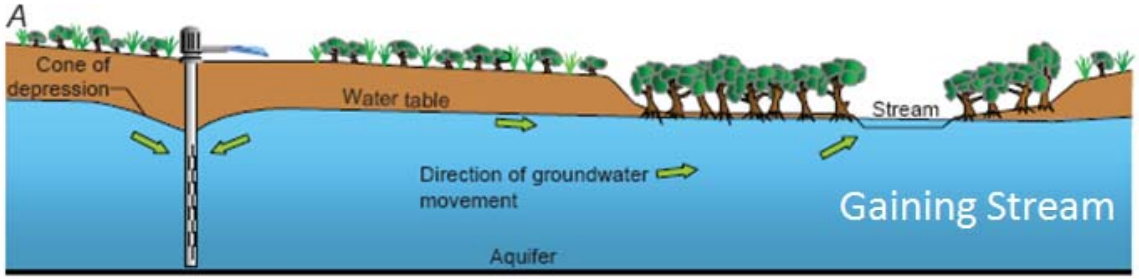
After Prolonged Pumping



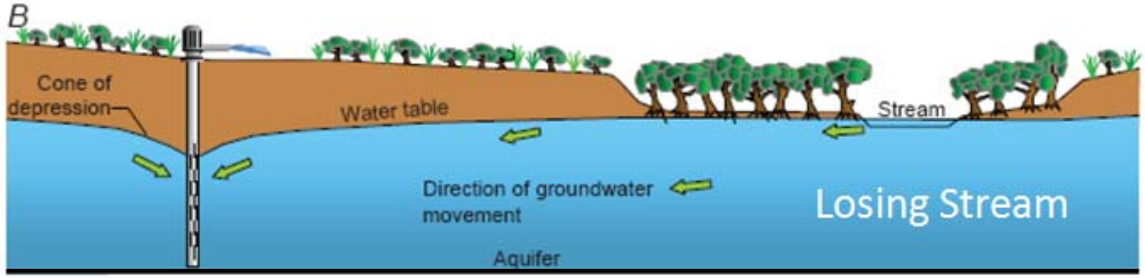
Source: Winter, T.C., J.W. Harvey, Franke, O.L., and W.M. Alley, 1998, Ground Water and Surface Water – A Single Resource, U.S. Geological Survey Circular 1139, Denver, CO.

