Big Picture and Local Tribal Water Plans

2013 USGS Tribal Water Resources Class
Grand Casino, Shawnee, Oklahoma

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Filling in the Pieces for Water Planning

What Goes into a Water Plan?

- The answer is specific to the hydrologic system and depends on:
  - Water source demand
  - Availability of water sources
  - Hydrogeologic framework
  - Data Available and Data Gaps
  - We need to look at the system holistically
  - Thus an Integrated Water Resources Plan for Sustainable Management is needed

Identifying possible goals of an integrated water resources management plan

Sustainability goals in accomplishing the economic, ecological, and cultural water needs of Tribal Lands

Possible goals for an integrated water resources management

- Overall goals could be to improve, protect, and increase water sustainability through--
  1. Examining ecological flow conditions
  2. Protecting riparian systems
  3. Increasing use of diverse and integrated regional resources
  4. Increasing reuse
  5. Increasing efficiencies
  6. Increasing aquifer recharge
  7. Protecting and managing groundwater withdrawal

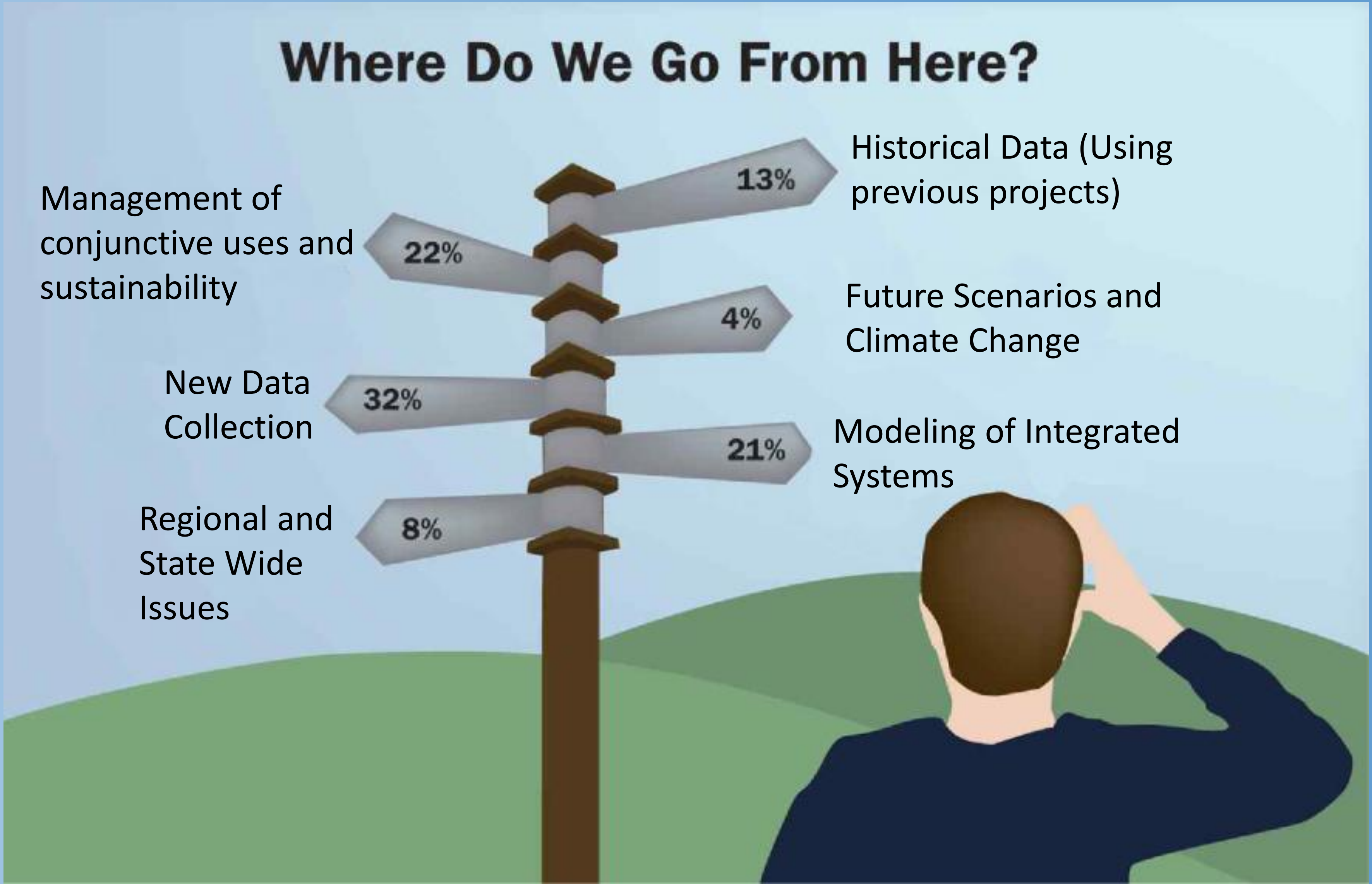
Tribal Water Plan Definition

- A Tribal Water Plan provides a collaborative planning framework for tribal officials, tribal branches of government, water and resource managers, businesses, academia, stakeholders, and the public to develop findings and recommendations and make informed decisions for a tribe's water future.
- Such plans, updated every five years, present the status and trends of a tribe's water-dependent natural resources; water supplies; and agricultural, urban, and environmental water demands for a range of plausible future scenarios.
- A Tribal Water Plan also evaluates the effects of different combinations of regional and statewide resource-management strategies to reduce water demand, increase water supply, reduce flood risk, improve water quality, and enhance environmental and resource stewardship.

What is the Role Of Science in Water Planning?

- Science is the foundation for credible decision making (U.S. EPA Office of Science and Policy)
- Science is non-advocacy.
- Science is one of the <u>several tools</u> that society uses to provide information needed to identify and answer questions.
- USGS is DOI's water science bureau (more later).

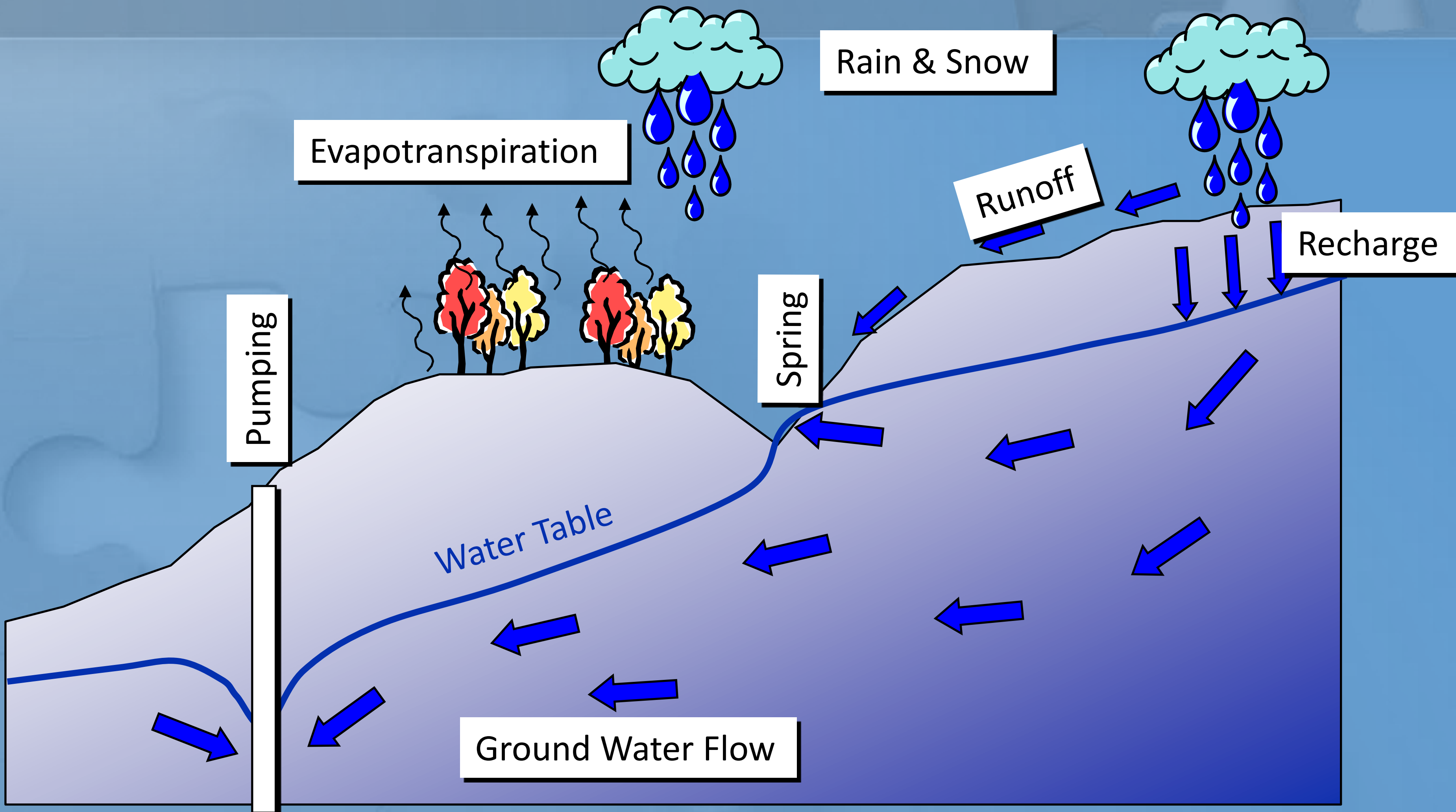
Implementation of Resources (Dollars)



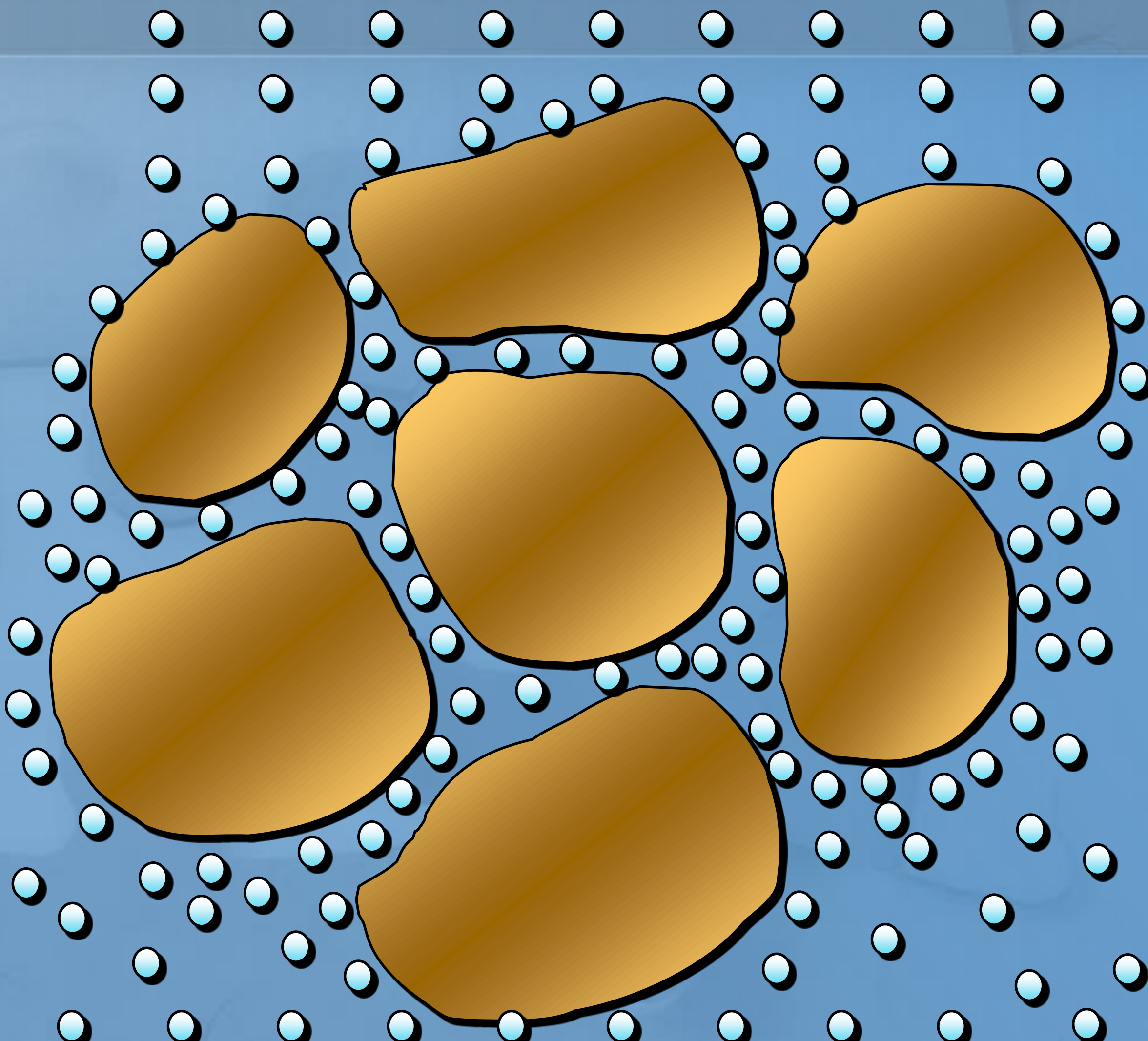
Review of Concepts

- Hydrologic Cycle
- Porosity Types
- Aquifer Types
- Stream Types
- Groundwater/Surface Water Interaction
- Groundwater/Lake Water Interaction

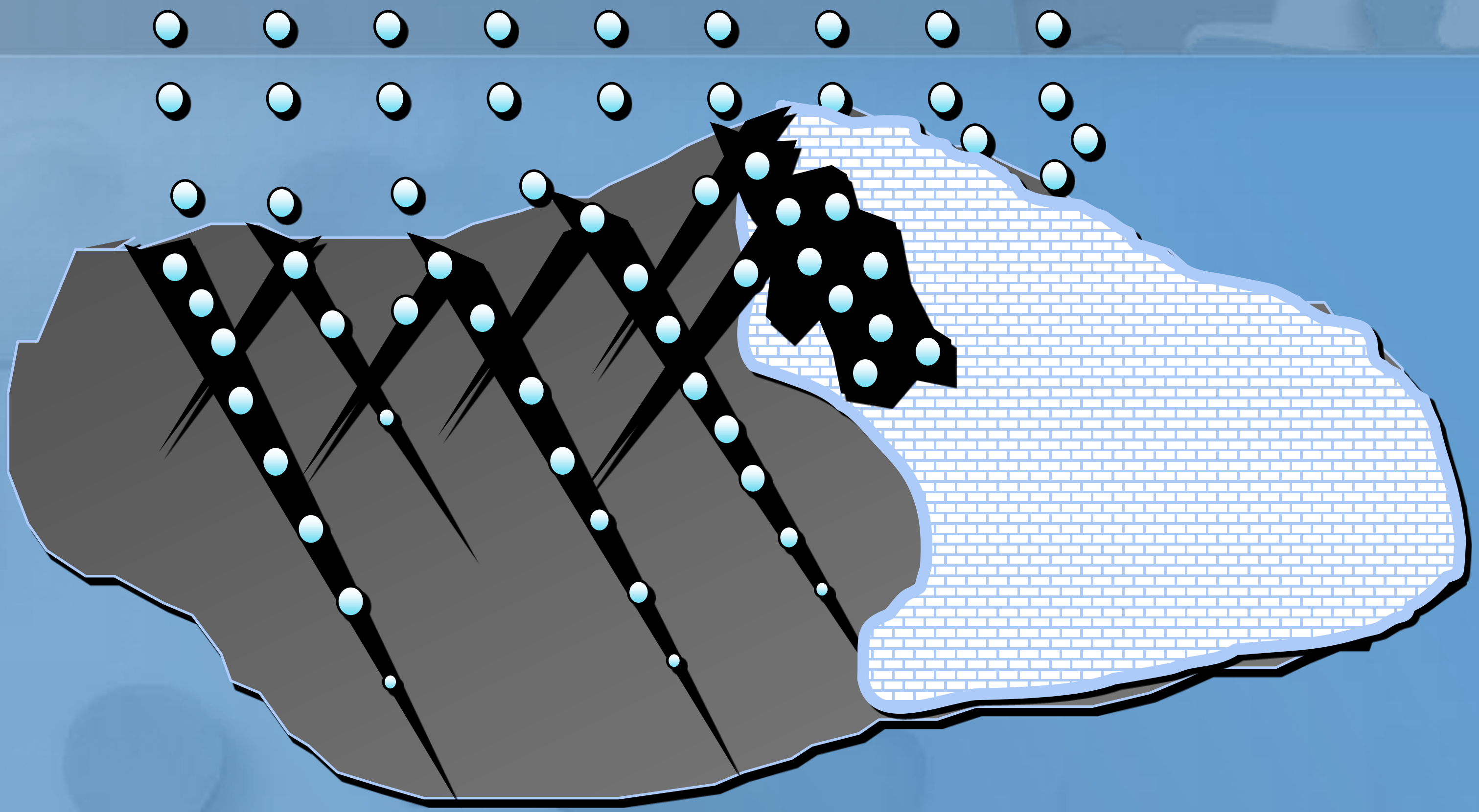
Hydrologic Cycle



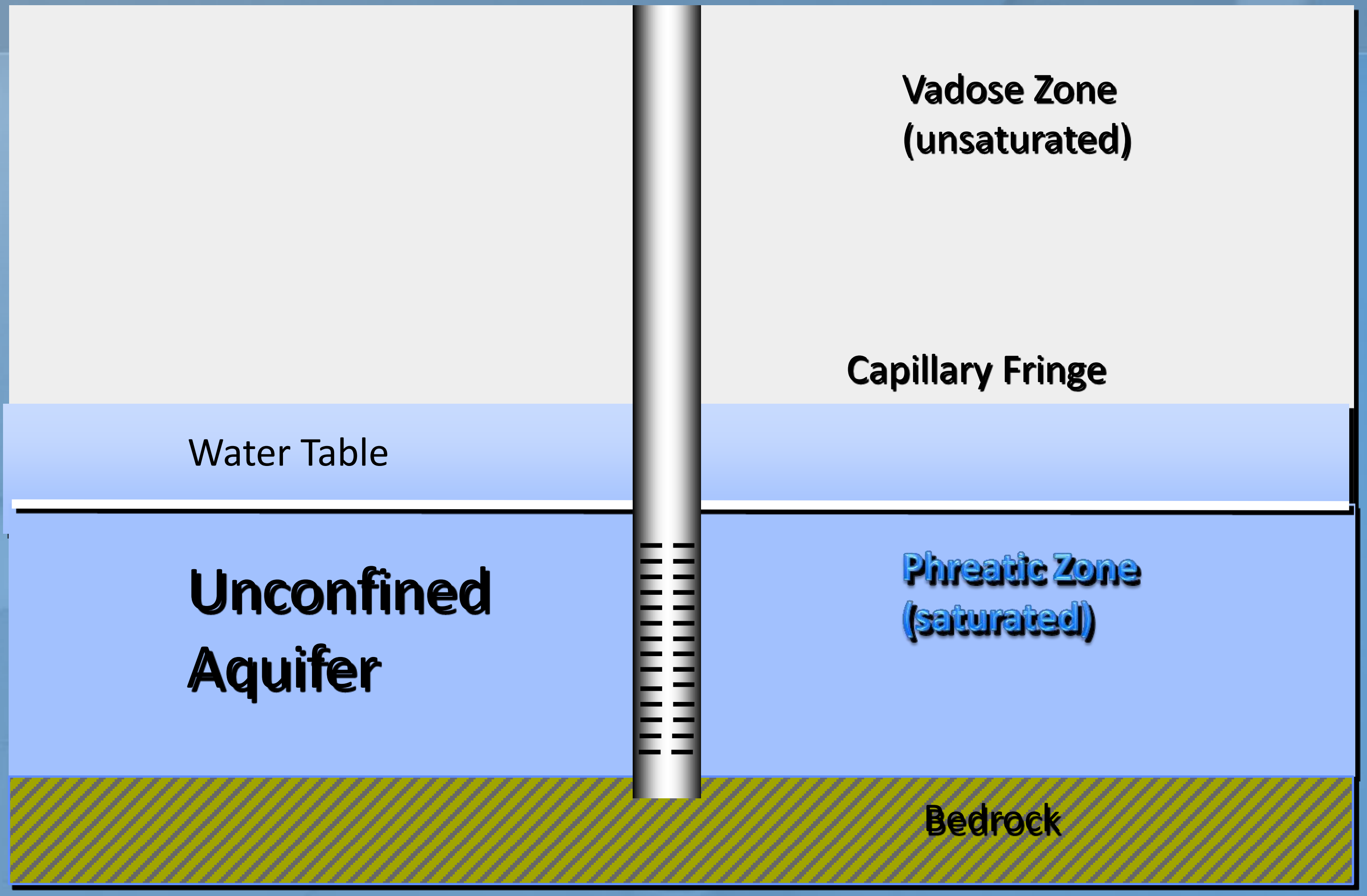
Primary Porosity



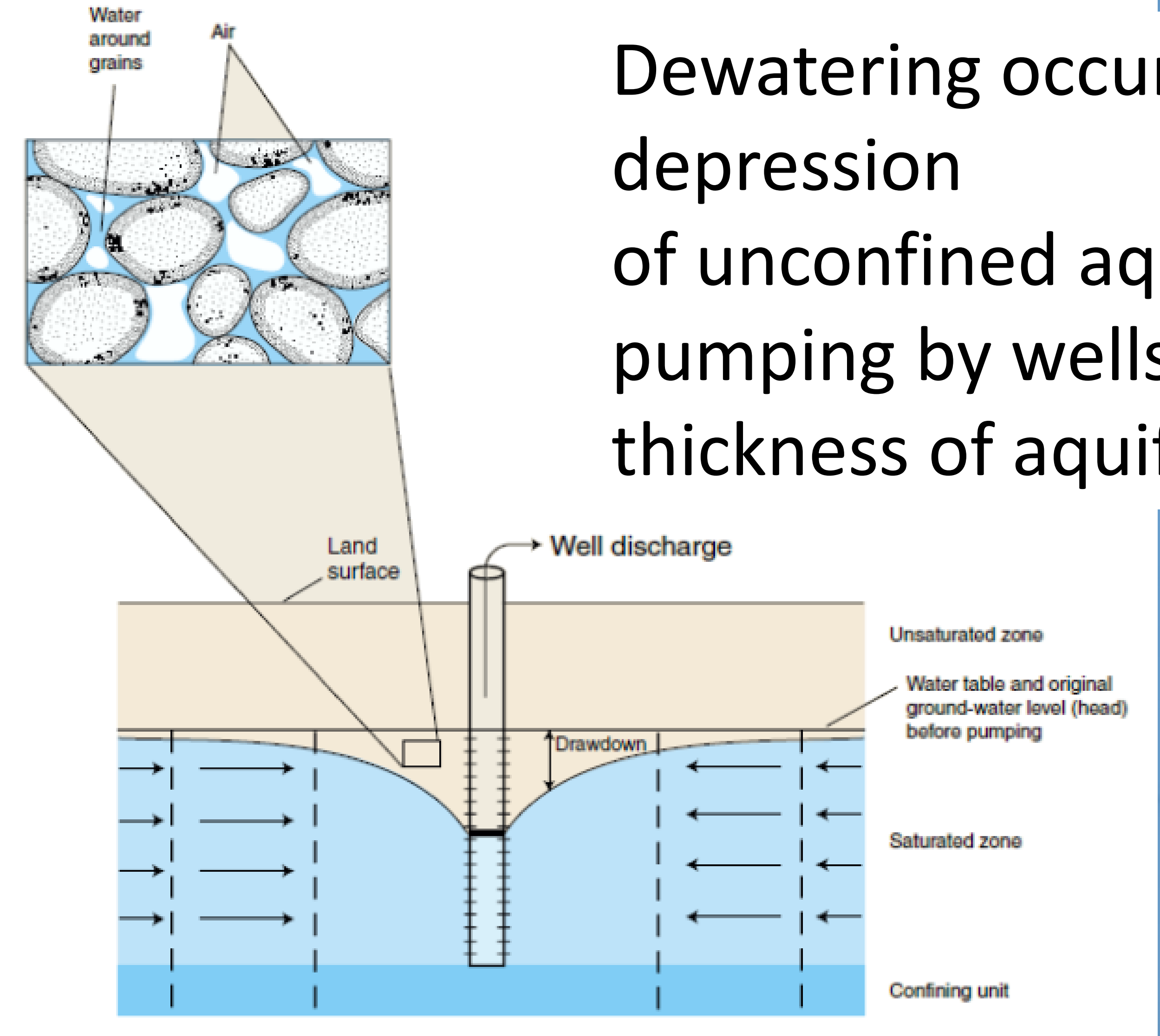
Secondary Porosity (Hard Rock Aquifers)