CAPTURE: Pumping-Induced Source Water for Wells

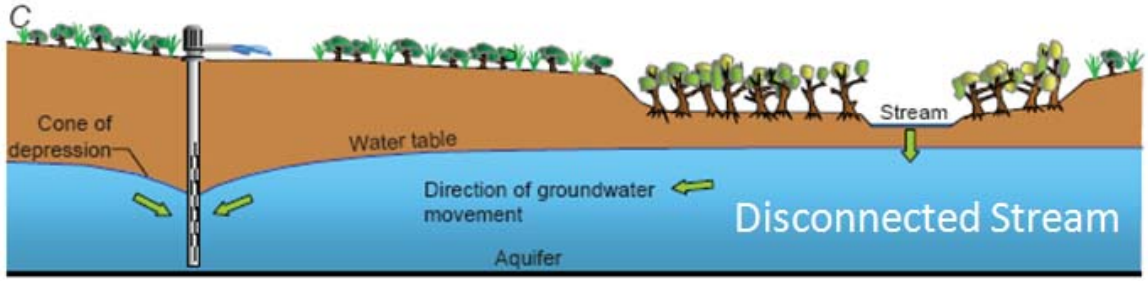
Short-term



Medium-term



Long-term

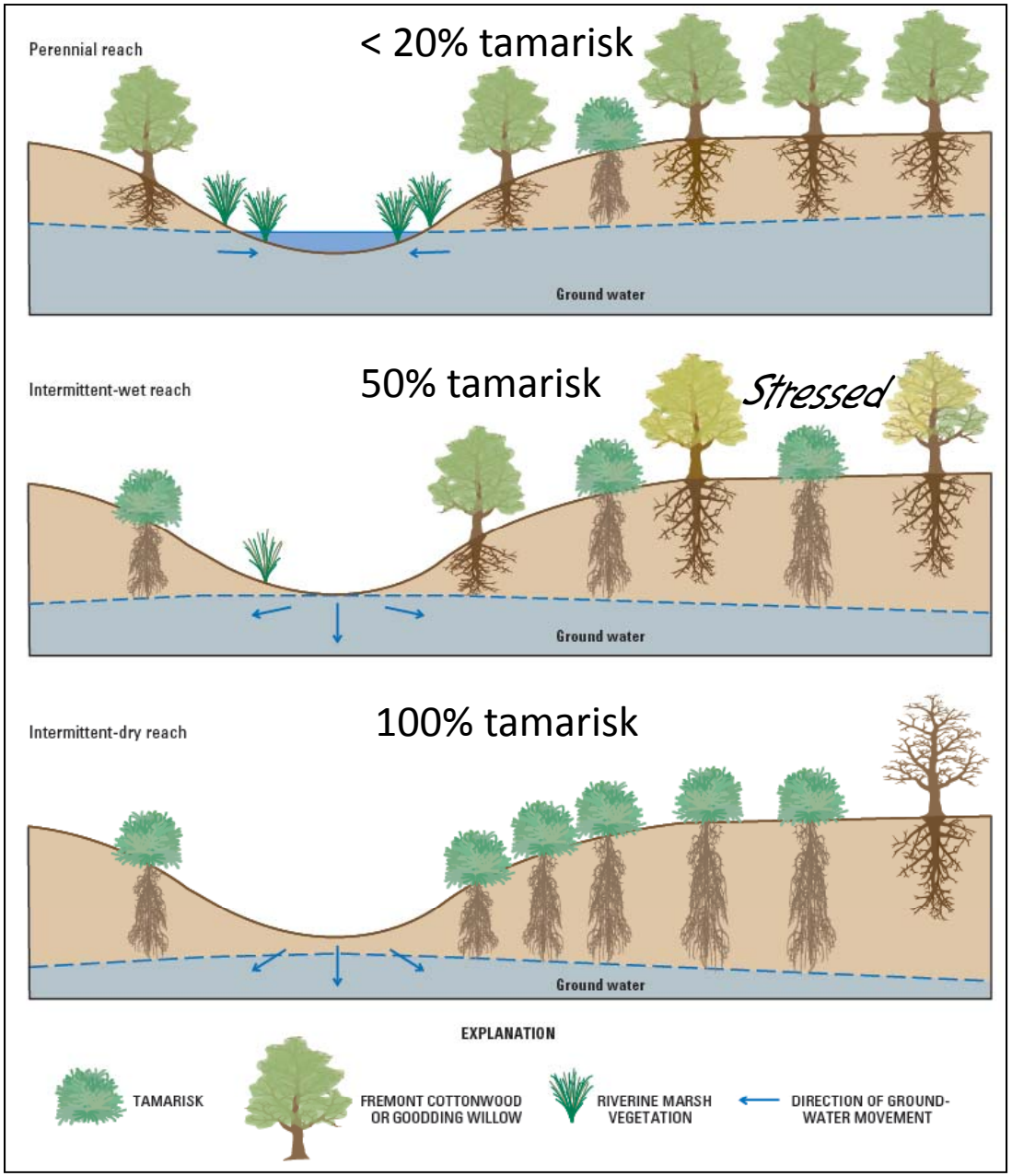


Source: SIR 2010-5147

Gaining

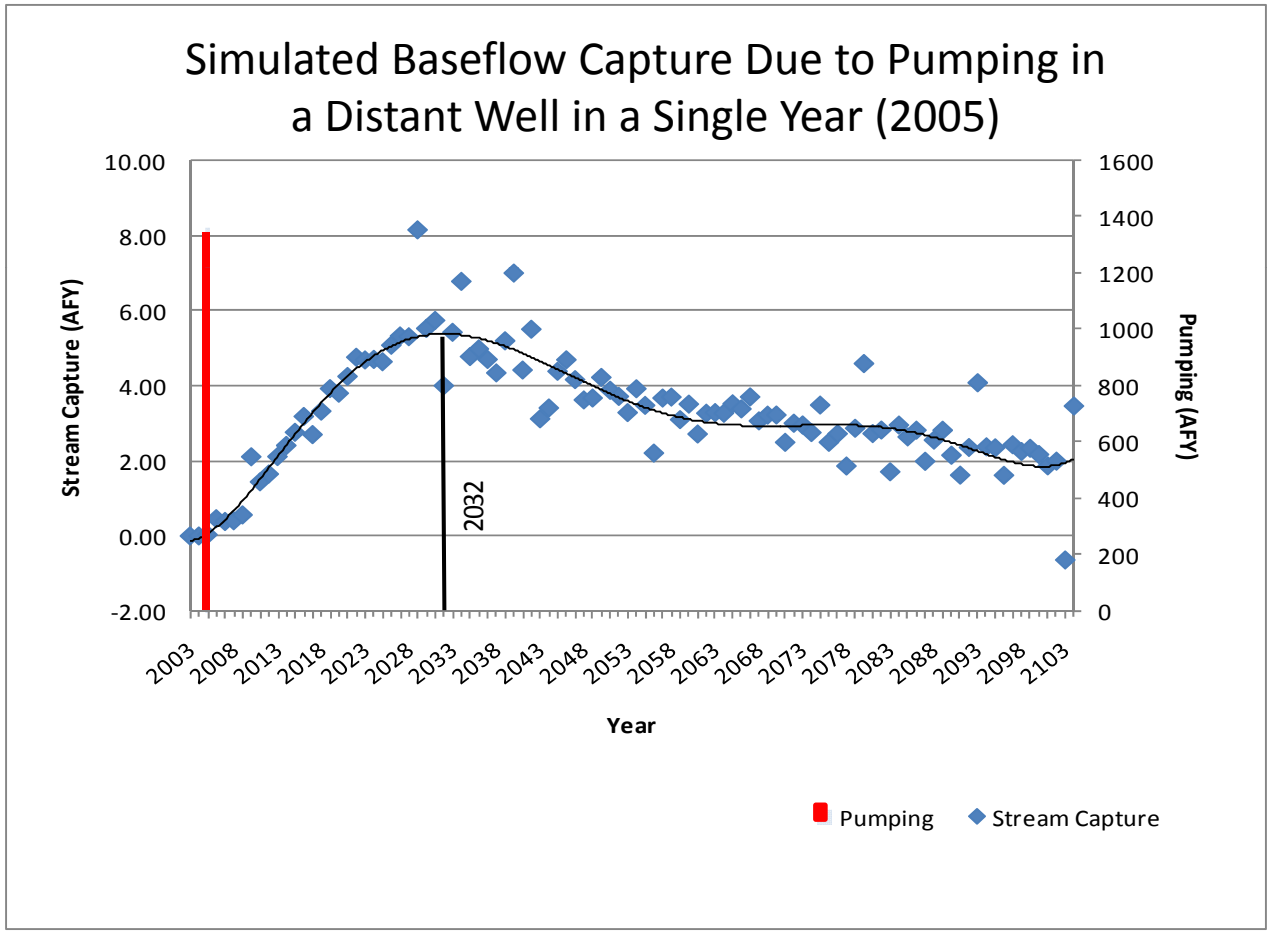
Losing

Disconnected



Source: Stromberg, J.C., Lite, S.J., Dixon, M., Rychener, M. and E. Makings, 2006, Chapter C in USGS SIR 2005-5163.

Effects of Pumping May Continue for a Long, Long Time... Even After Pumping Stops



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Hydrologic Tools for Understanding Water Systems

GROUNDWATER MODELS

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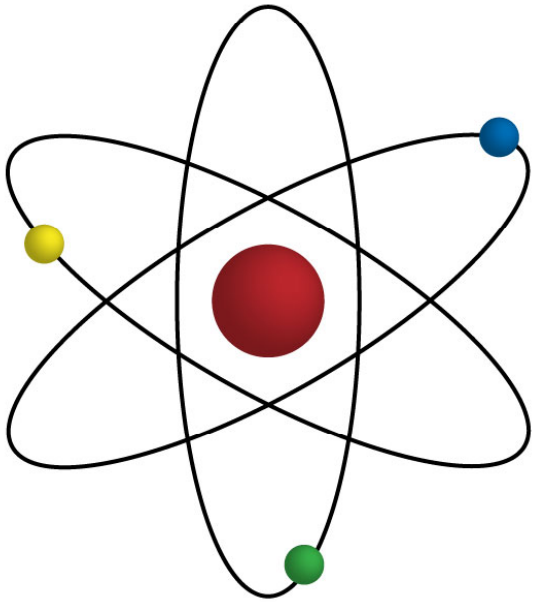
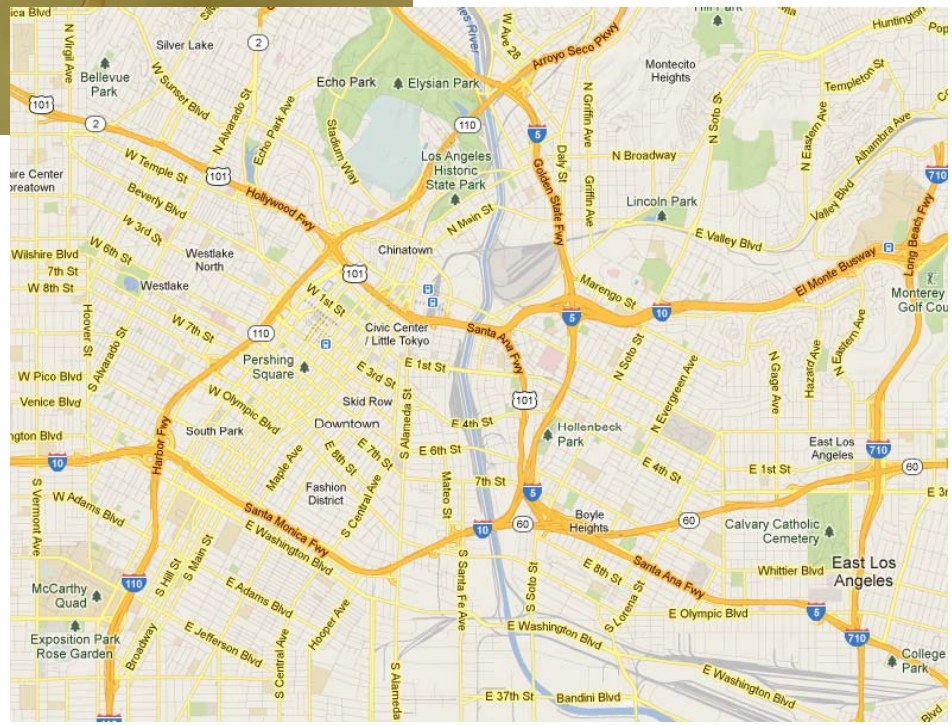
MODEL: A Description or Analogy Used to Help Visualize Something that Cannot be Directly Observed.