Saturated And Unsaturated



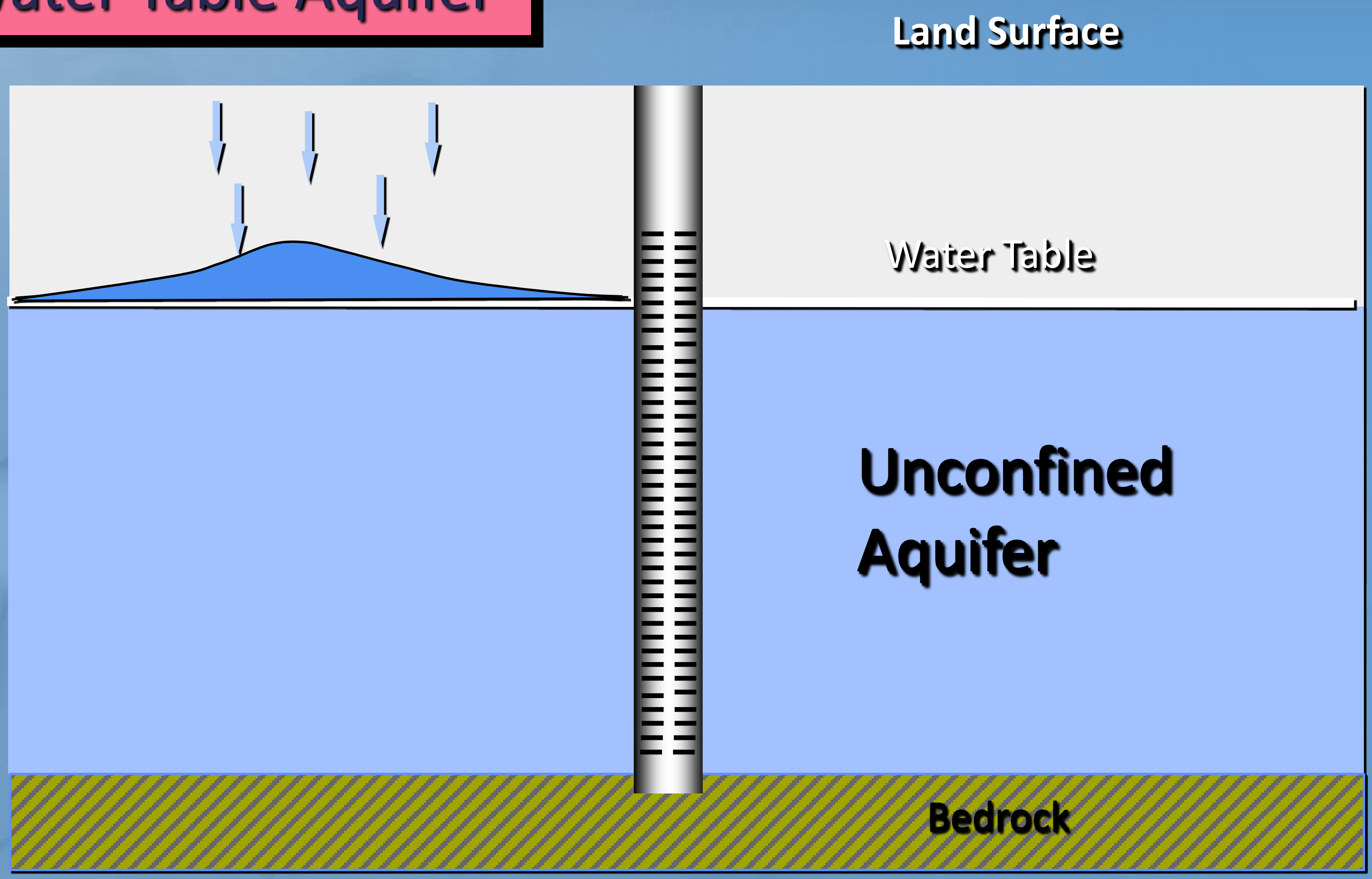
Pumping a single well in an idealized unconfined aquifer.



Dewatering occurs in cone of depression
of unconfined aquifers during pumping by wells (saturated thickness of aquifer decreases).

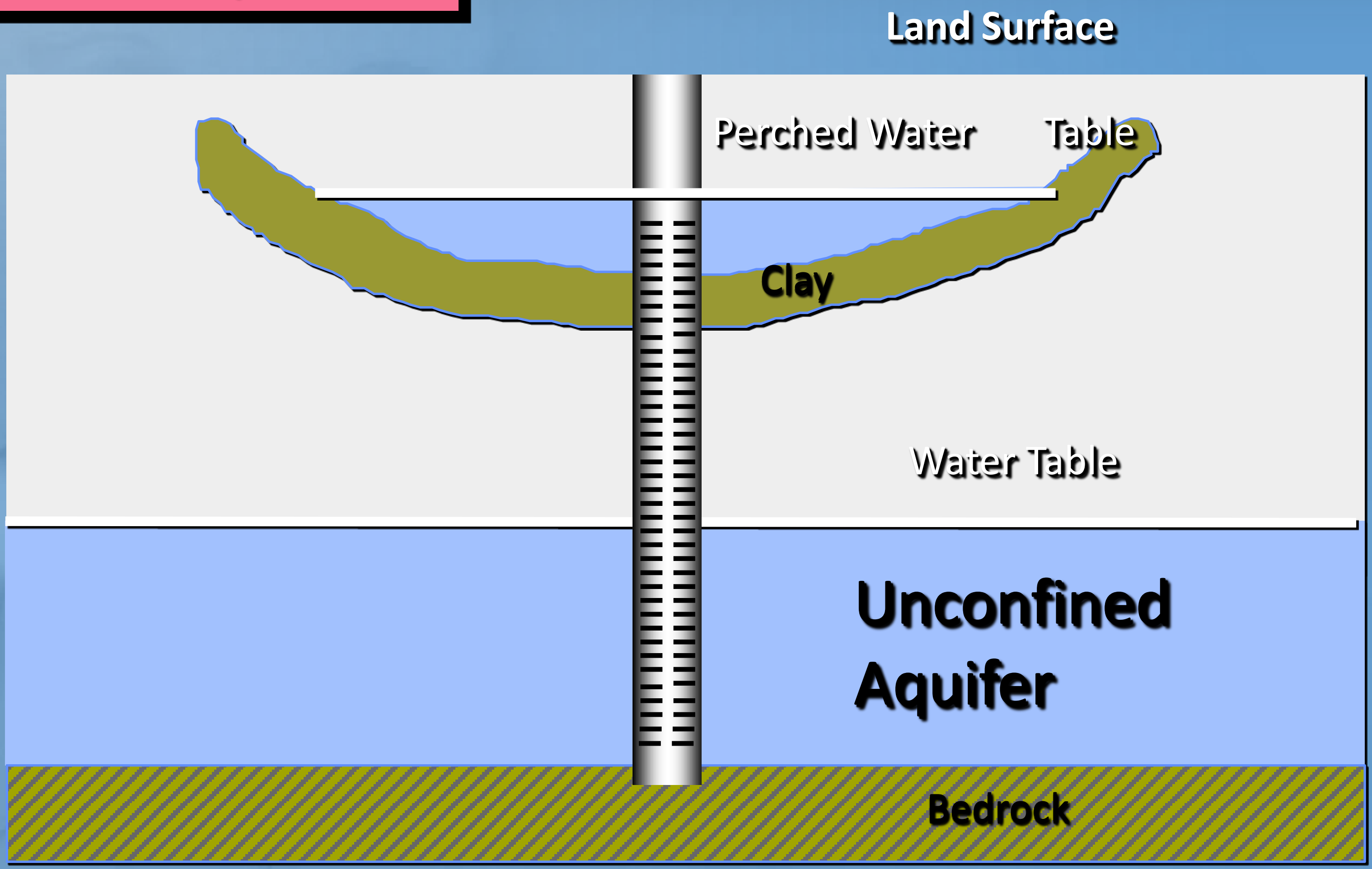
Aquifer Types

Water Table Aquifer



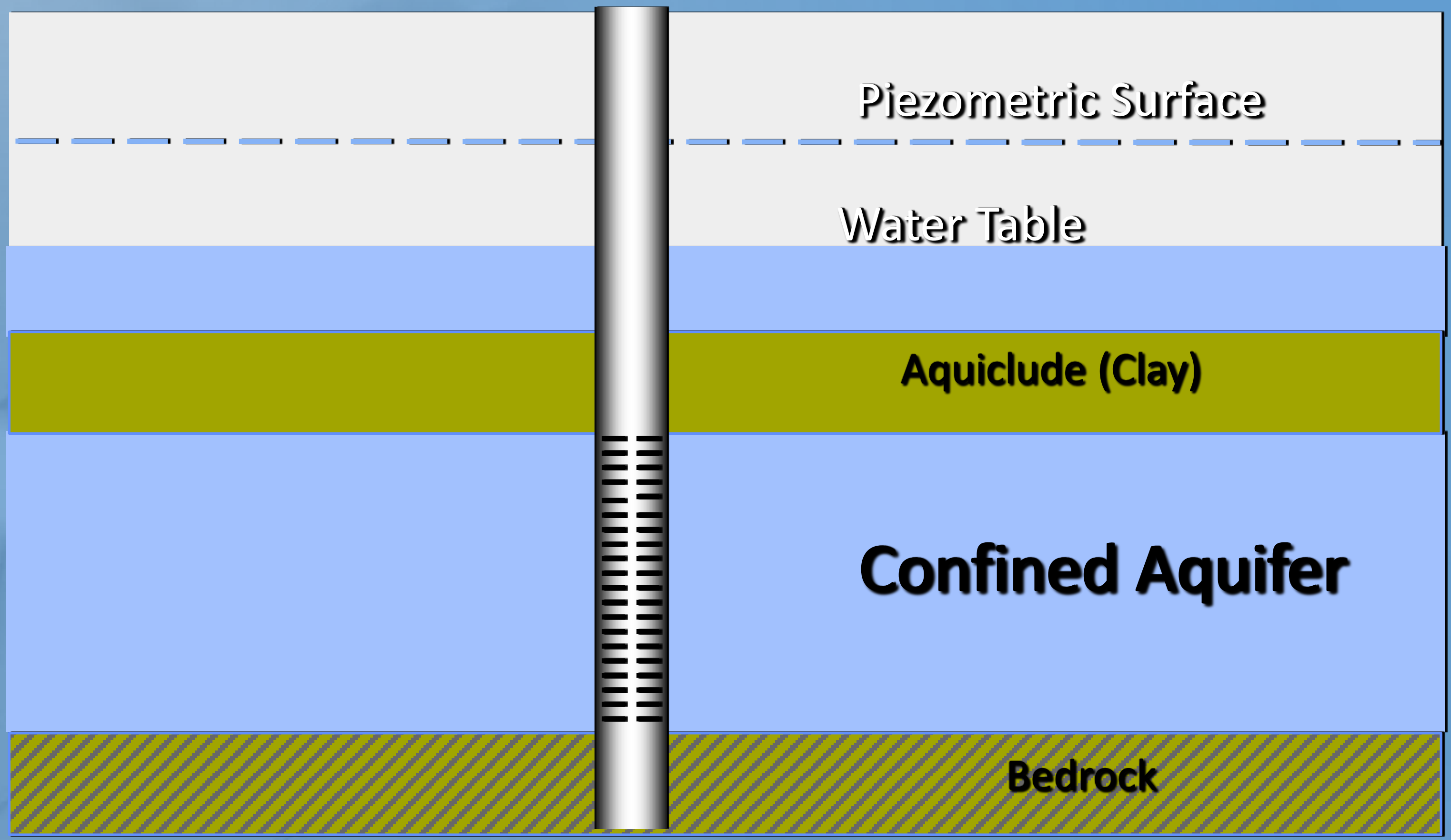
Aquifer Types

Perched Aquifer

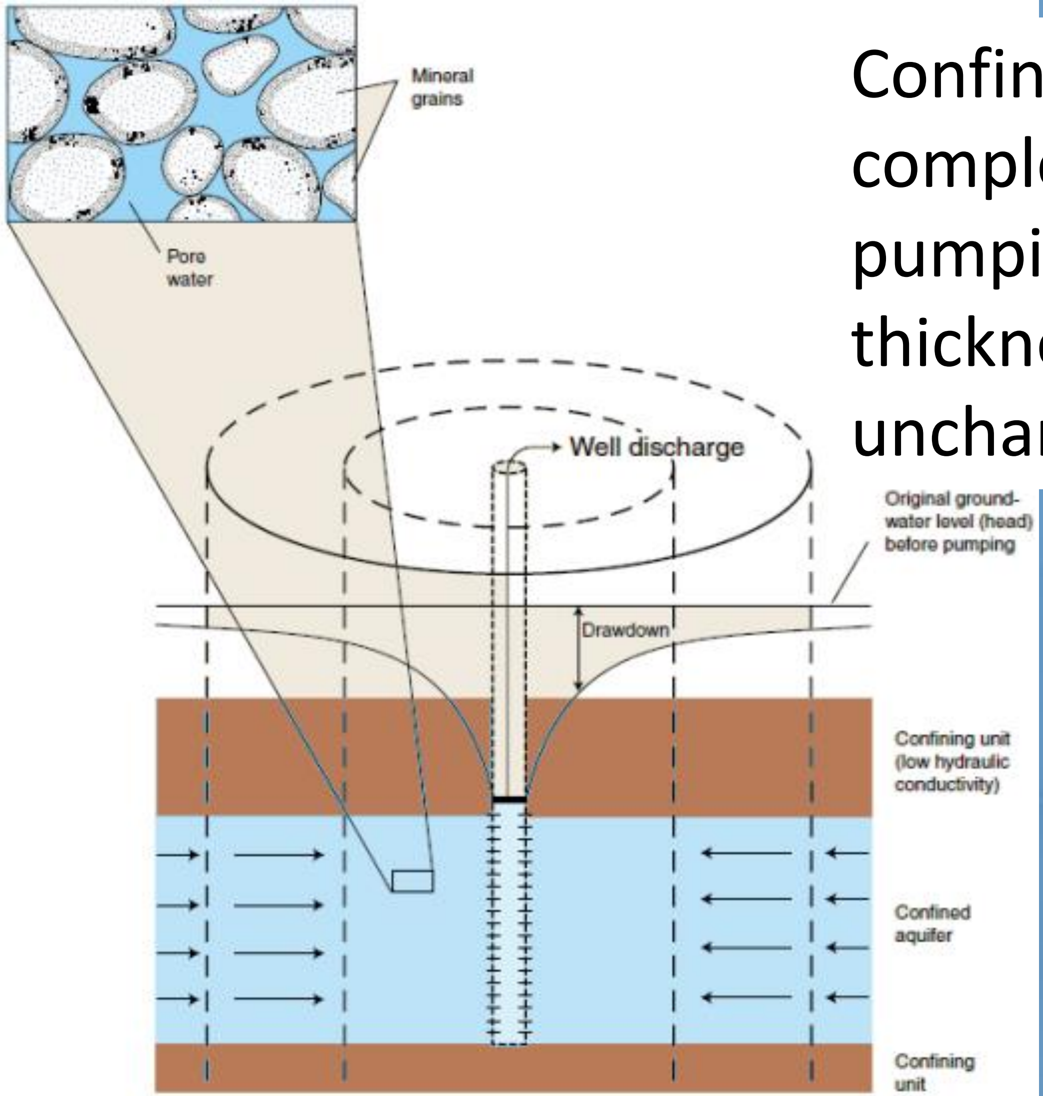


Aquifer Types

Artesian Aquifer



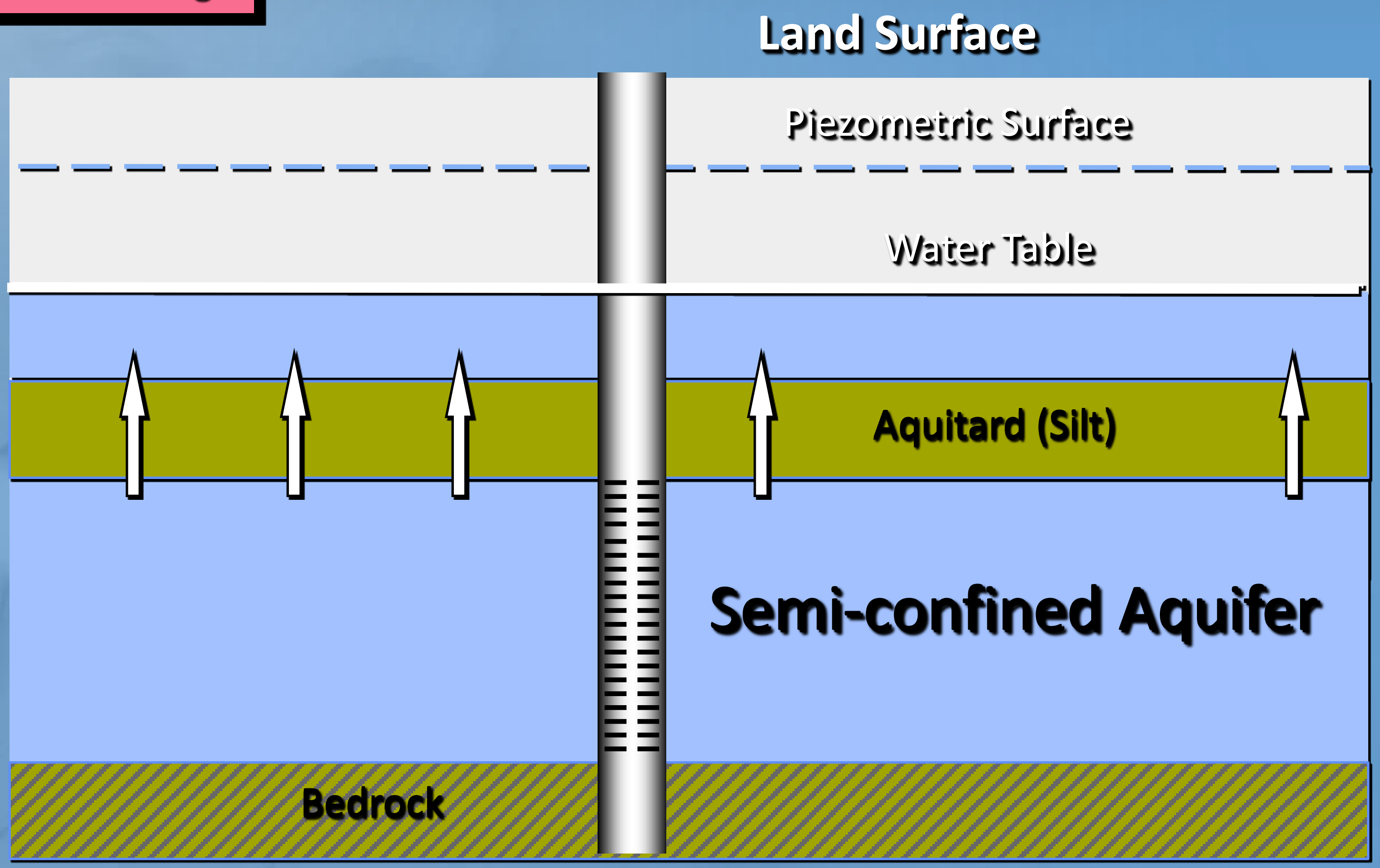
Pumping a single well in an idealized confined aquifer.



Confined aquifers remain completely saturated during pumping by wells (saturated thickness of aquifer remains unchanged).