-- Merriam-Webster Dictionary definition no. 11





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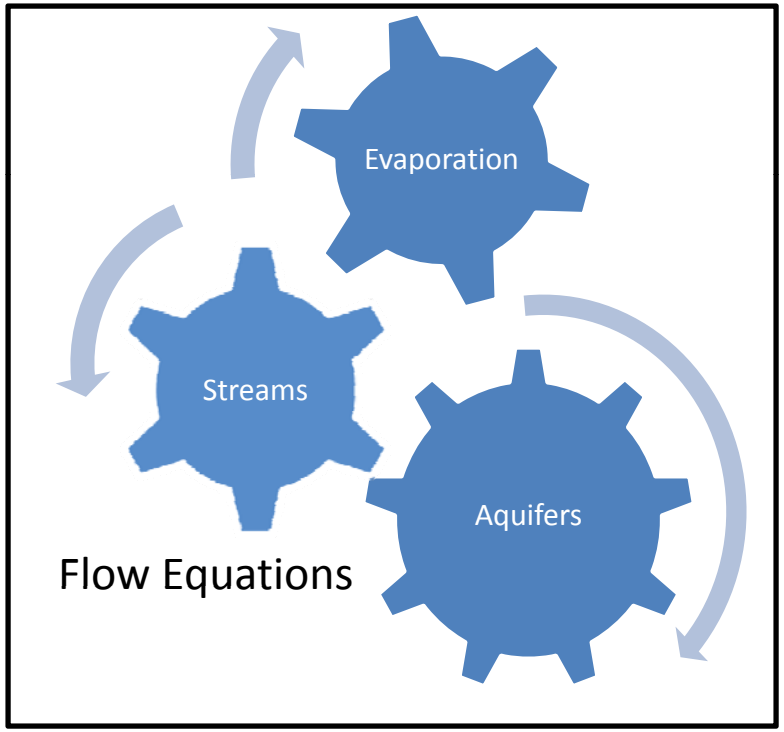
GROUNDWATER MODEL: A Computer Program that Uses Flow Equations to Make Sense of a Complex Natural System.

Numerical Model

INPUT

Pumping,
Stream Diversions,
Evaporative
Demand



OUTPUT

Groundwater
Conditions,
Baseflow,
Evaporative
Consumption

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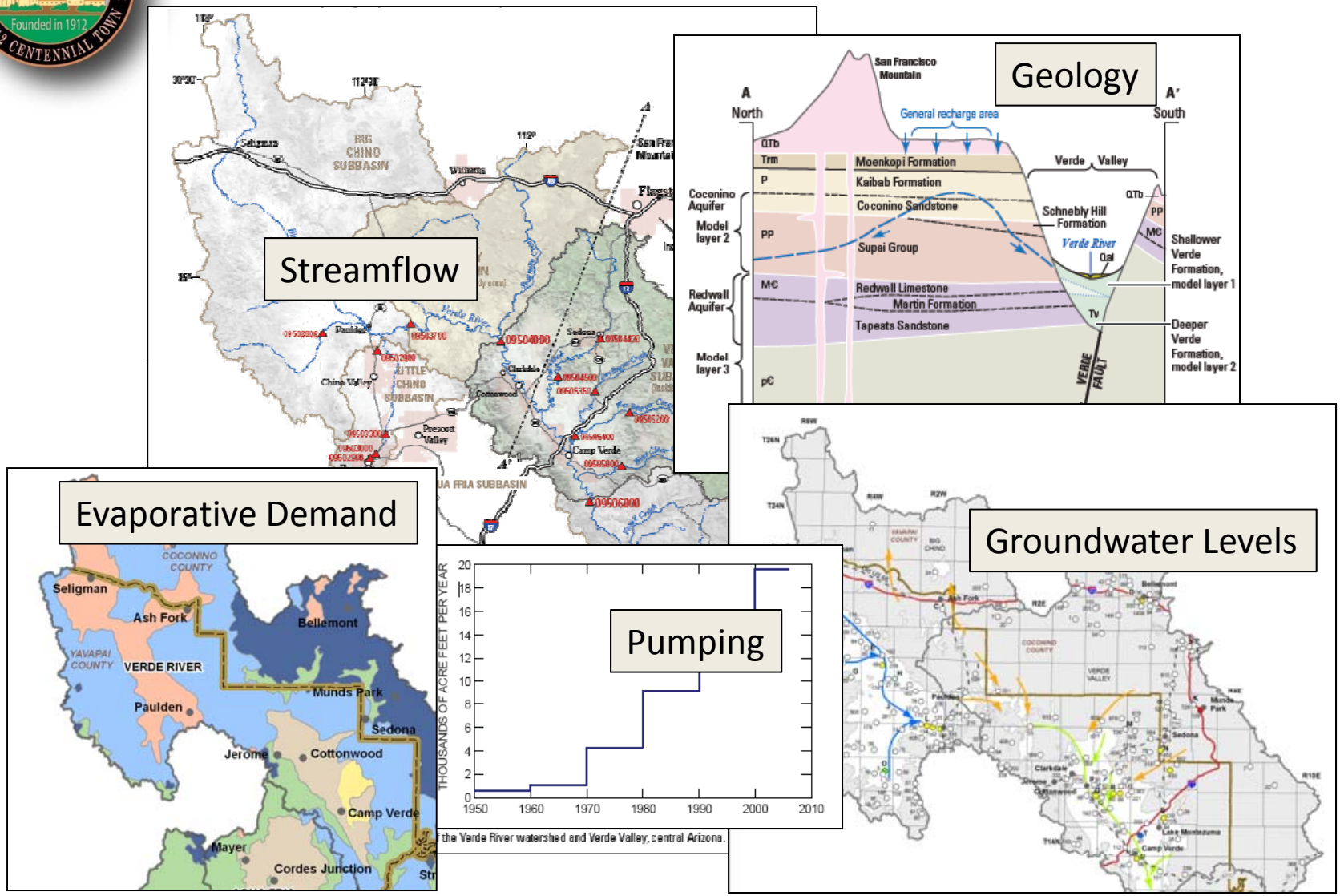
Why Use a Groundwater Model?