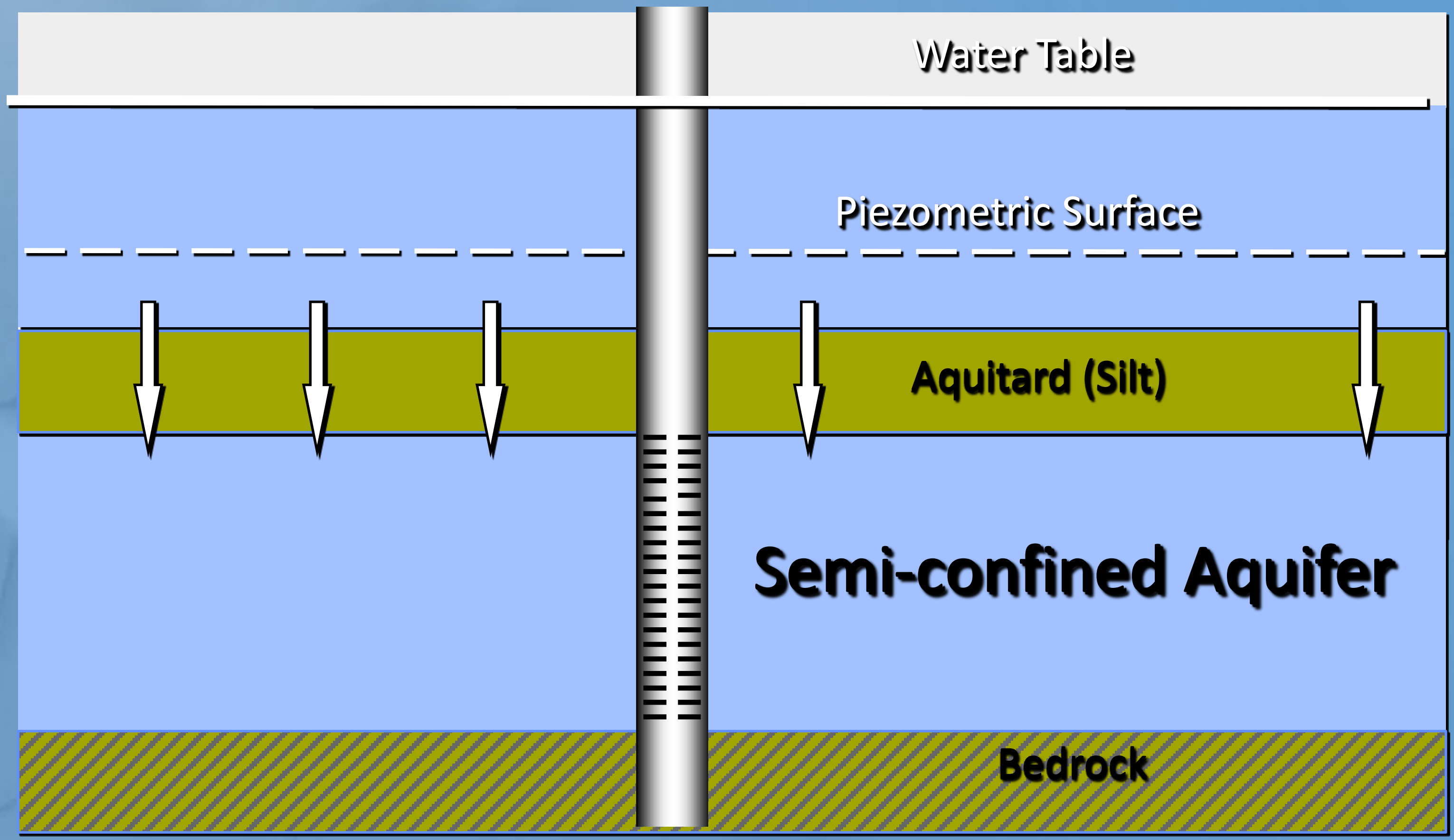
Leaky Aquifer

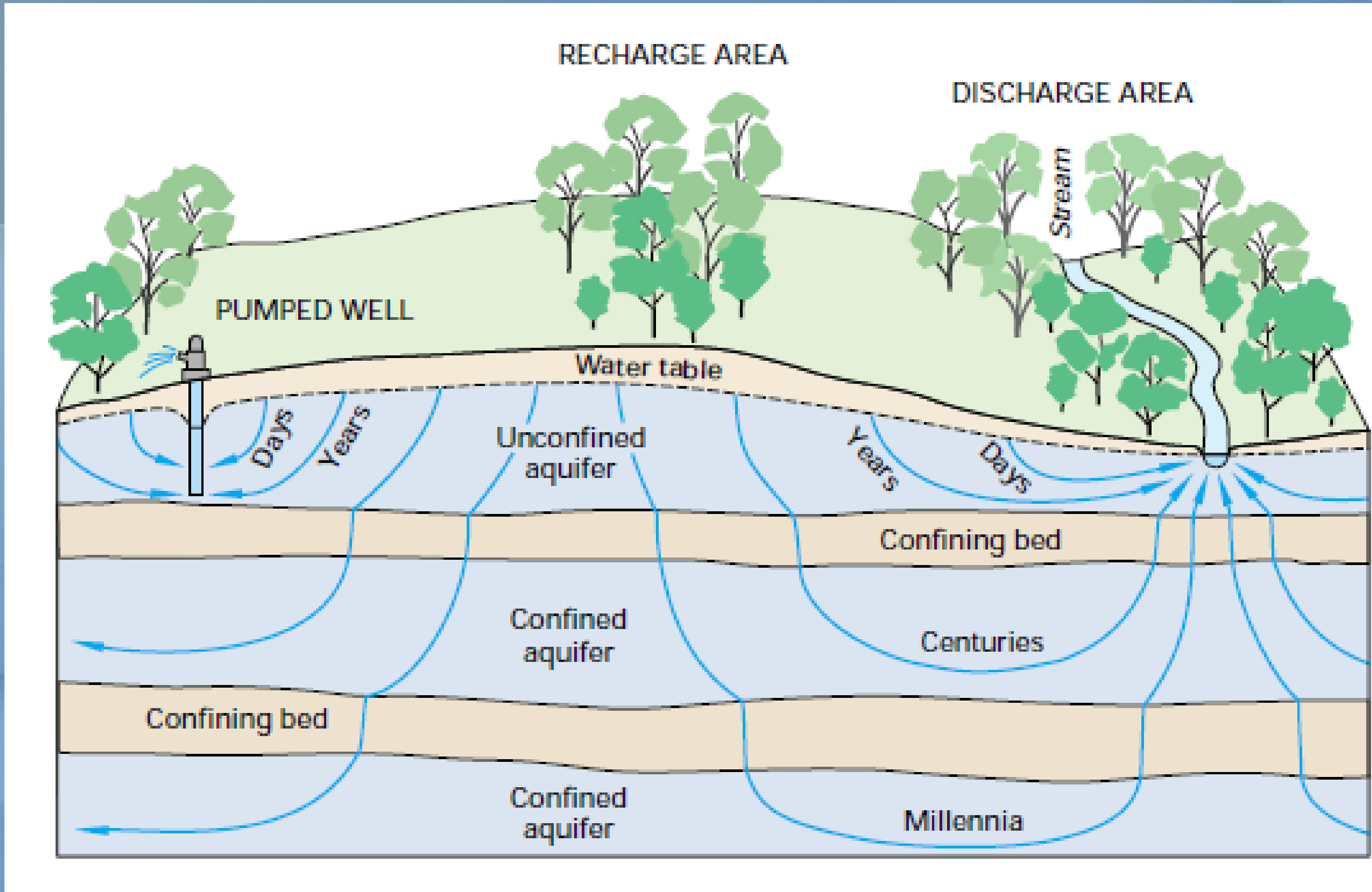
Upward Leakage



Leaky Aquifer

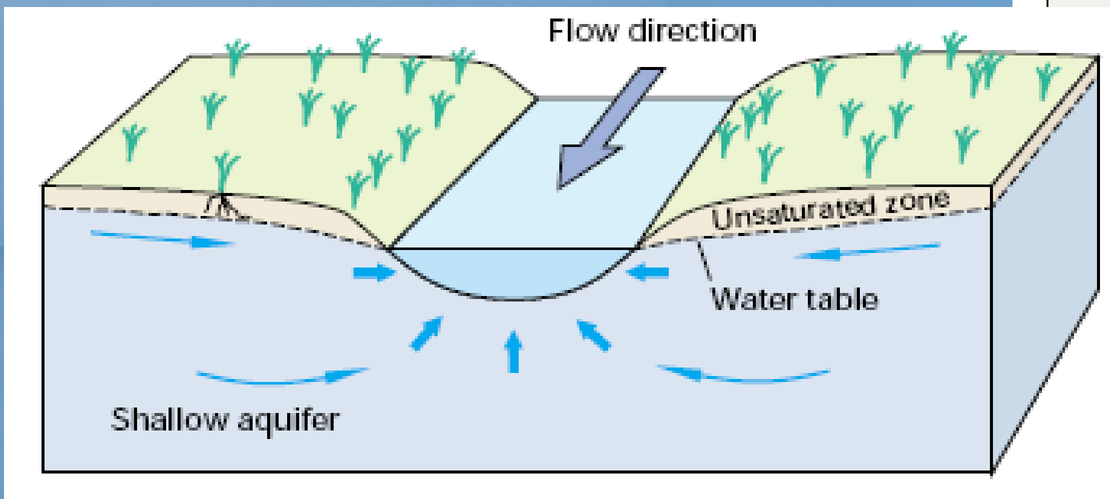
Downward Leakage

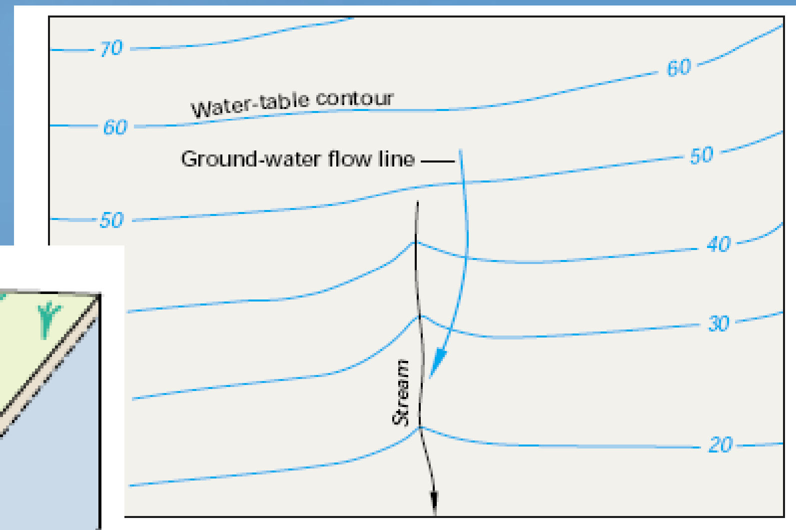




Groundwater flow paths vary in length, depth, and travel time from points of recharge to points of discharge.

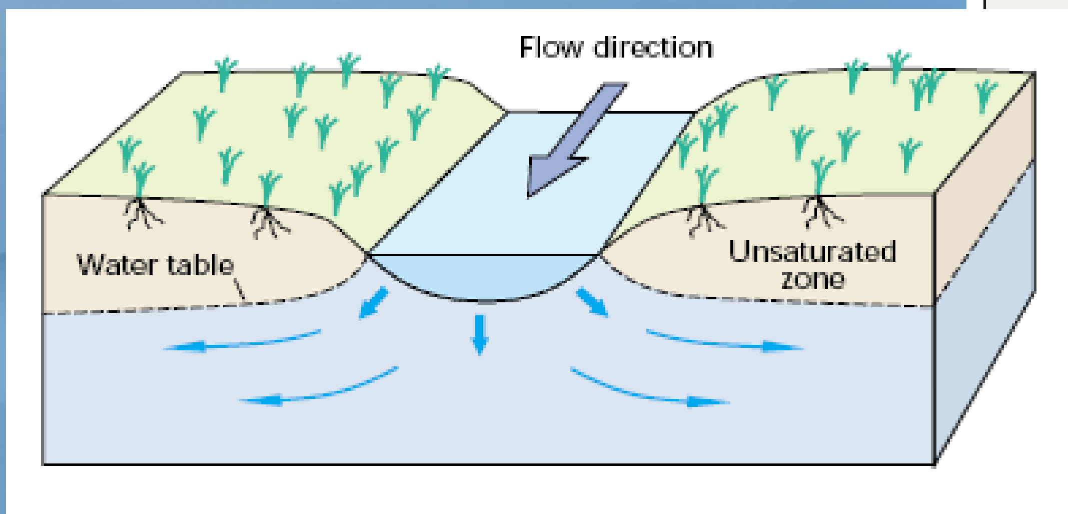
Interaction of Groundwater and Streams: Gaining Streams

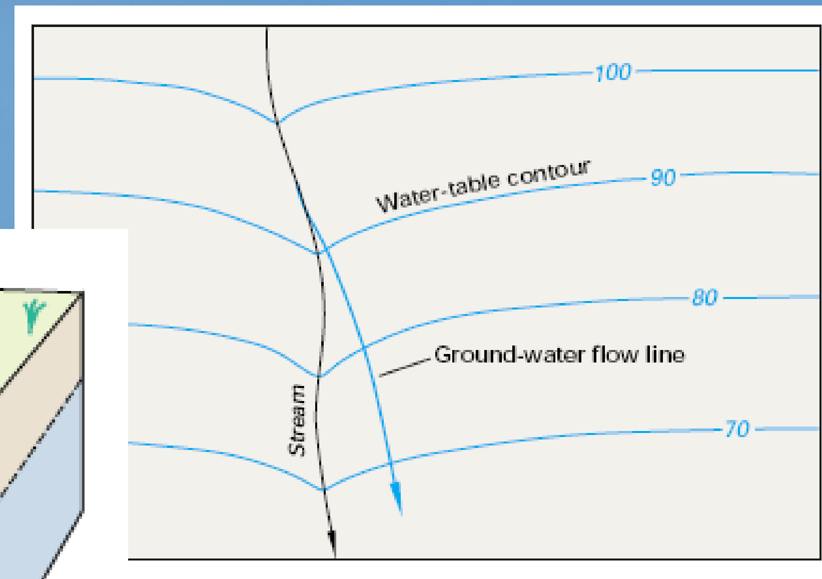




Gaining streams receive water from the groundwater system. Contour lines point in the upstream direction where they cross the stream.

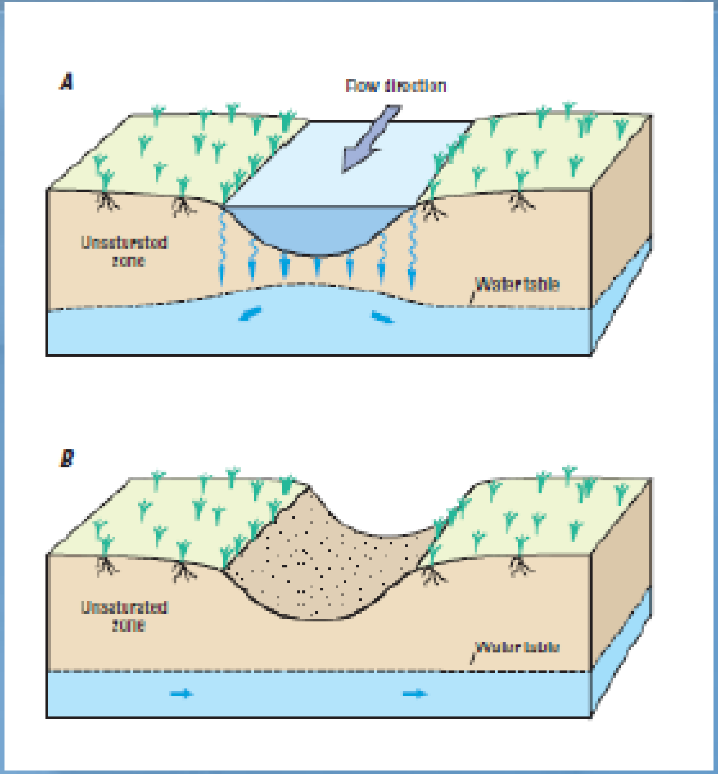
Interaction of Groundwater and Streams: Losing Streams





Losing streams lose water to the groundwater system. Contour lines point in the downstream direction where they cross the stream. Here, the stream is underlain by a saturated zone.

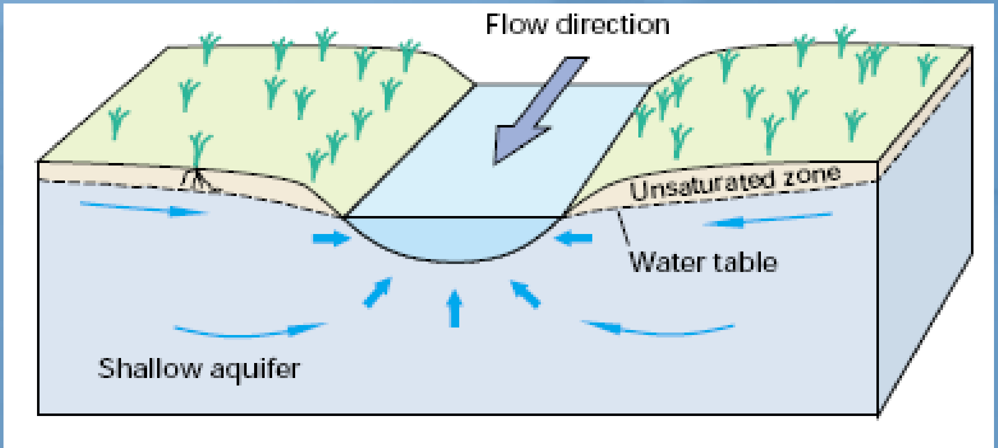
Interaction of Groundwater and Streams: Disconnected Streams



Disconnected streams are separated from the groundwater system by an unsaturated zone. In (A), streamflow is a source of recharge; in (B) streamflow and recharge have ceased.

Partially and Fully Penetrating Streams

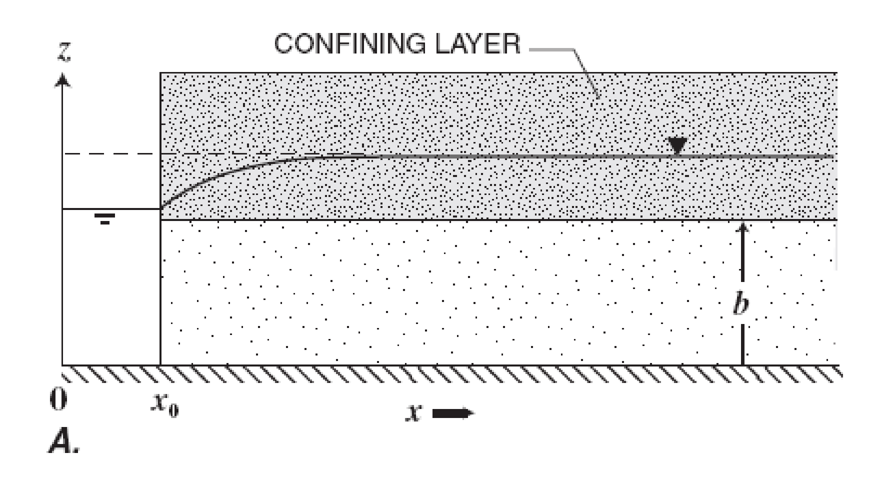
- Most streams are shallow relative to the thickness of the aquifer in which they lie. Such streams often are referred to in the literature as partially penetrating streams.
- Seepage between a partially penetrating stream and the contiguous aquifer occurs both horizontally and vertically through streambank and streambed materials:



A shallow stream that partially penetrates an aquifer.

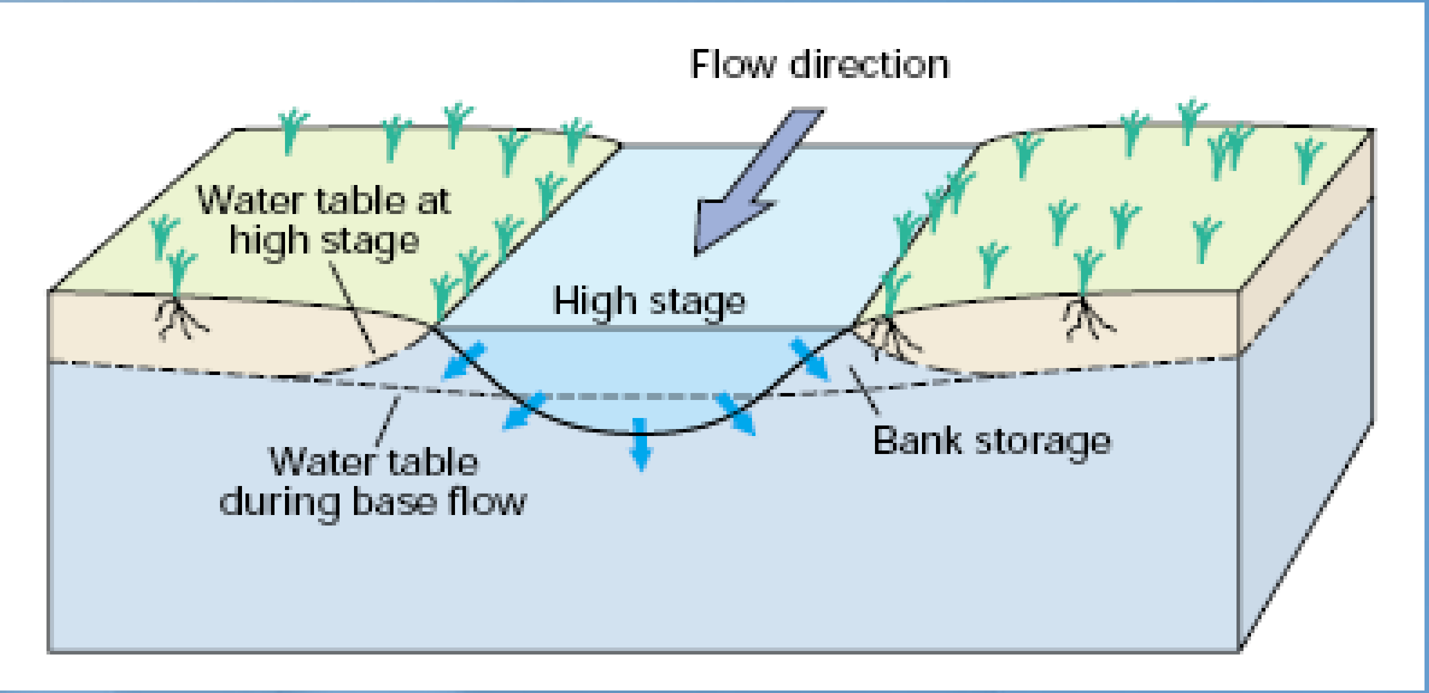
Partially and Fully Penetrating Streams

- There are probably relatively few streams that are deep enough to penetrate the full thickness of the aquifer in which they lie. Such streams often are referred to in the literature as fully penetrating streams.
- Seepage between a fully penetrating stream and the contiguous aquifer occurs horizontally through streambank materials:

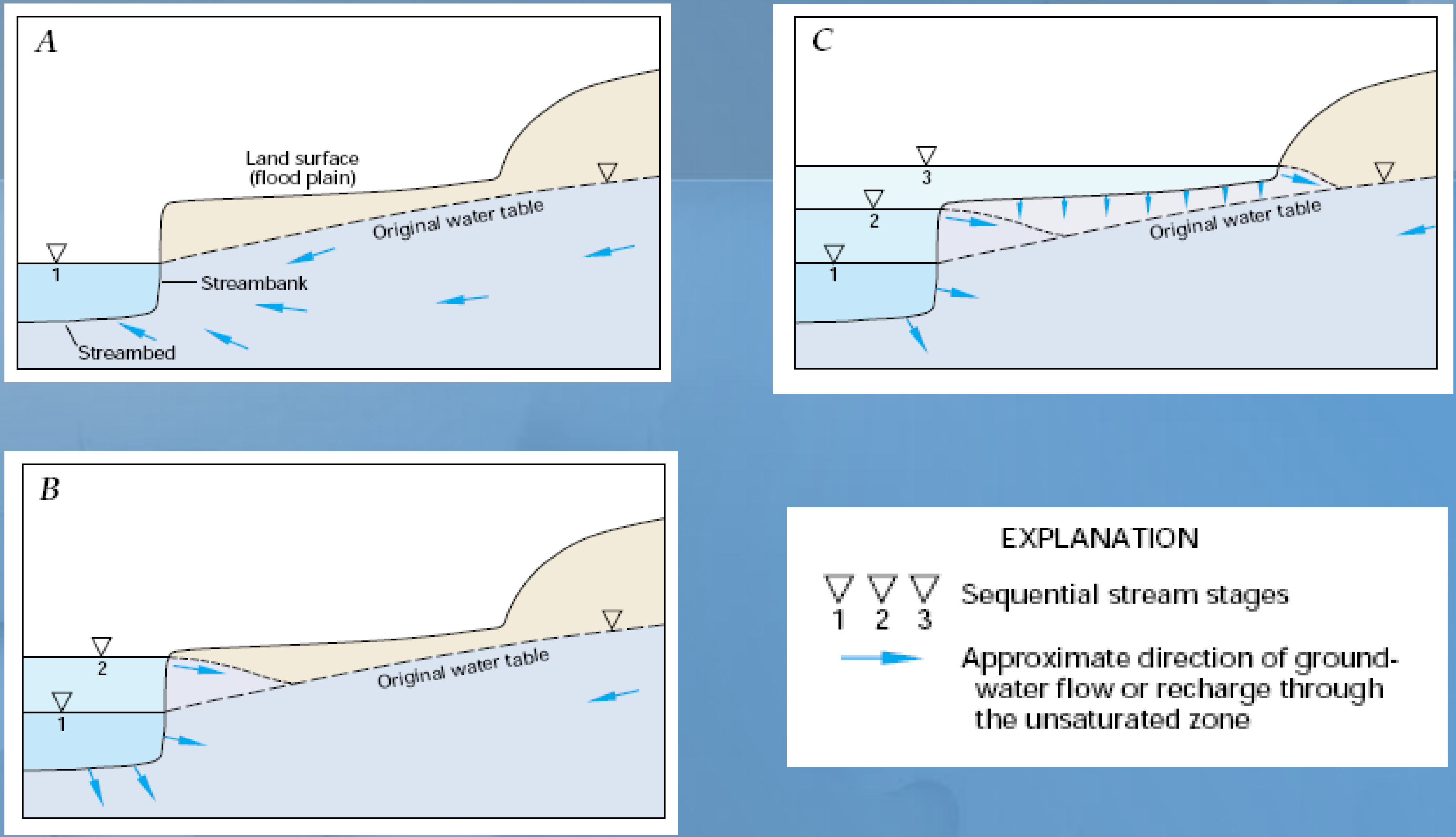


A deep stream that fully penetrates an aquifer.

Interaction of Groundwater and Streams: Bank Storage

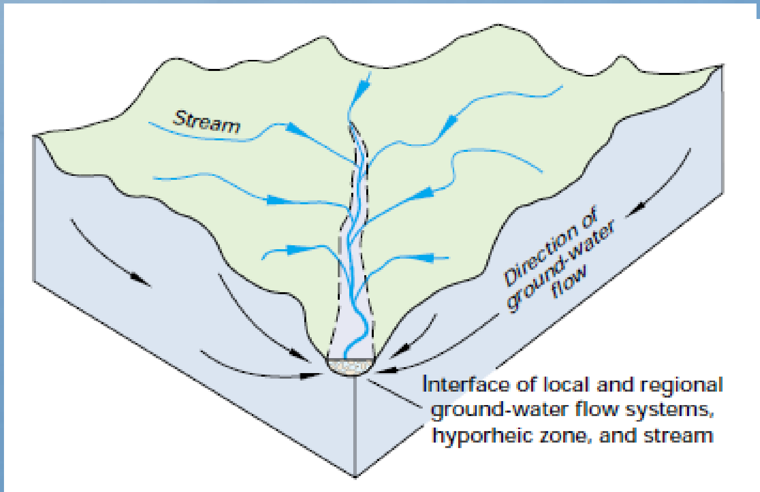


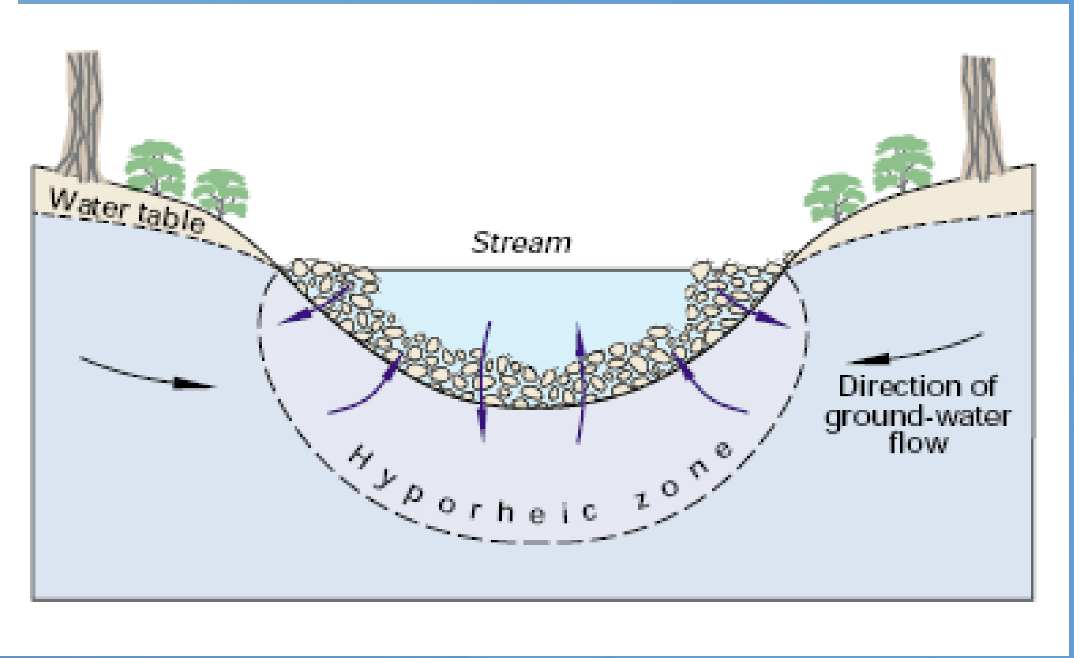
A rapid rise in stream stage can cause water to move from the stream into the streambanks as bank storage.



Widespread recharge to the water table can occur in a flooded area if the rise in stream stage is sufficient to overtop the streambanks.

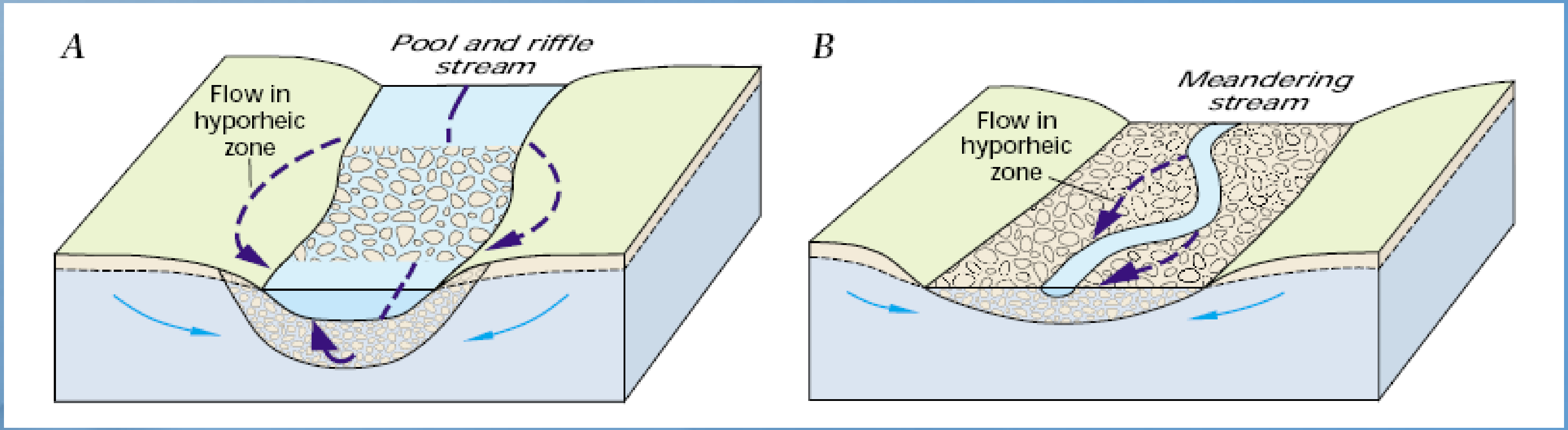
The Hyporheic Zone:
In many stream settings, surface water flows through short segments of its adjacent bed and banks and then back into the stream. This subsurface zone is called the hyporheic zone.





The chemical and biological character of the hyporheic zone may differ markedly from adjacent surface and groundwaters because of mixing of surface and groundwaters within the zone.

Flow within the Hyporheic Zone



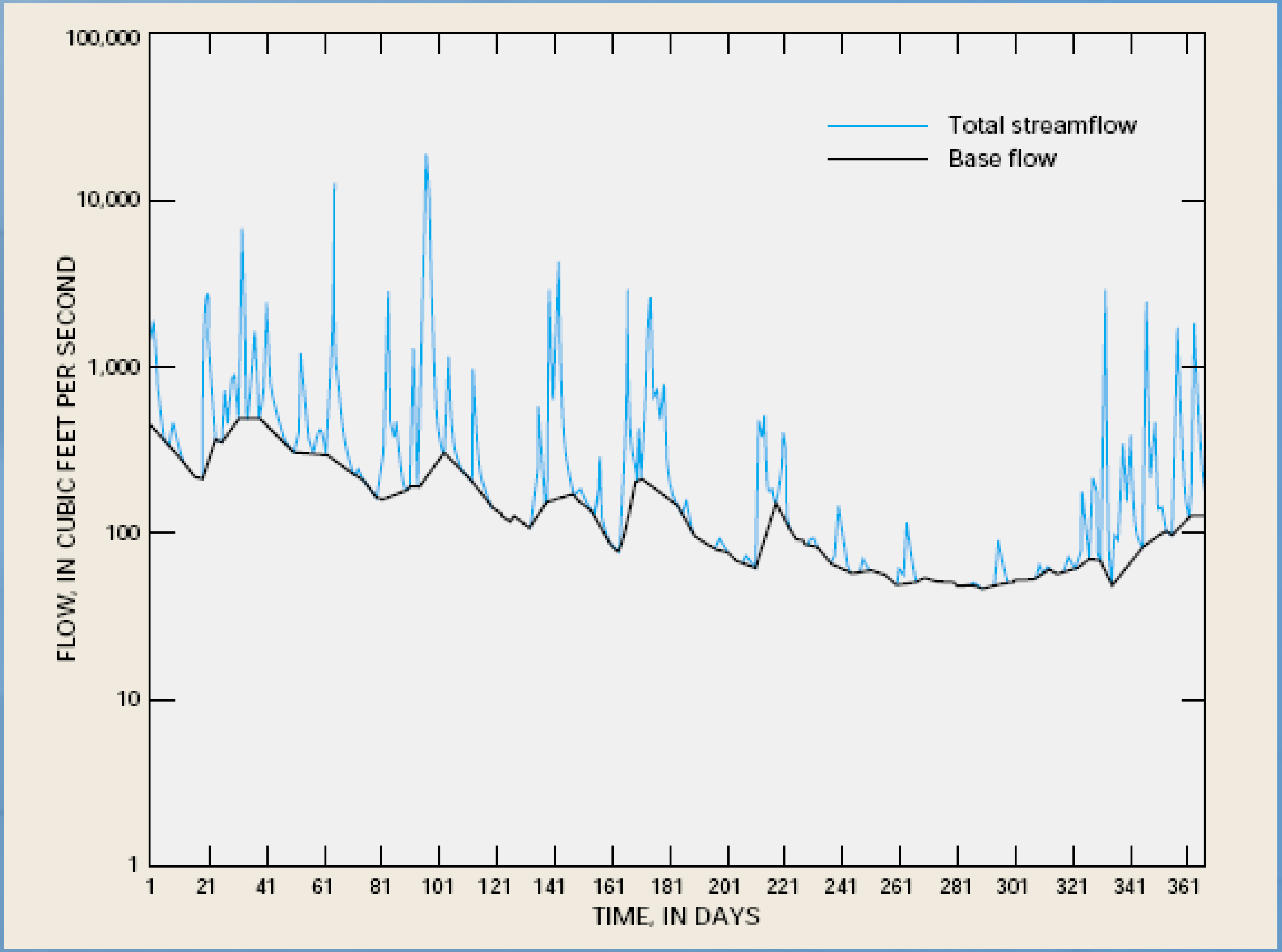
Some gaining streams have reaches that lose water to the aquifer under normal conditions of streamflow, due to abrupt changes in streambed slope (A) or to stream meanders (B).

Base Flow—The Groundwater Component of Streamflow

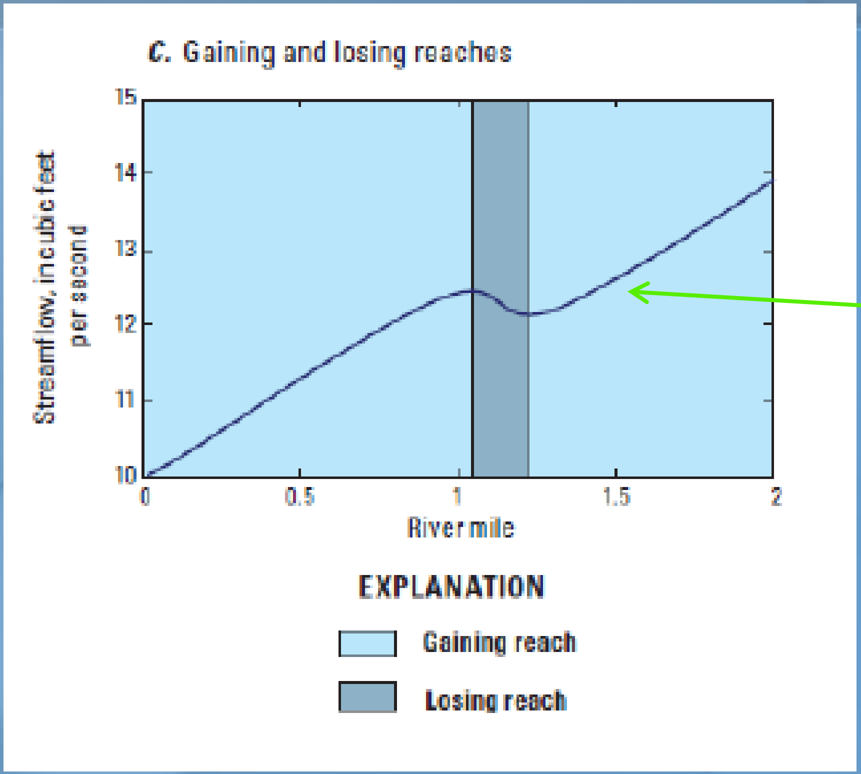
- Groundwater contributes to streams in most physiographic and climatic settings, yet the proportion of stream water that is derived from groundwater inflow varies across these settings.

- Streamflow hydrograph-separation techniques can be used to estimate the amount of groundwater that contributes to streamflow; that is, the groundwater component, or base flow, of streamflow.

The base-flow component of streamflow estimated from a streamflow hydrograph for the Homochitto River, Mississippi



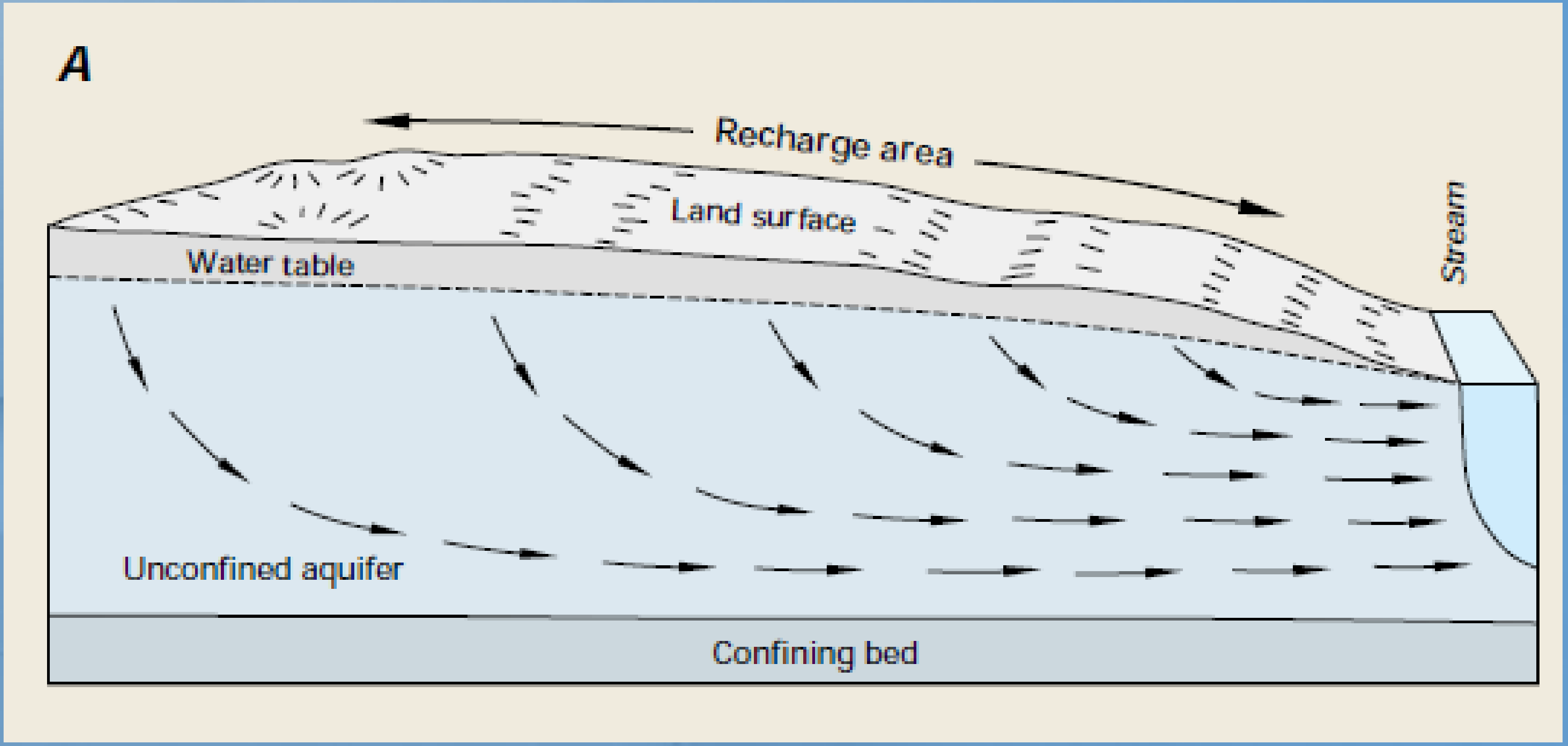
Streamflow hydrograph along a river



We call these seepage runs

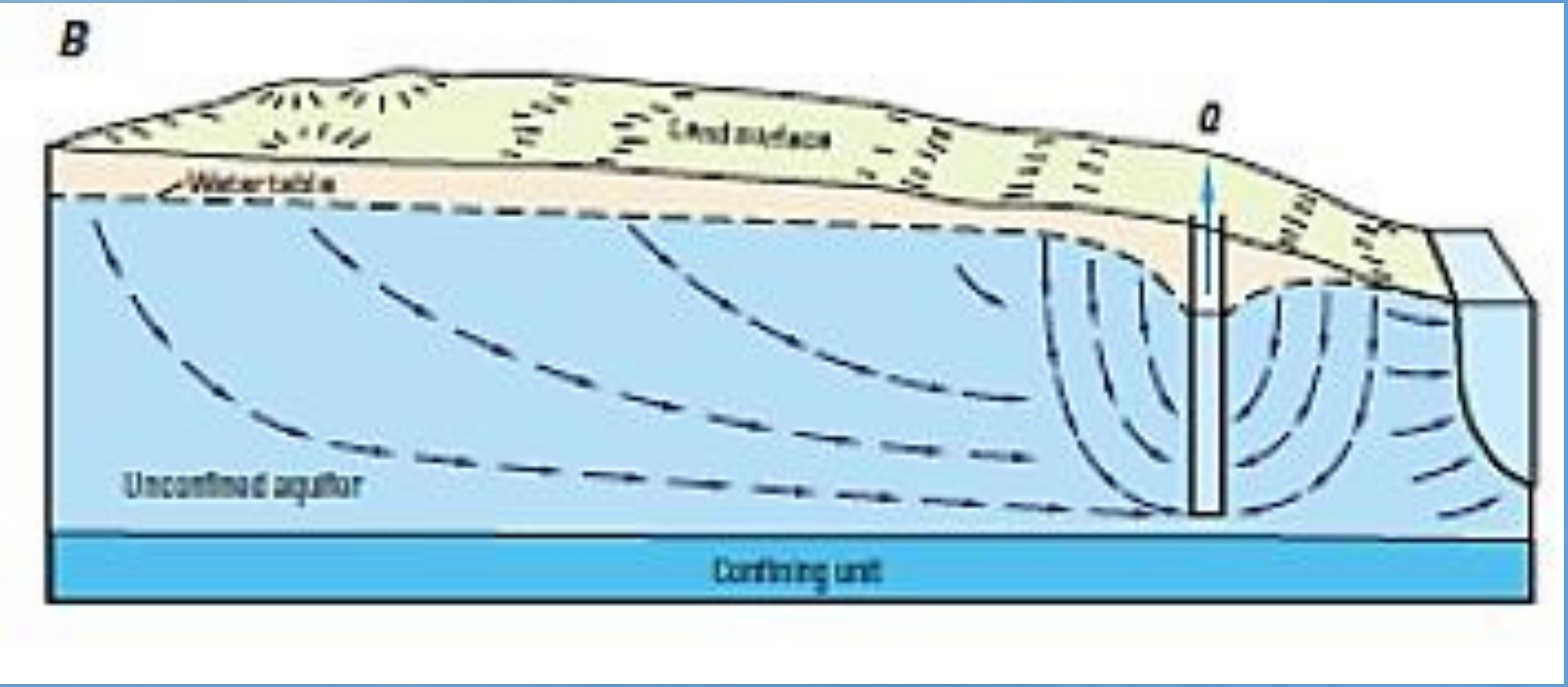
Streamflow increases along the gaining reaches and decreases along the losing reaches (during periods of no direct surface-water runoff to the river).