- To test the outcome of actions that can't easily be done in real life.
  - future pumping
  - moving wells
  - creating new recharge projects

What We Know About Our System



Lacher Hydrological Consulting

Source: SIR 2013-5029

From Conceptual to Numerical Model

Conceptual

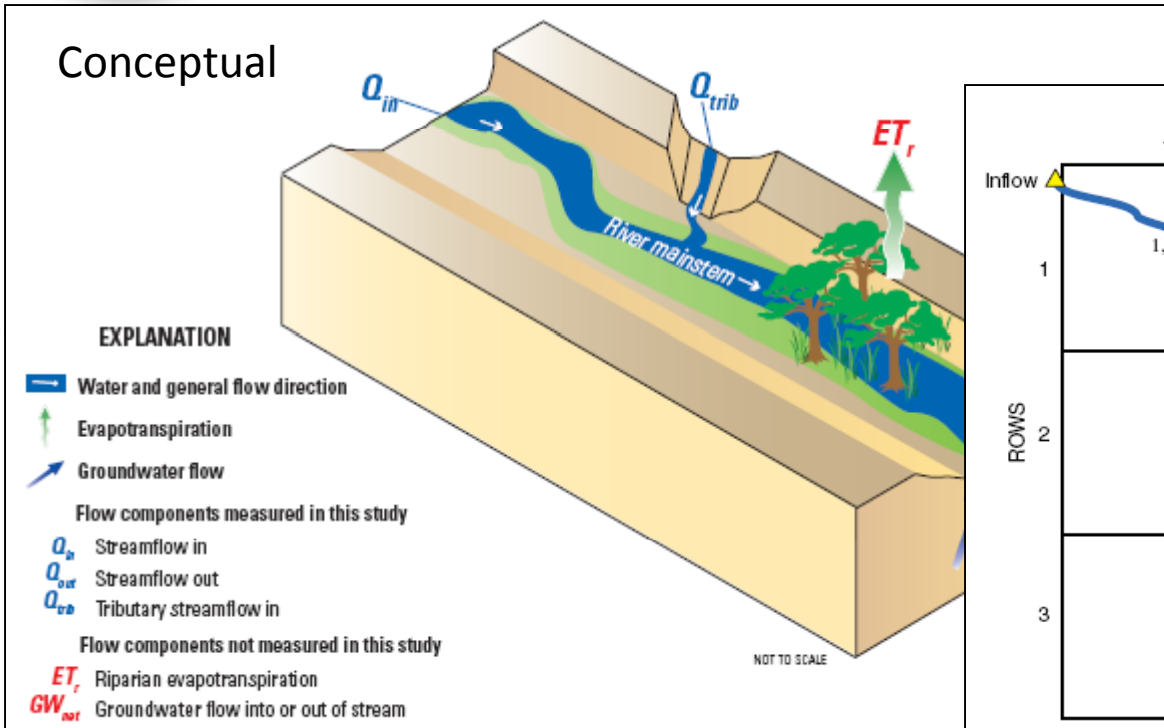
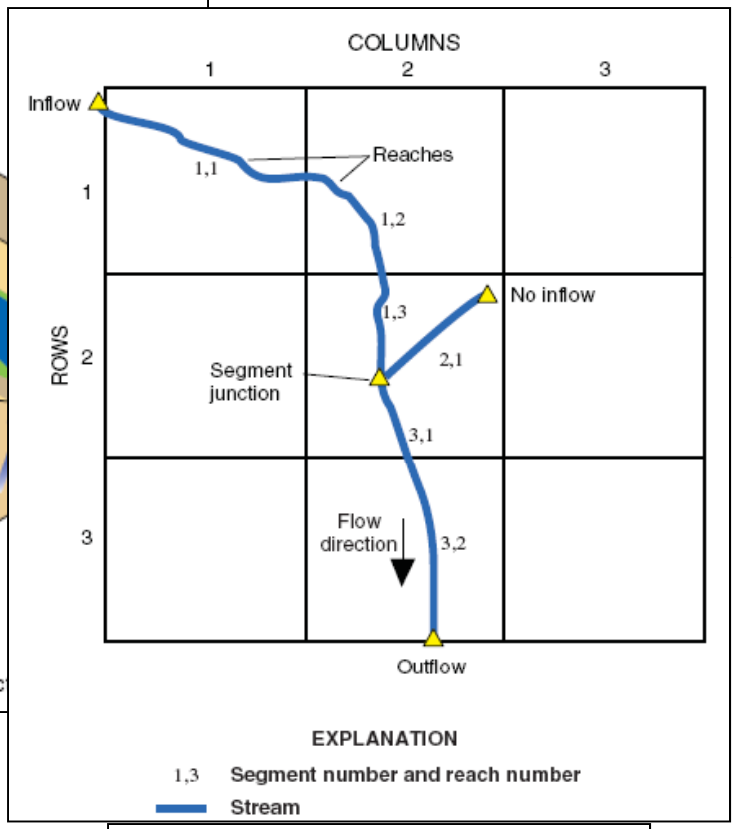