Effects of Groundwater Pumping on Streamflow



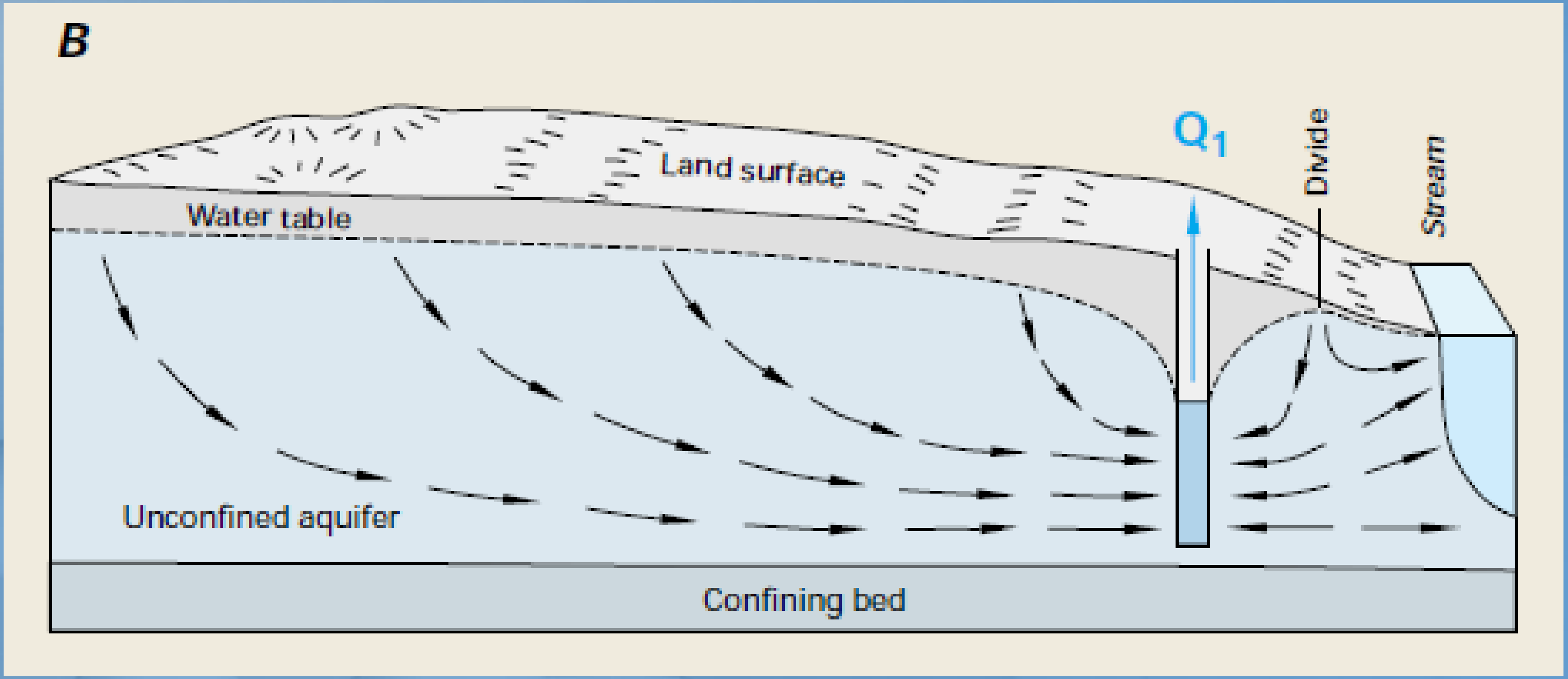
Groundwater discharges to stream under natural conditions.

Effects of Groundwater Pumping on Streamflow



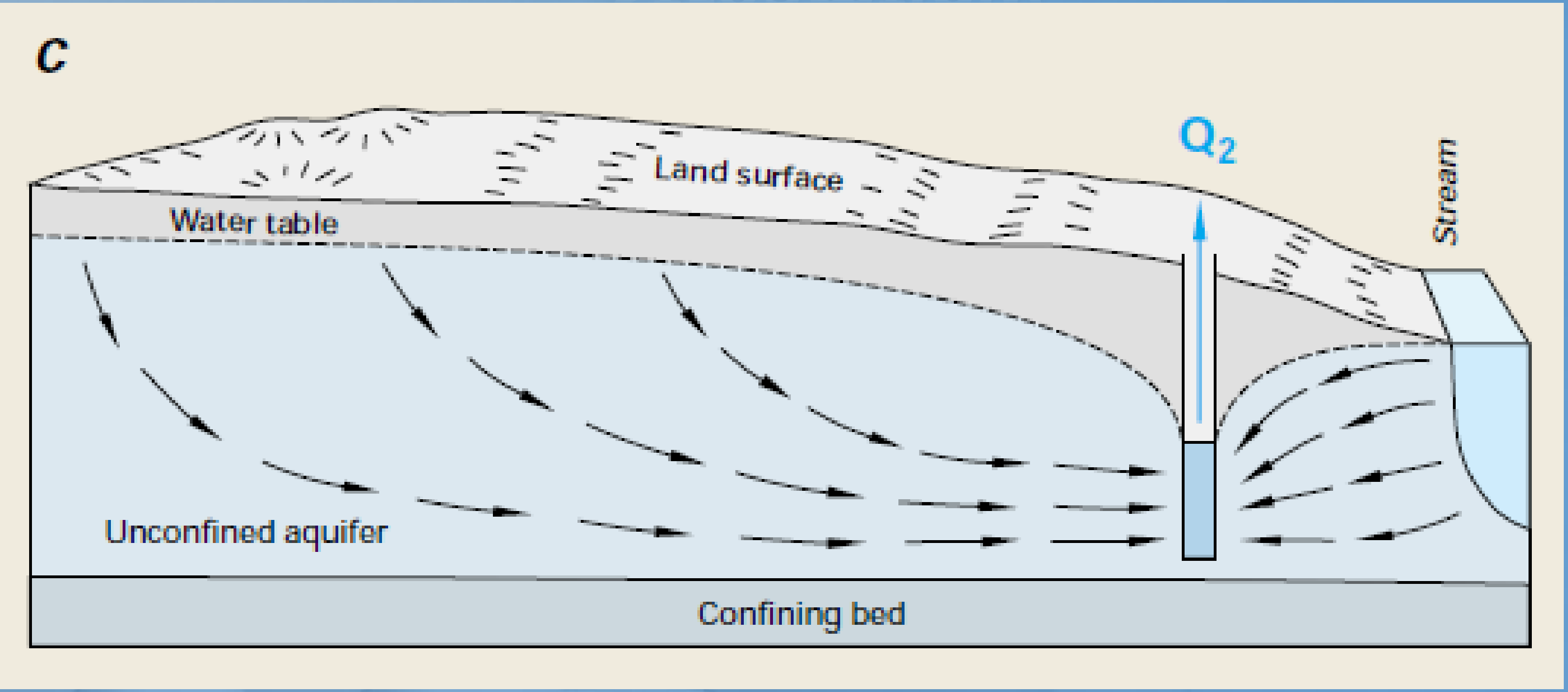
Soon after pumping begins, all of the pumped water is from aquifer storage.

Effects of Groundwater Pumping on Streamflow



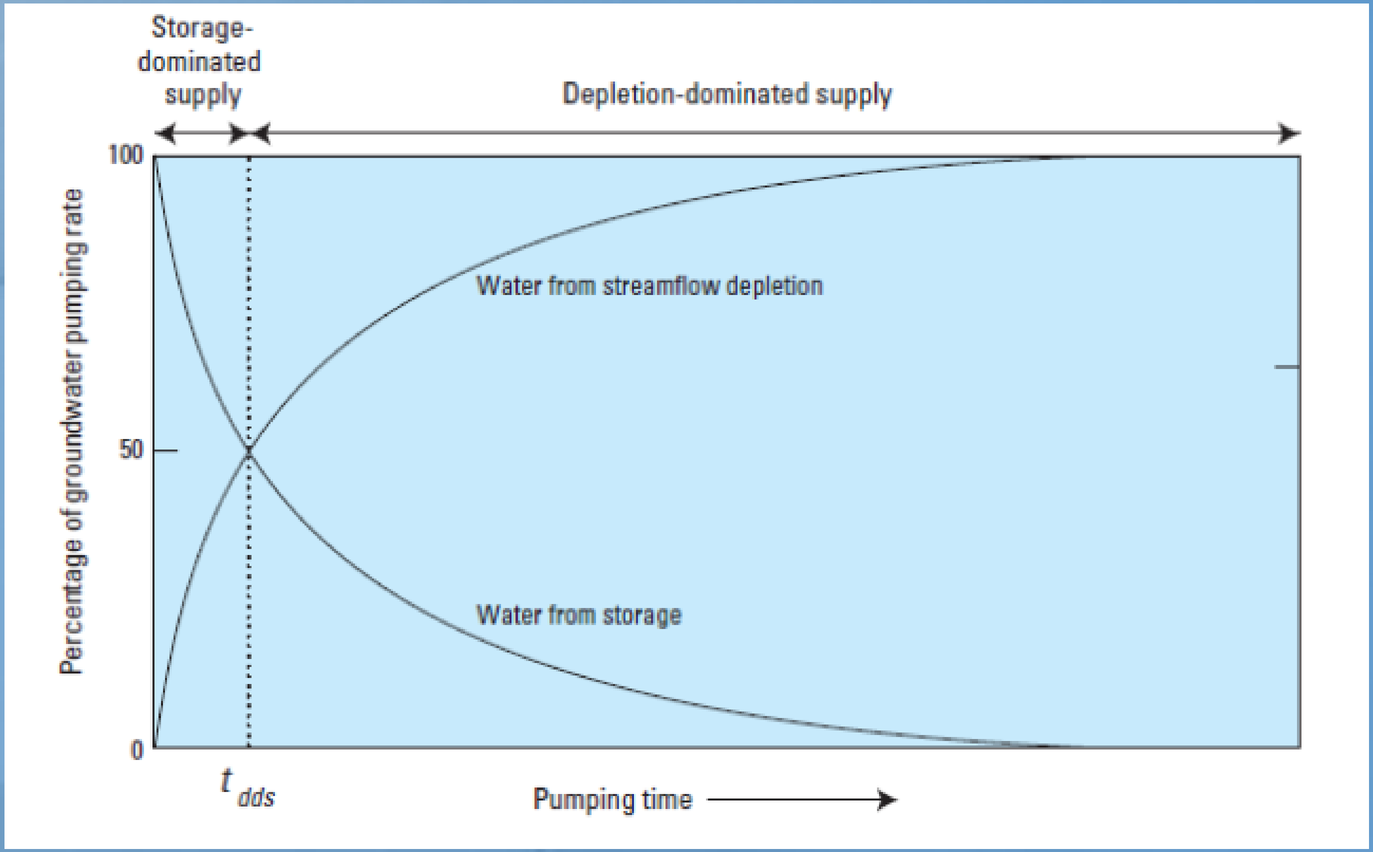
As the cone of depression expands outward from the well, the well captures groundwater that would otherwise have discharged to the stream ("captured groundwater discharge").

Effects of Groundwater Pumping on Streamflow



In some circumstances (high pumping rate, well close to stream) the well also may cause water to flow from the stream to the aquifer ("induced infiltration" of streamflow).

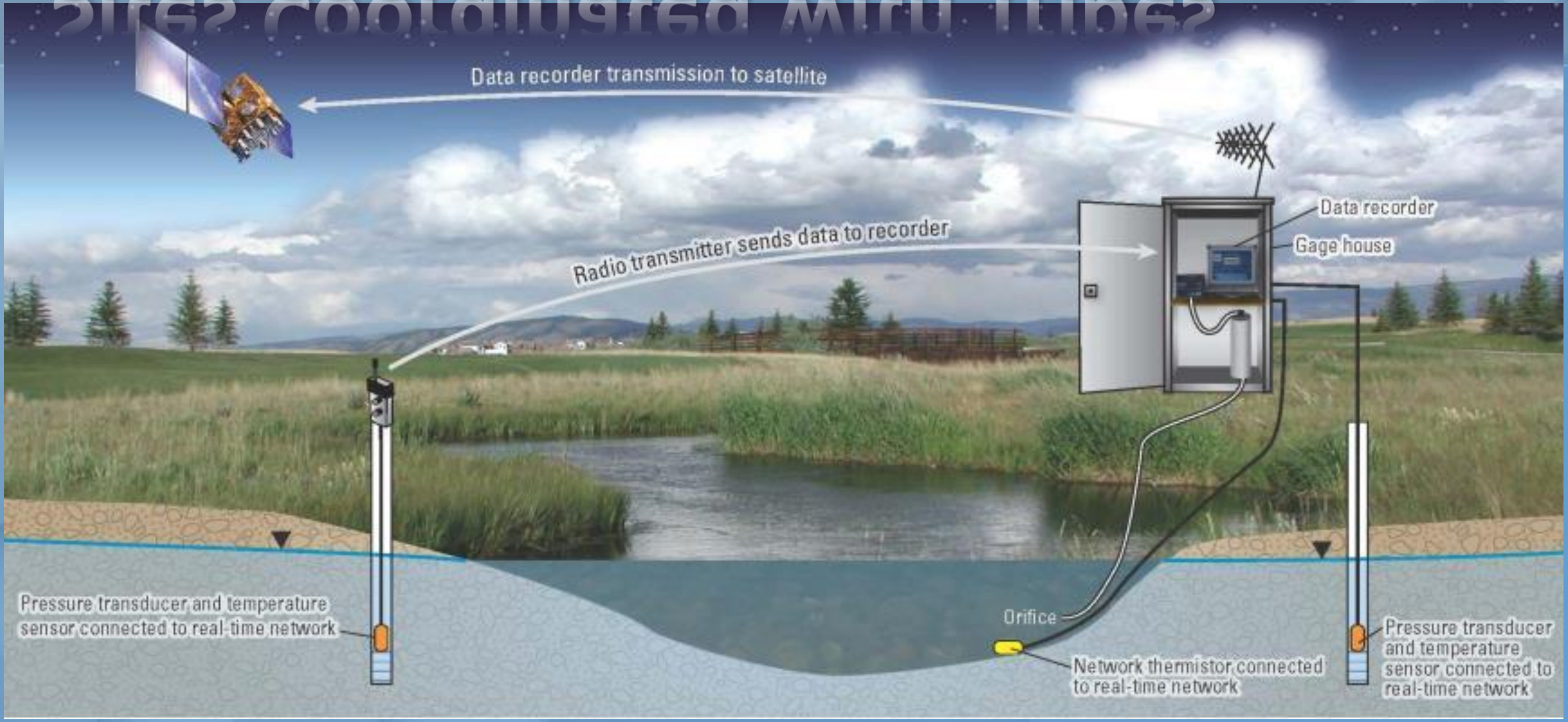
Sources of Water to a Well as a Function of Time



Streamflow depletion is the sum of captured groundwater discharge and induced infiltration of streamflow.

Groundwater withdrawals deplete streamflow and stress aquatic communities in the Ipswich River, Massachusetts

New USGS GW/SW Interaction Sites Coordinated with Tribes



- GW elevation and temperature
- SW elevation and temperature
- SC in MS

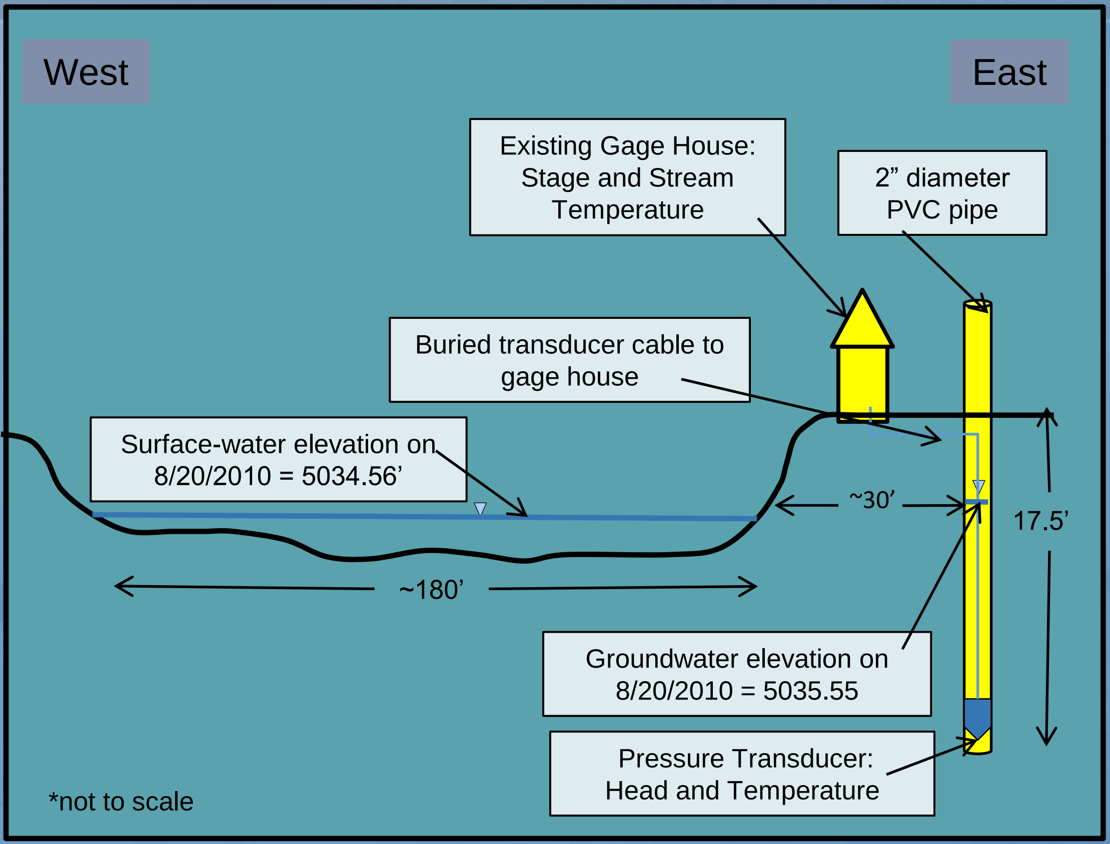
The Setup, Suite of 4 + 1

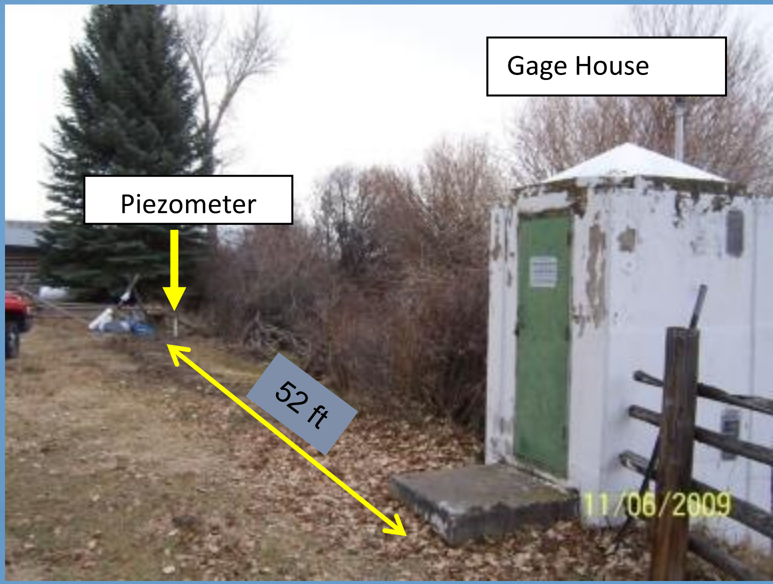
Results

Big Hole River, Montana

- Critical river for Arctic grayling
- 85 years of SW record
- Many stations in basin – only yr round

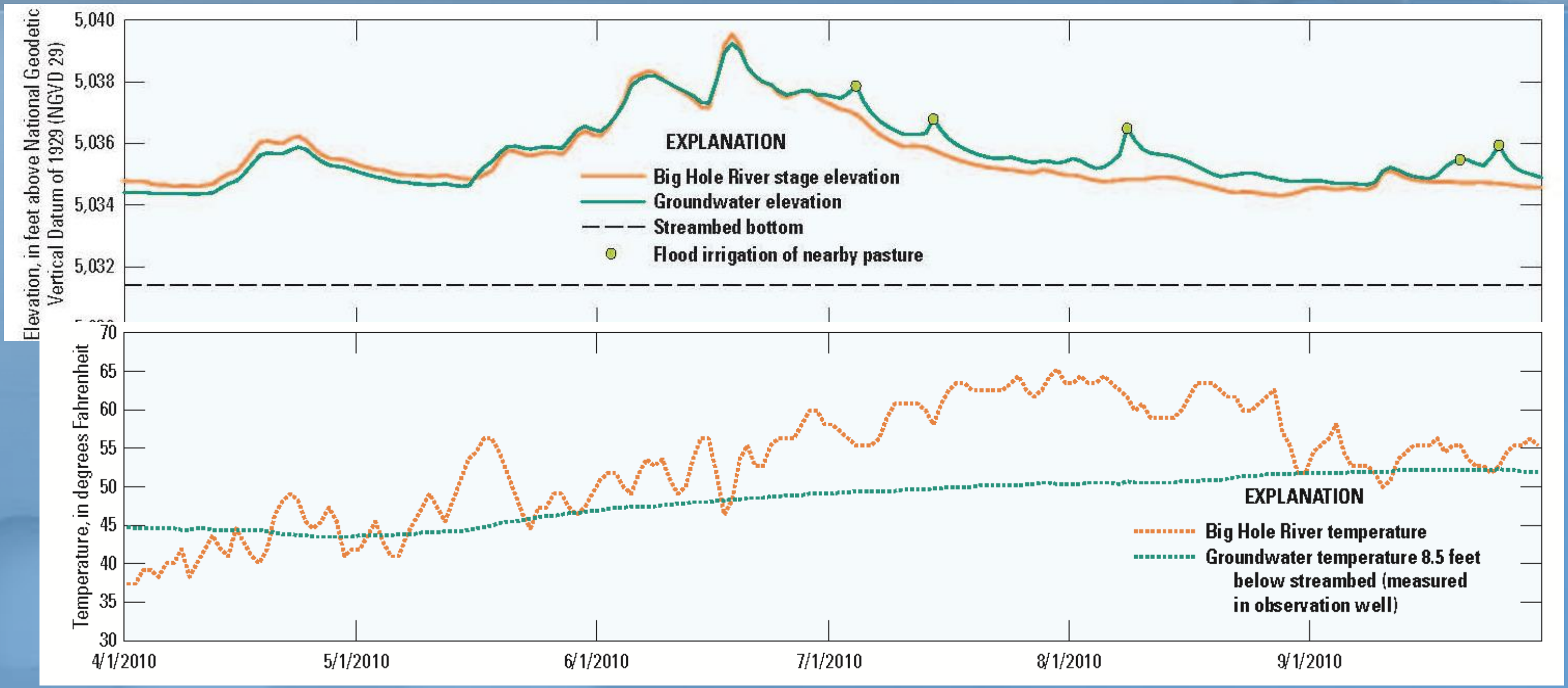
Big Hole River near Melrose, MT: add-on to existing stream gage