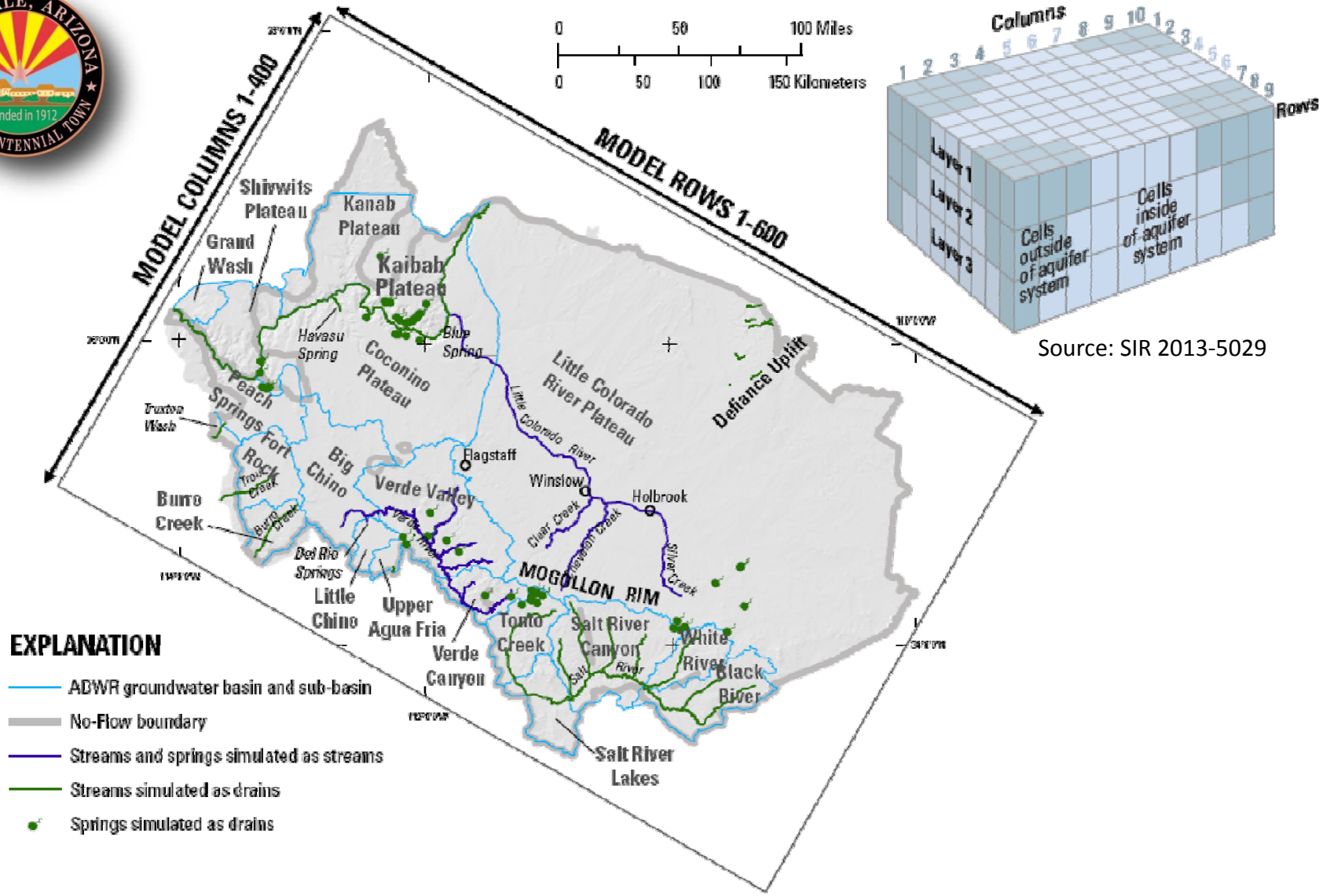
Figure 4. Conceptual diagram of a simple, idealized perennial stream system with no human ac