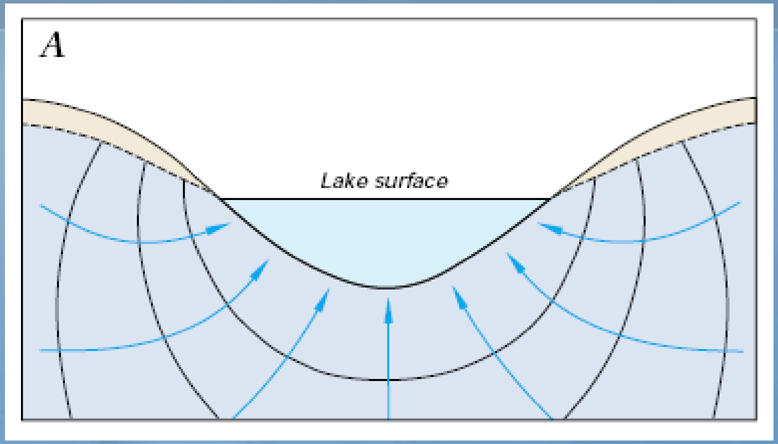


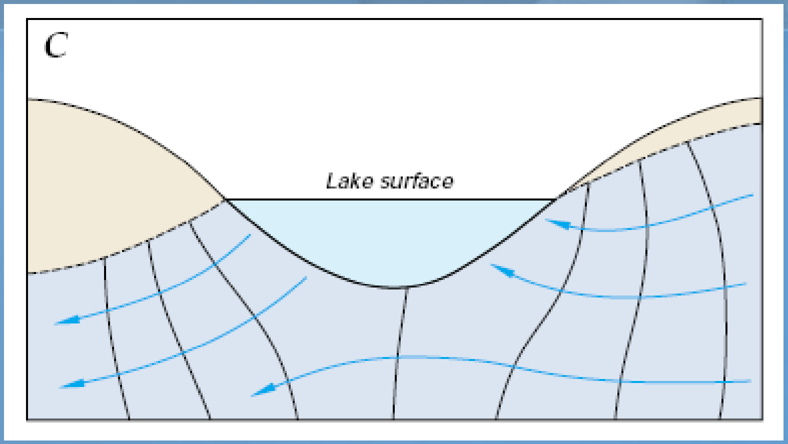
Results

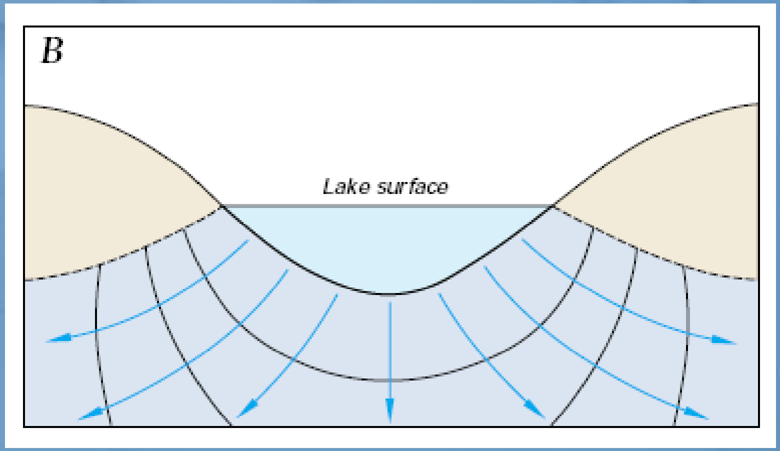
Big Hole River, Montana



Interaction of Groundwater and Lakes

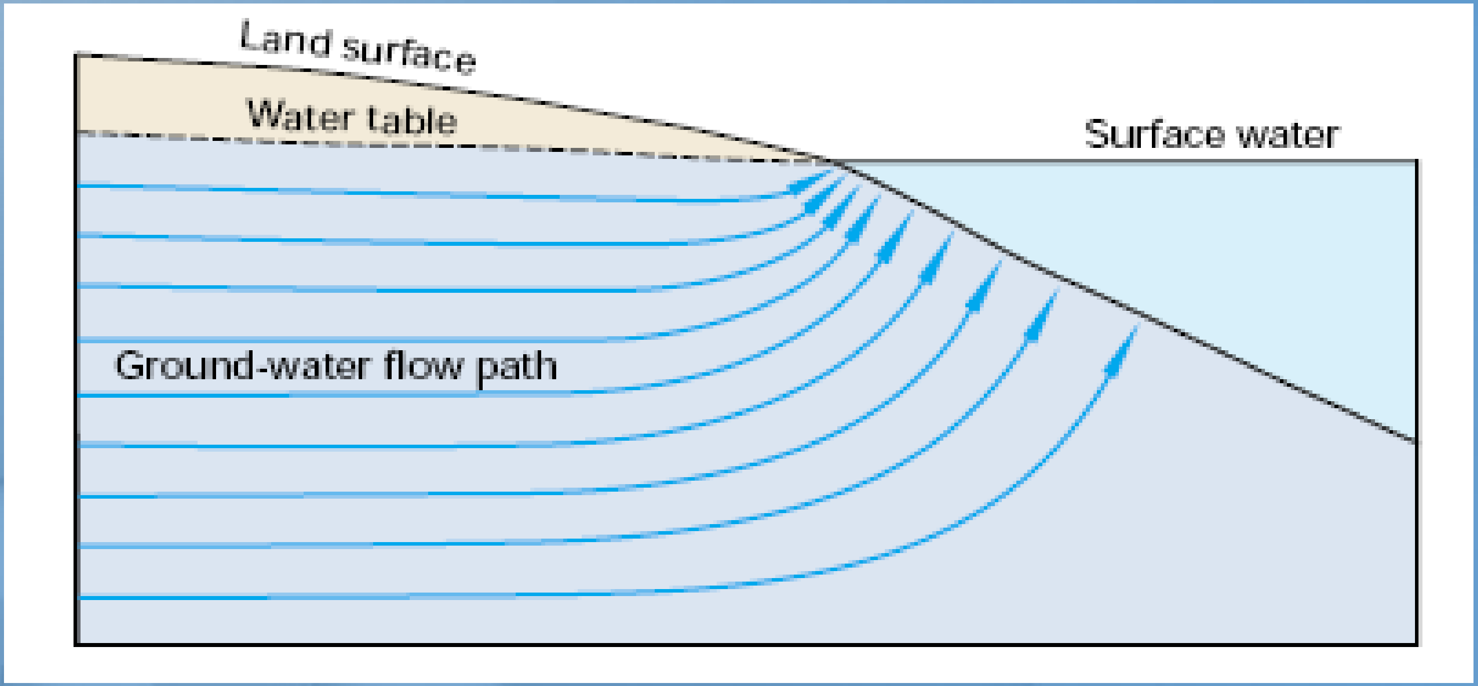






Lakes can receive groundwater inflow (A), lose water as seepage to groundwater (B), or both (C).

Groundwater Seepage Into Surface Water



Seepage rates are usually greatest near shore and decrease nonlinearly away from the shoreline.

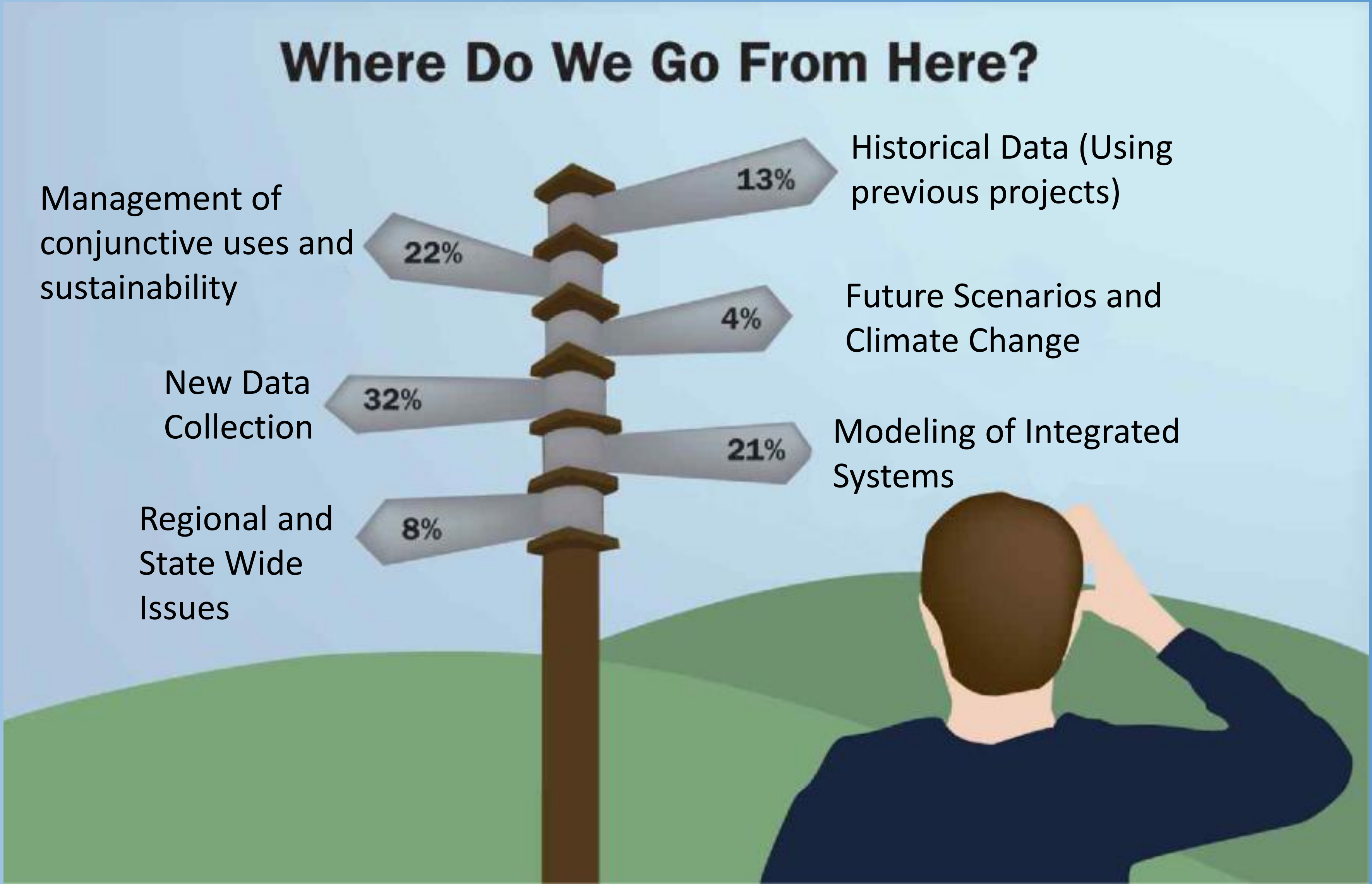
Groundwater pumping can also affect Lake Levels, which affect Lake Ecosystems and Lake Esthetics

Dock on Crooked Lake in central Florida in the 1970's.

The same dock in 1990.

In highly developed areas of west-central Florida, lake levels declined and wetlands dried out over a two-decade period as a result of both extensive pumping from the Floridian aquifer and low precipitation during a drought.

Example of Implementation of Resources Dollars for a Water Plan



Historical Data (Using previous projects)

Management of conjunctive uses and sustainability

Future Scenarios and Climate Change

New Data Collection

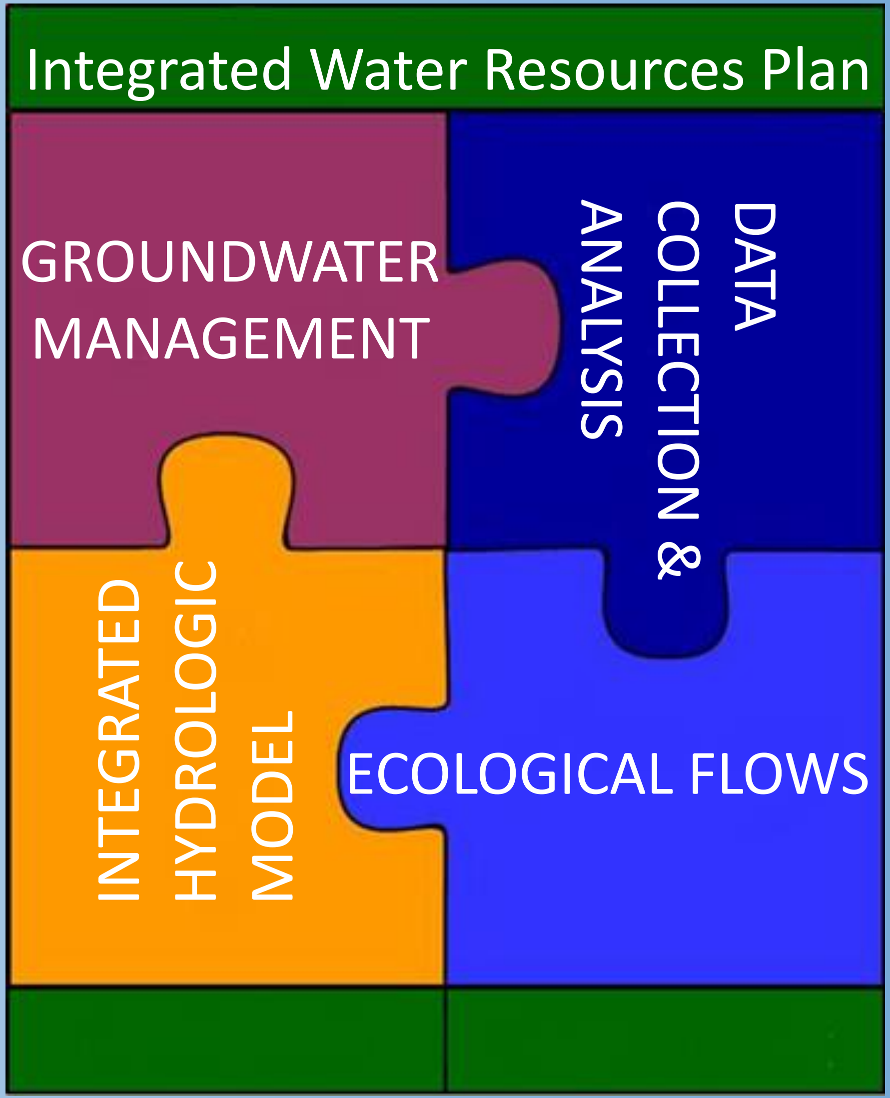
Modeling of Integrated Systems

Regional and State Wide Issues

Current USGS Projects for Tribal Water Planning (#1)

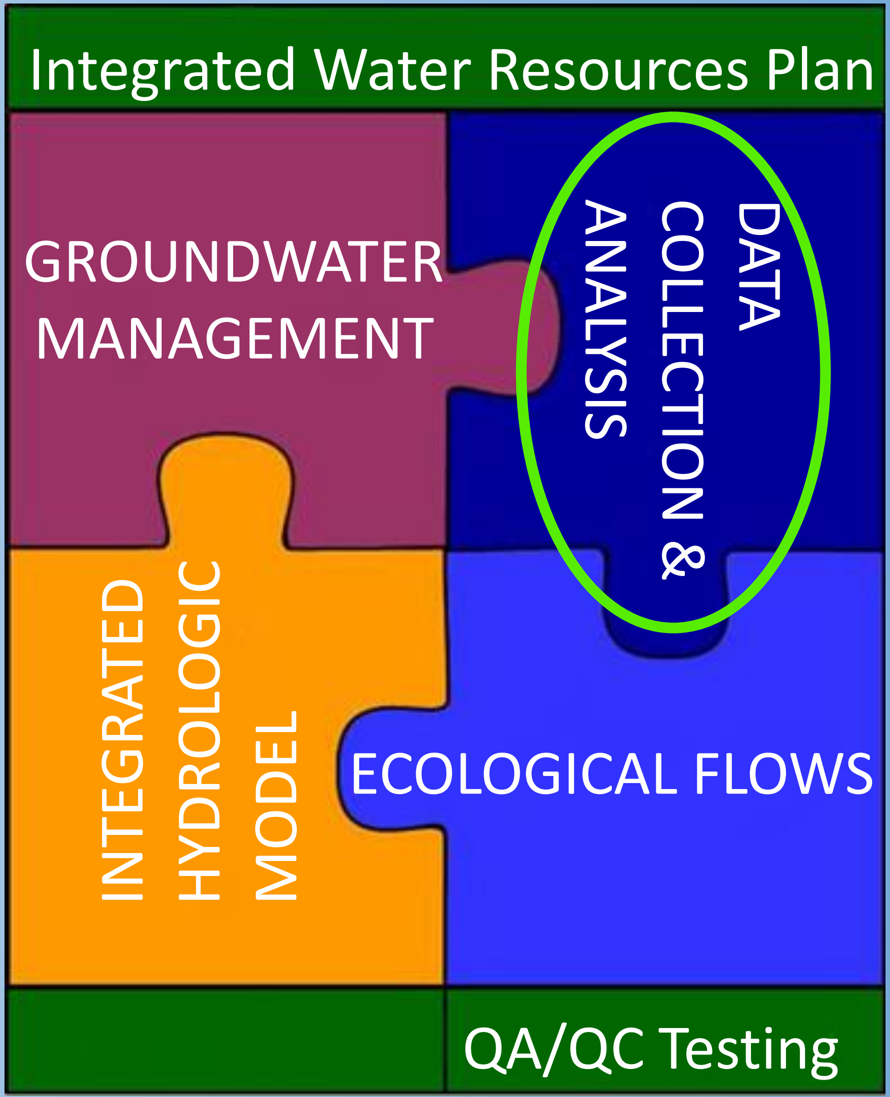
- The Citizen Potawatomi Nation Tribal Water Plan will aid with development of a comprehensive water resources objectives for social and economic development that honors the environmental protection and sustainability of tribal lands and resources. The evaluations and assessments performed for this Plan will help to identify effective actions and policies for meeting a tribe's resource management objectives in the near term and for several generations into the future.