Source: SIR 2012-5192

Numerical



$$Q_L = \frac{KwL}{m}(h_s - h_a)$$

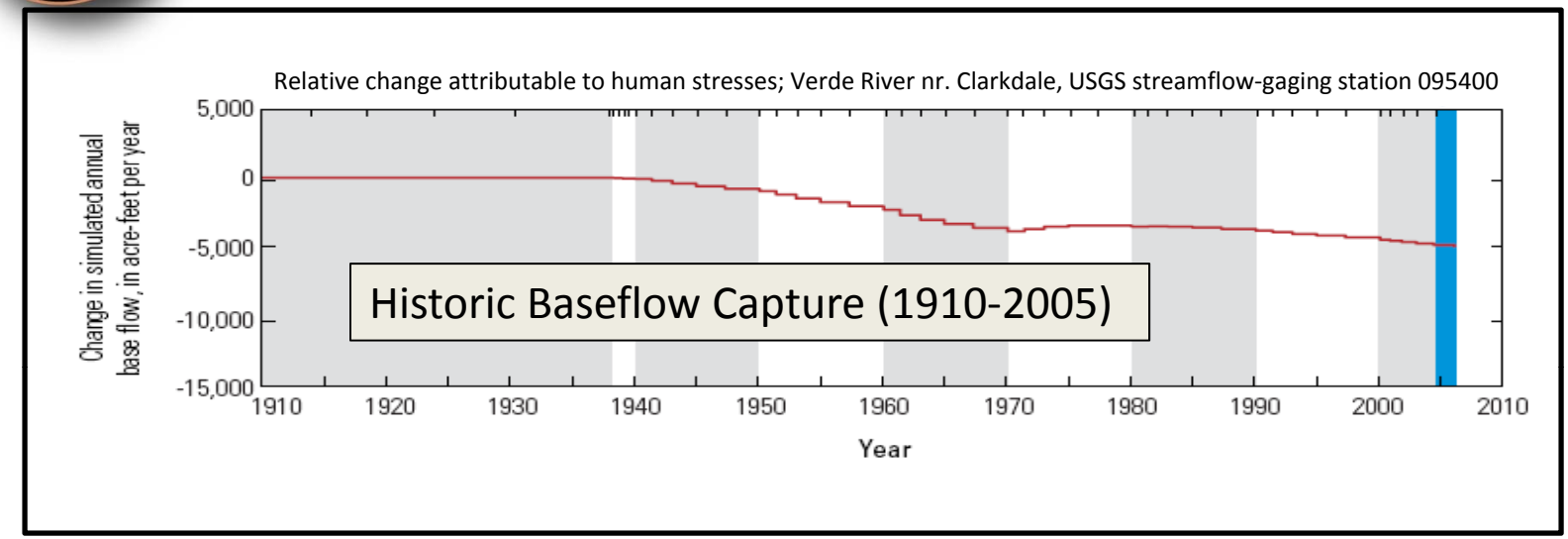


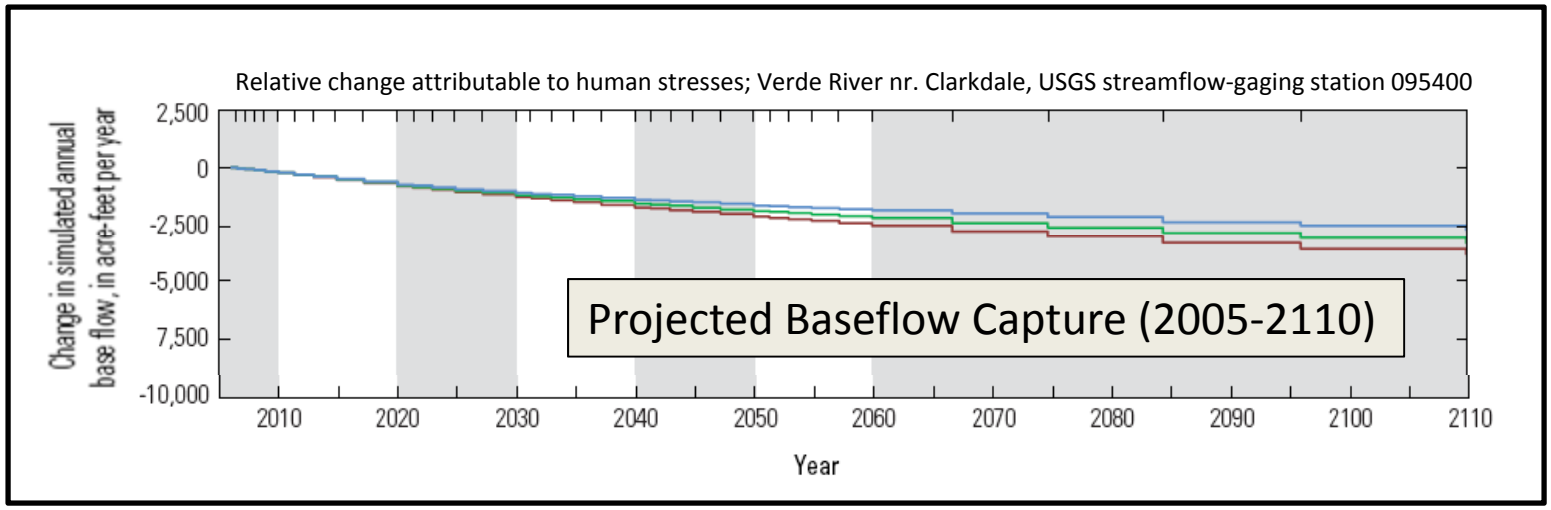
Source: SIR 2013-5029

Figure 11. Boundary conditions for the Northern Arizona Regional Groundwater-Flow Model.