Putting the pieces together



- Paths to a Water Plan
  - Data Collection and Analysis
  - Ecological Flows
  - Integrated Hydrologic Model
  - Groundwater Management and Optimization

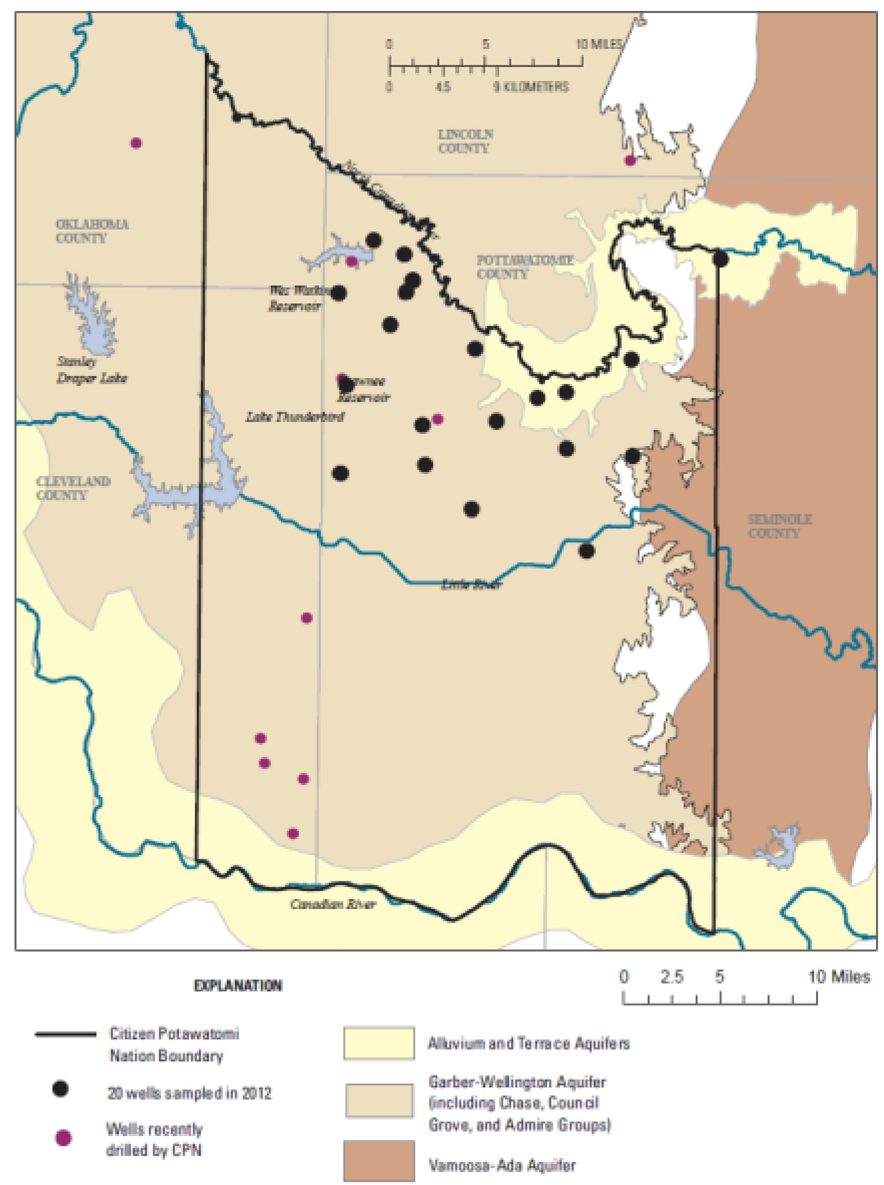
Tribal Lands Data Collection & Analysis



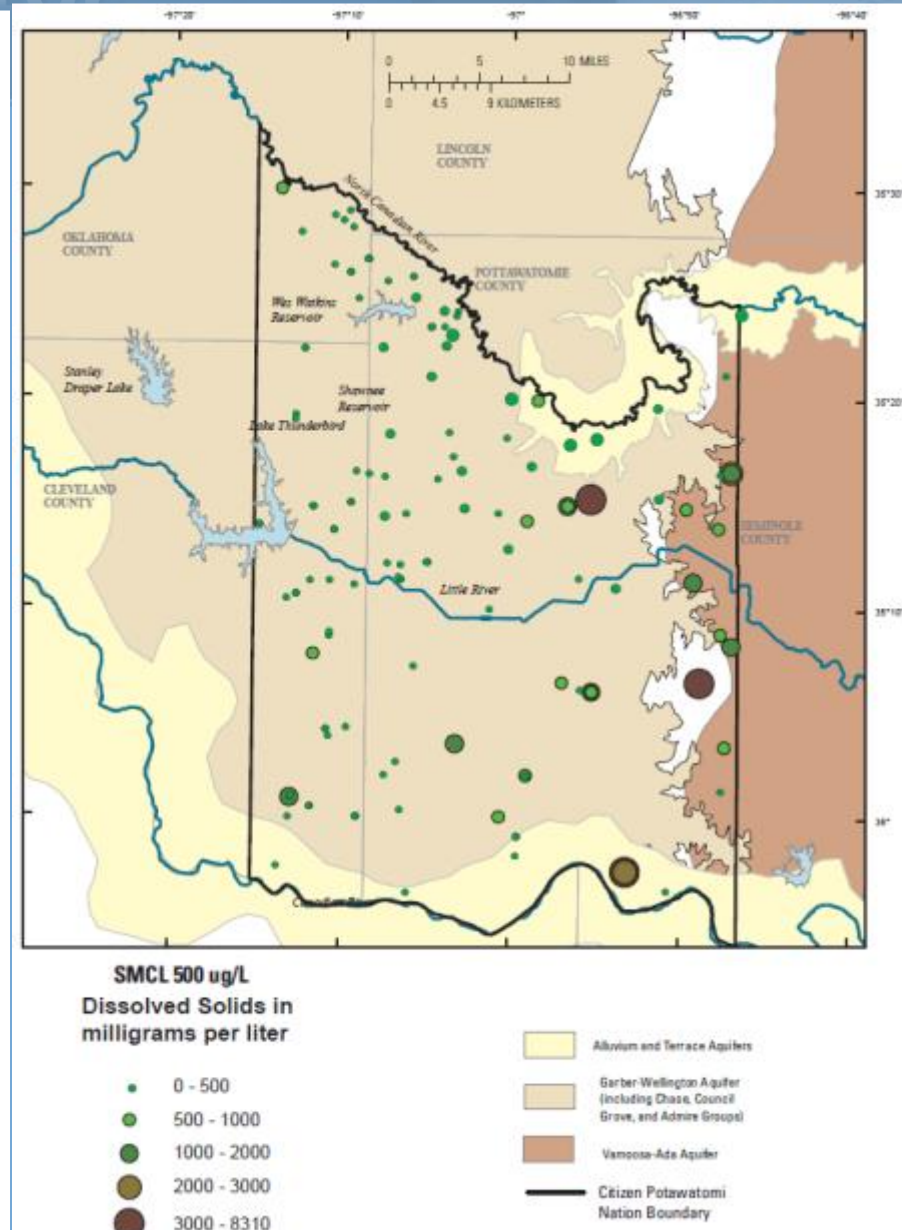
Data Collection & Analysis

- Collect water resource management information
- Analyze hydrologic and hydrogeologic data and evaluate data gaps
- Fill data gaps with prescribed site investigations
- Perform aquifer testing, surface and borehole geophysics on sites
- Perform water quality analysis at prescribed sites

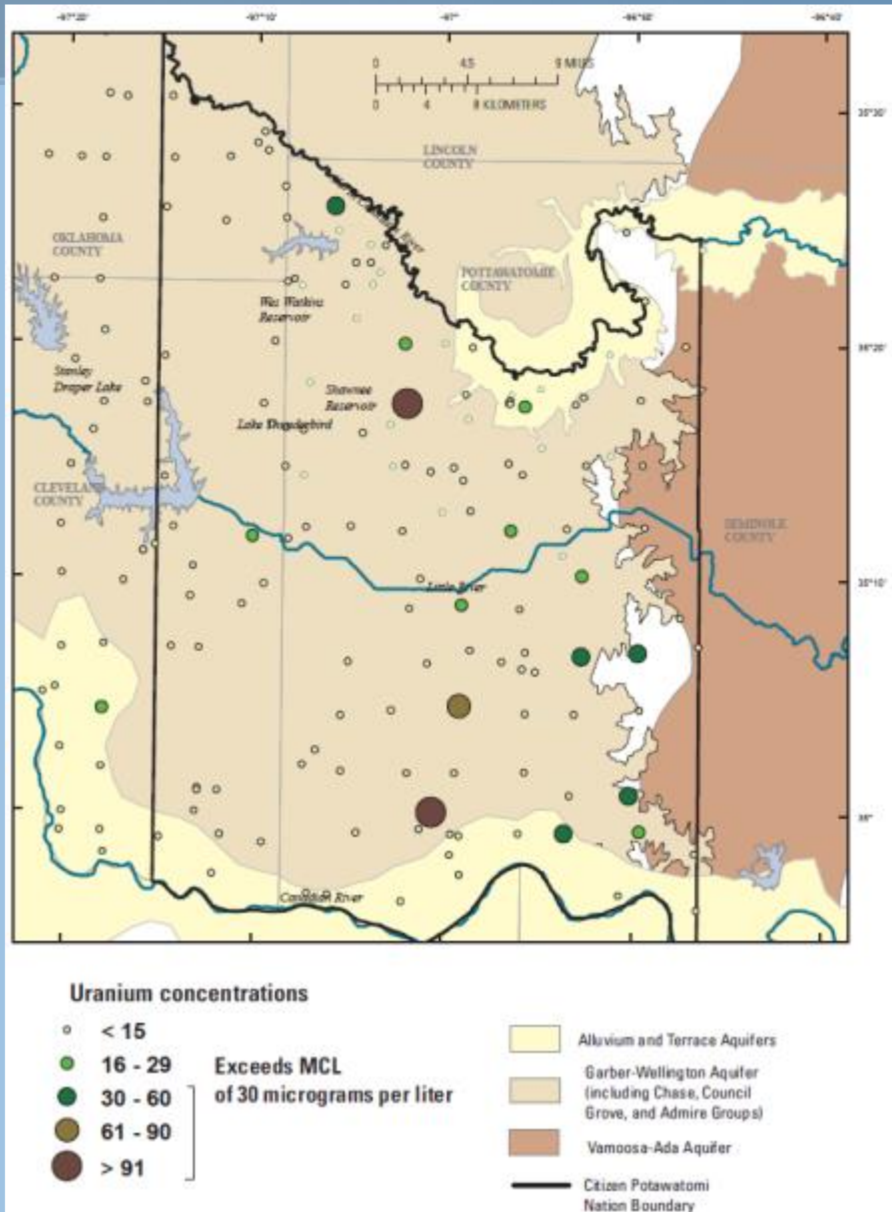
Groundwater Sites

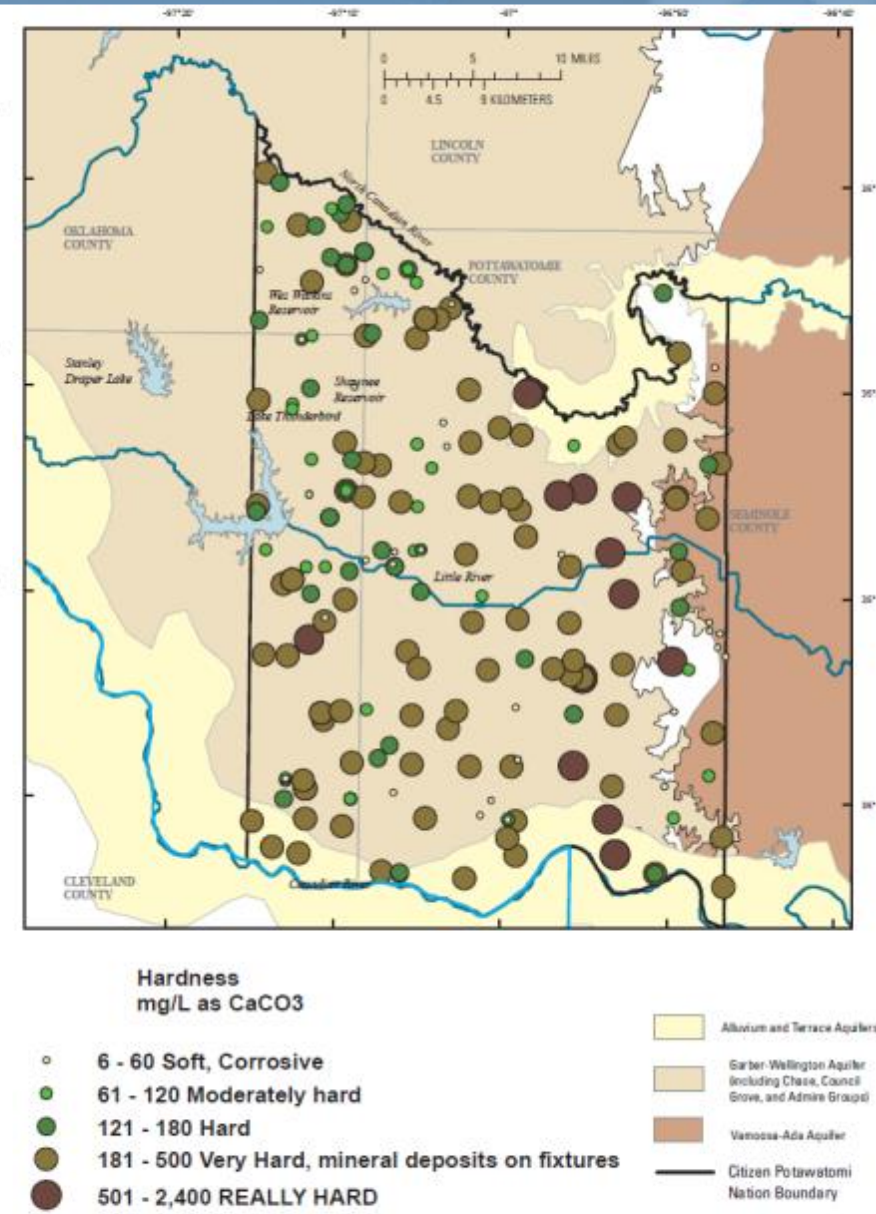


Major aquifers and locations of well sampled in 2012 and new wells recently drilled by CPN.

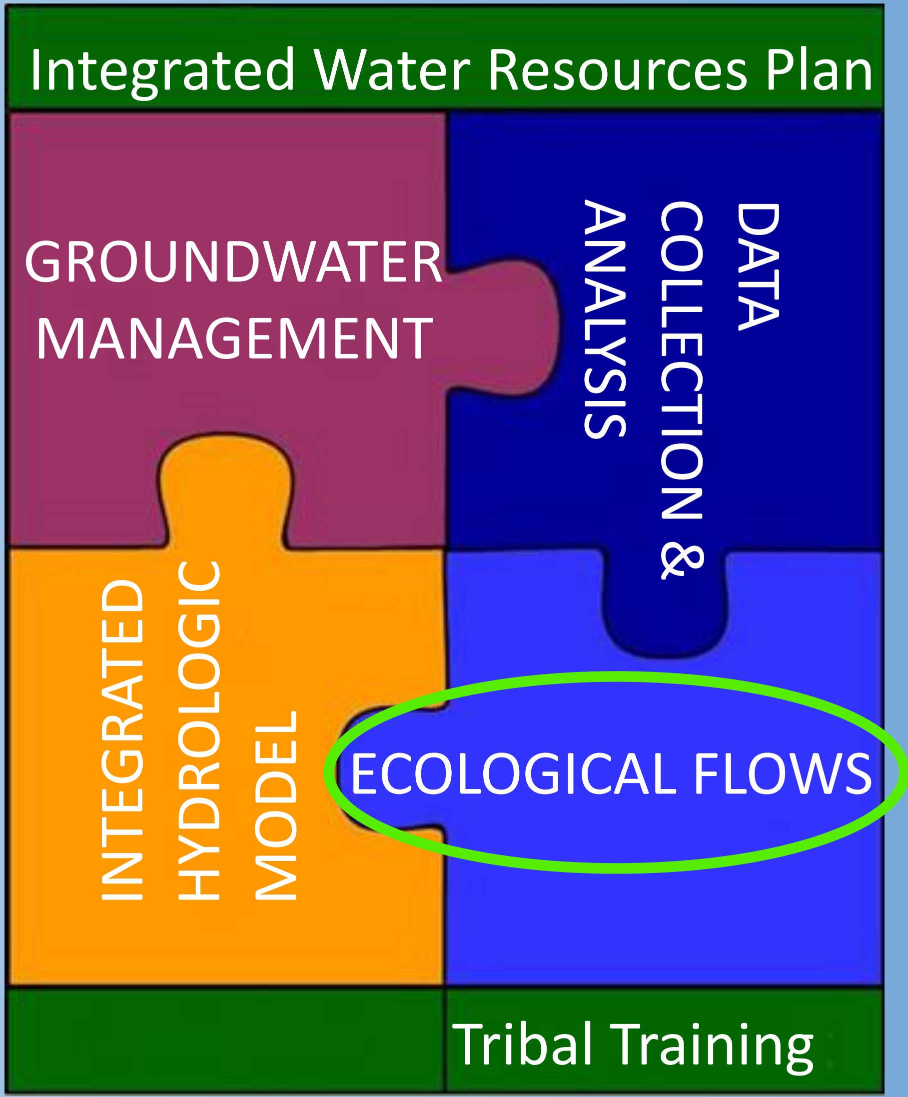


Groundwater Quality



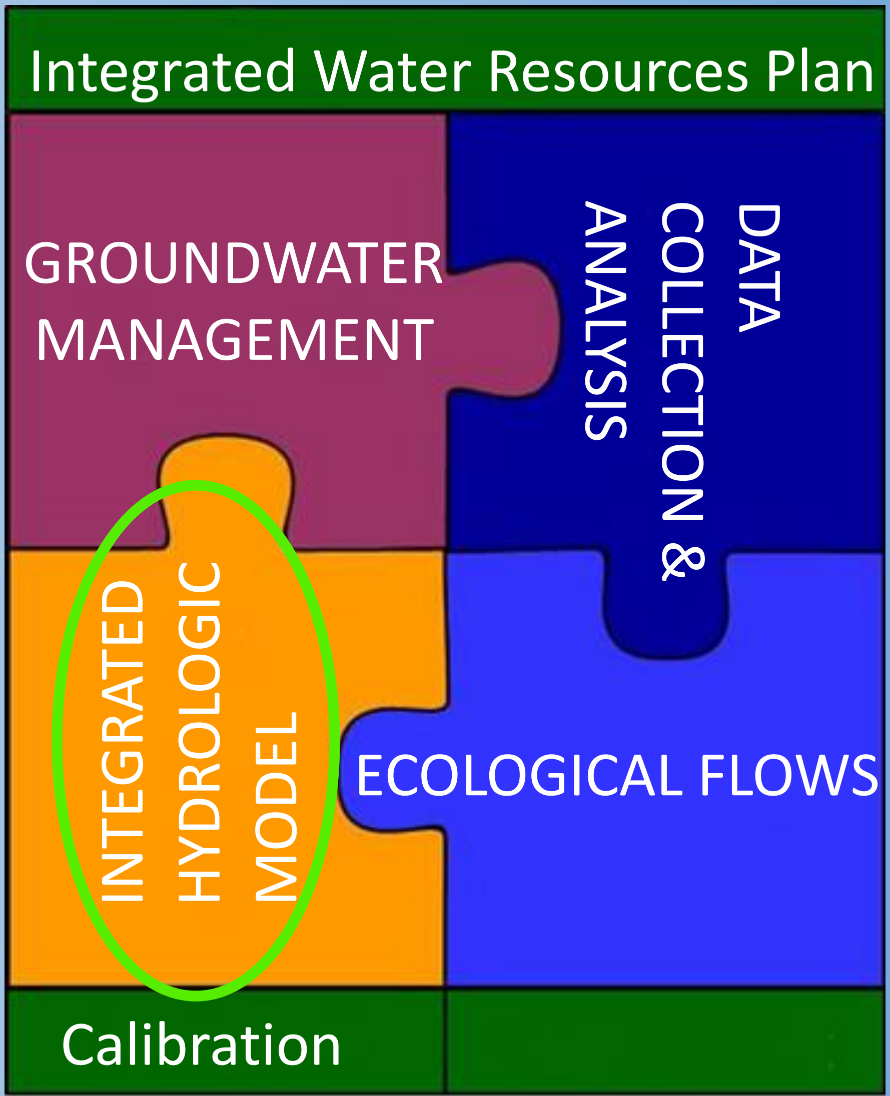


Ecological Flows Management



- Ecological Flows
  - Define ecological flow requirements
  - Work with and train Tribal Partners about ecological flow classifications
  - Classify ecological flow for rivers and streams on tribal lands based on multiple parameters
  - Build Ecological Flow Classification System

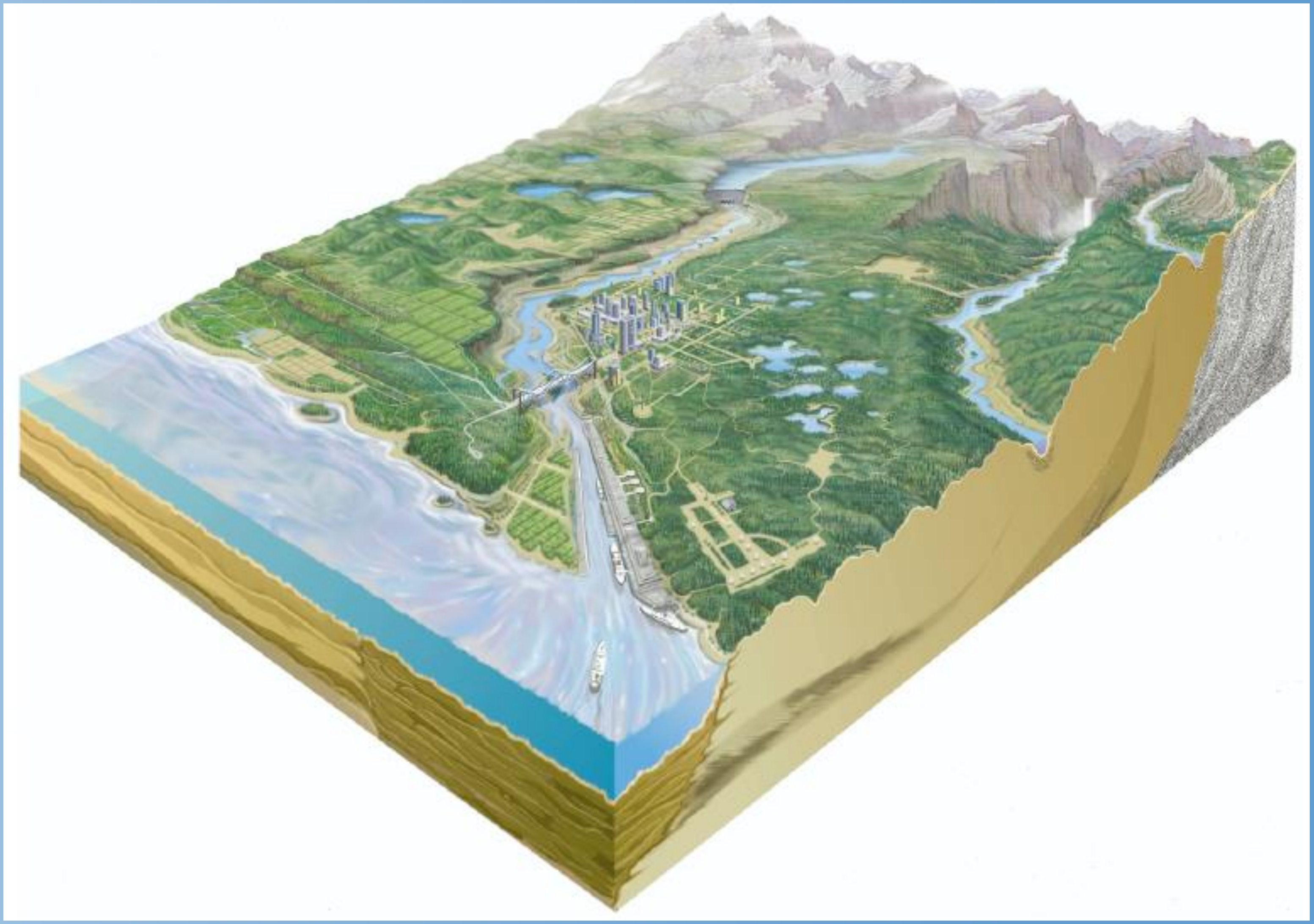
Building an Integrated Hydrologic Model (IHM)



IHM

- Build a groundwater flow model of the tribal area
- Build a surface water flow model of tribal area
- Integrated the two models
- Connect real time and long term field measurements to the IHM
- Calibrate and test IHM parameters

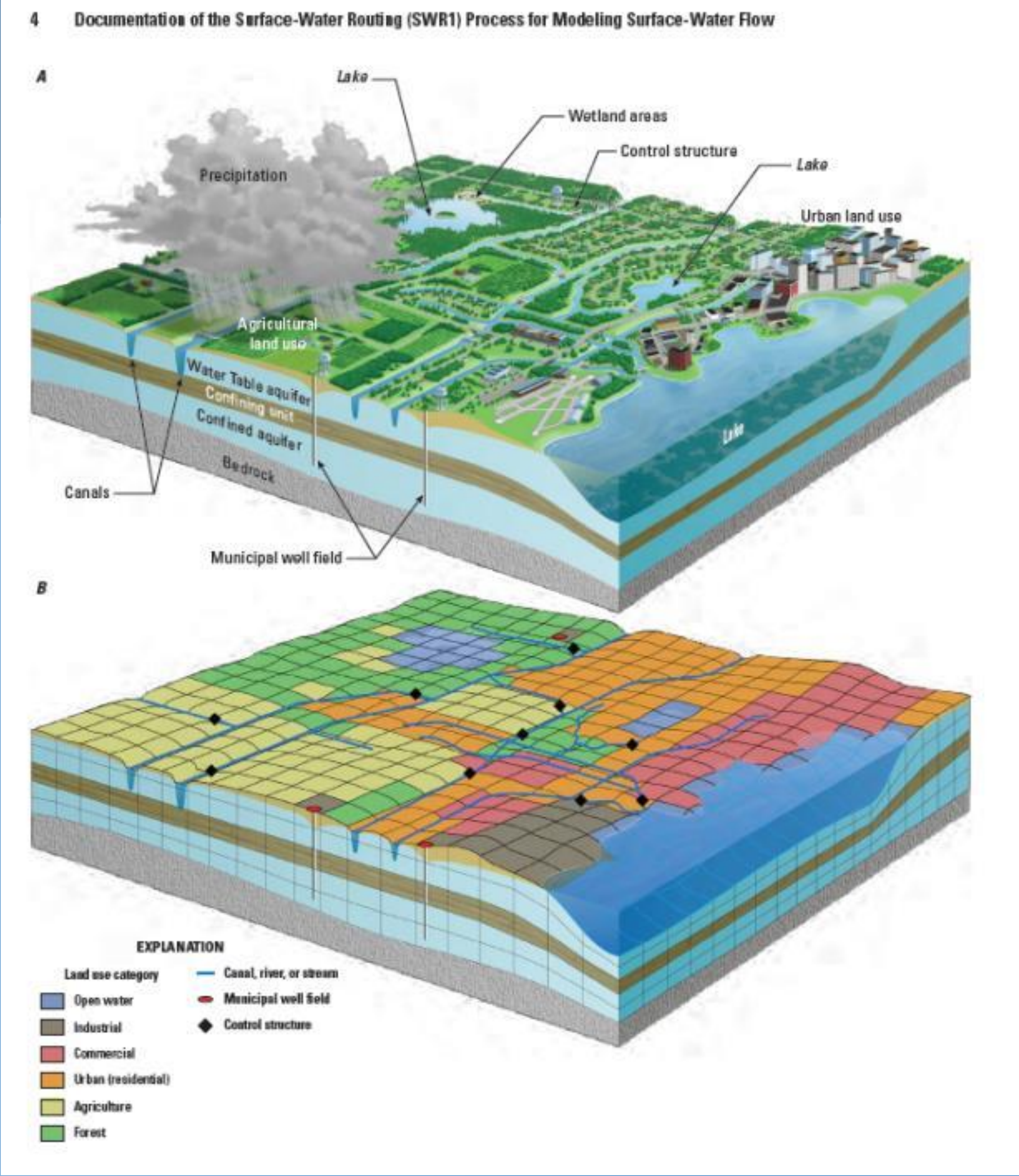
Human activities and structures (conceptual landscape), affect the interaction of groundwater and surface water in all types of landscapes.