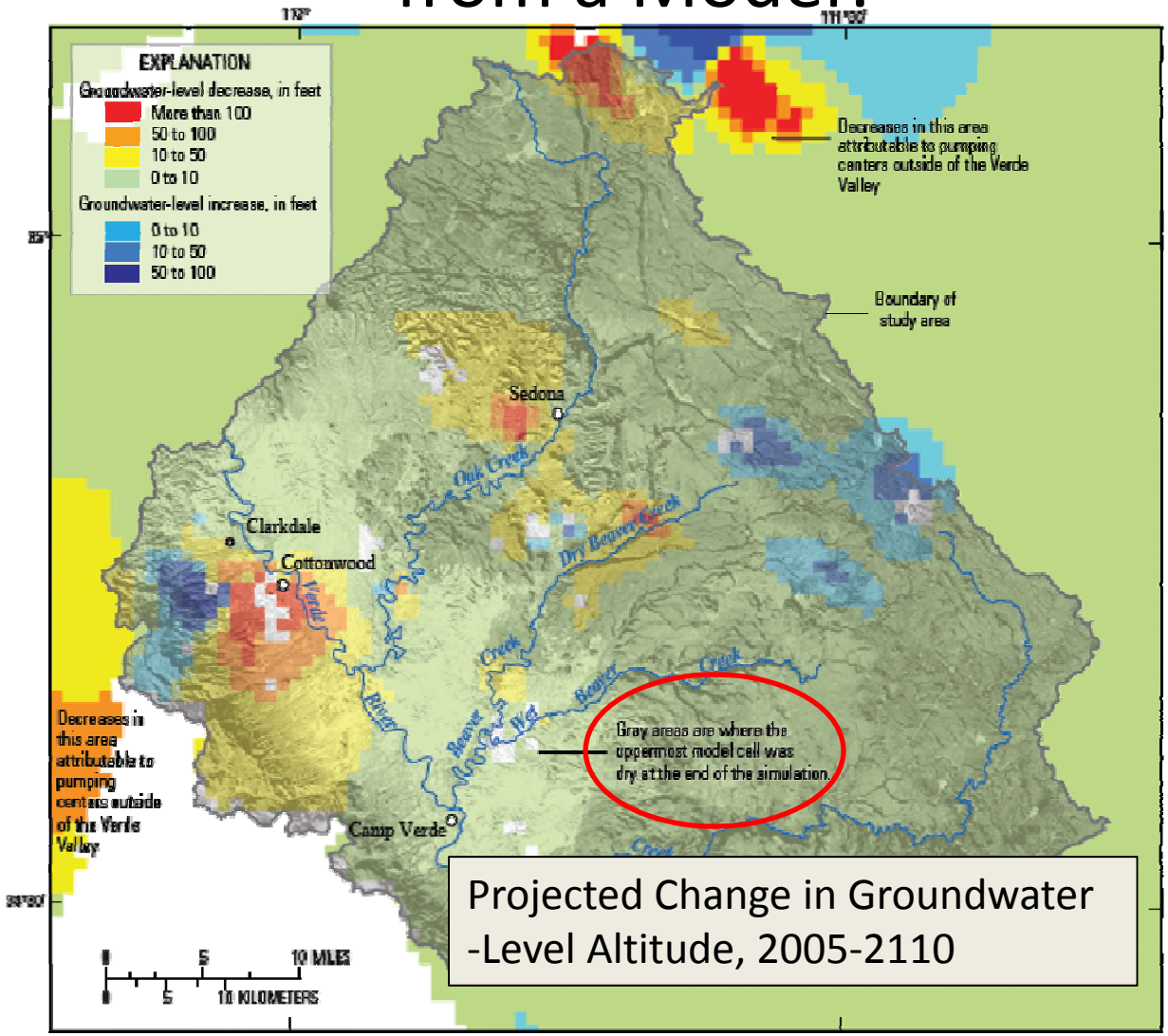
Source: SIR 2010-5180

What Can We Learn About Baseflow From a Groundwater Model?





What Can We Learn About Groundwater from a Model?



Projected Change in Groundwater -Level Altitude, 2005-2110

Source: SIR 2013-5029

Summary and Conclusions

- Groundwater Use Affects Surface Water.
- A Groundwater Model Can Help Guide Water Management Decisions.

Next Time....

- Learn about the Clarkdale Model!
  - purpose
  - methods
  - anticipated outcomes

Thank you!