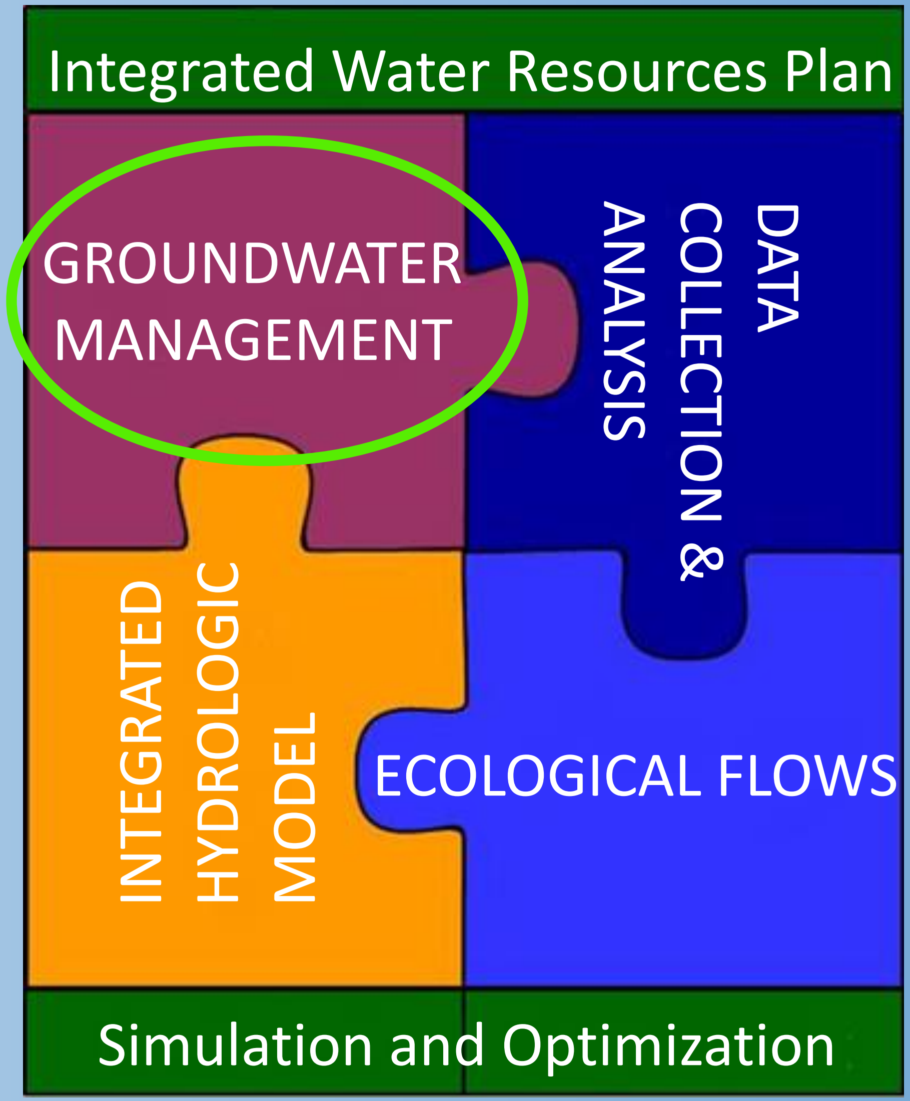
Integrated Hydrologic Model (IHM)

Building the Water Balance Model

- Looks at all water uses
- Uses different water inputs
- Just like a bank account, keeps track of the balance



Groundwater Management and Optimization (GWM)



- GWM
  - Define Optimization Objectives
  - Link ecological flows & IHM
  - Simulate groundwater pumpage scenarios
  - Implement well and well field design and placement
  - Apply simulation and optimization to integrated water resource planning

Simulated Results of Groundwater Management for Tribal Water Planning

Optimal Groundwater Pumping Solution

Feasible

Groundwater

Pumping

While

Maintaining

Ecological Flows

Best Theoretical Solution to Water Plan

Near optimal strategies that satisfy integrated water resource management goals

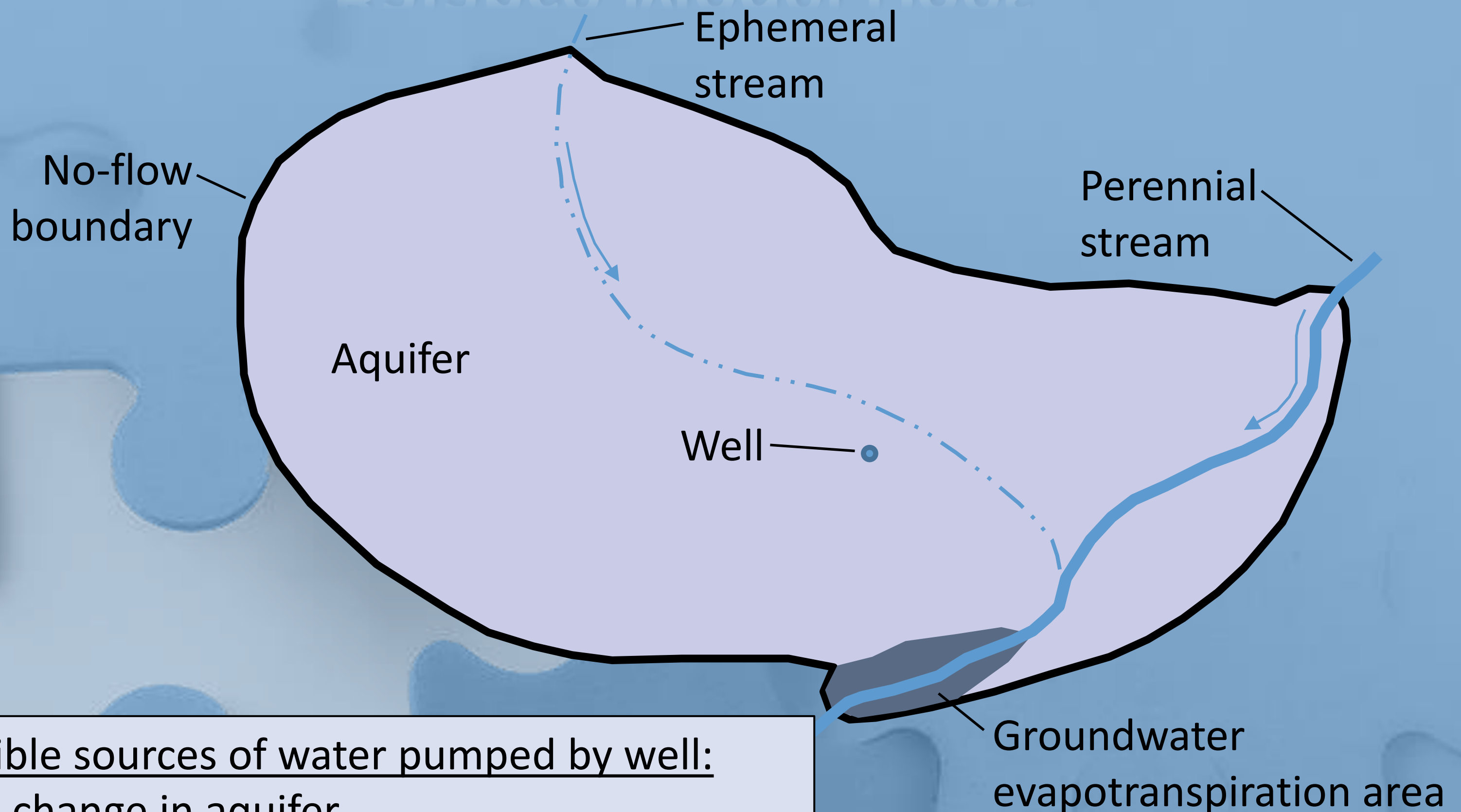
Physically possible, but not desirable

Risky and perhaps physically impossible

Infeasible Solutions

Maximum Annual Yield Not Physically Possible

Hypothetical Example of what a Water Balance Model Does

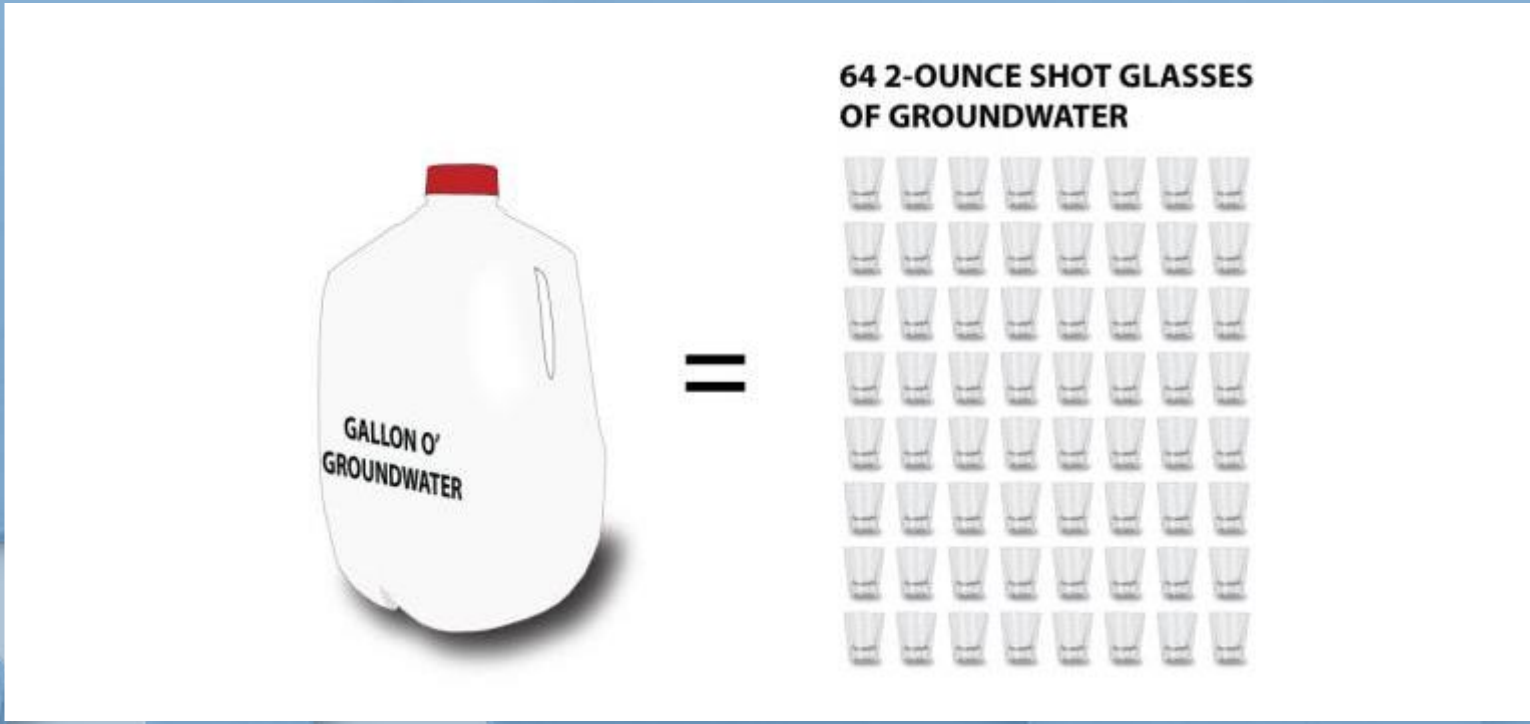


<u>Four possible sources of water pumped by well:</u>

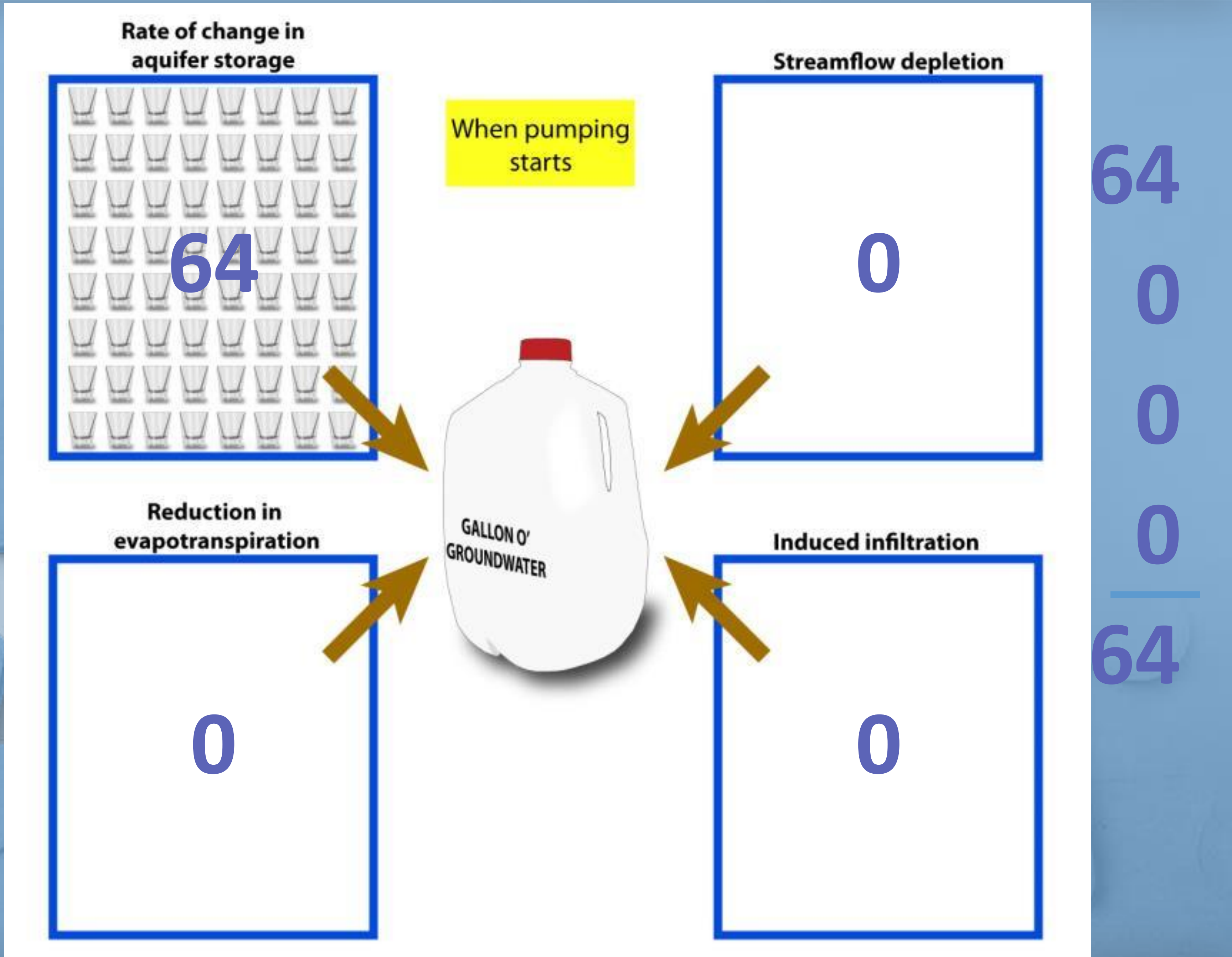
1. Storage change in aquifer
2. Increased flow from perennial stream to aquifer
   Decreased GW discharge to perennial stream
3. Decreased discharge by GW evapotranspiration
4. Induced infiltration of flows in ephemeral stream

The sum of these two is "streamflow depletion"

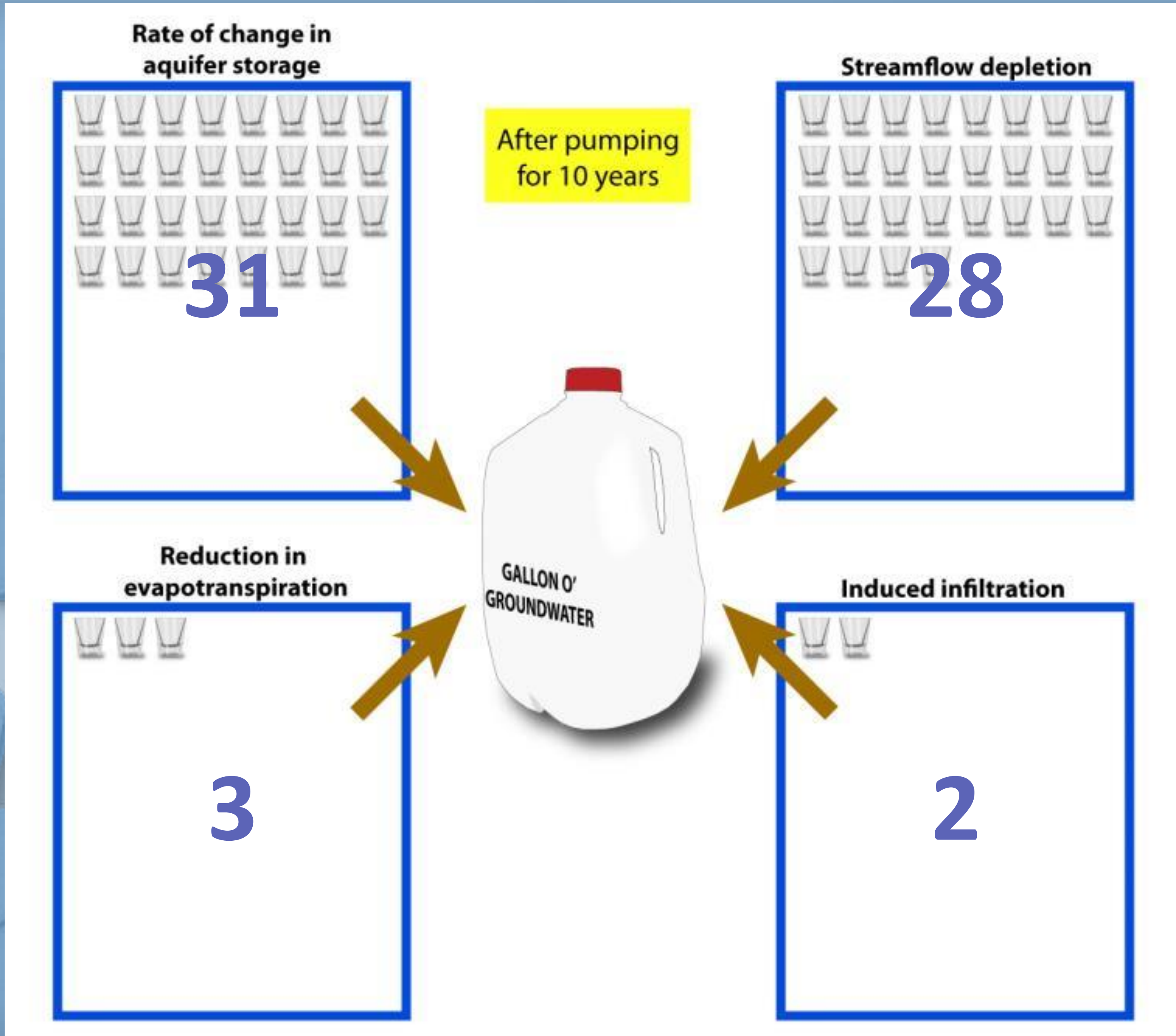
Dividing a Gallon of Groundwater for Tracking Purposes



The following series of four slides shows sources of a gallon of groundwater pumped at different times, starting with when pumping begins.

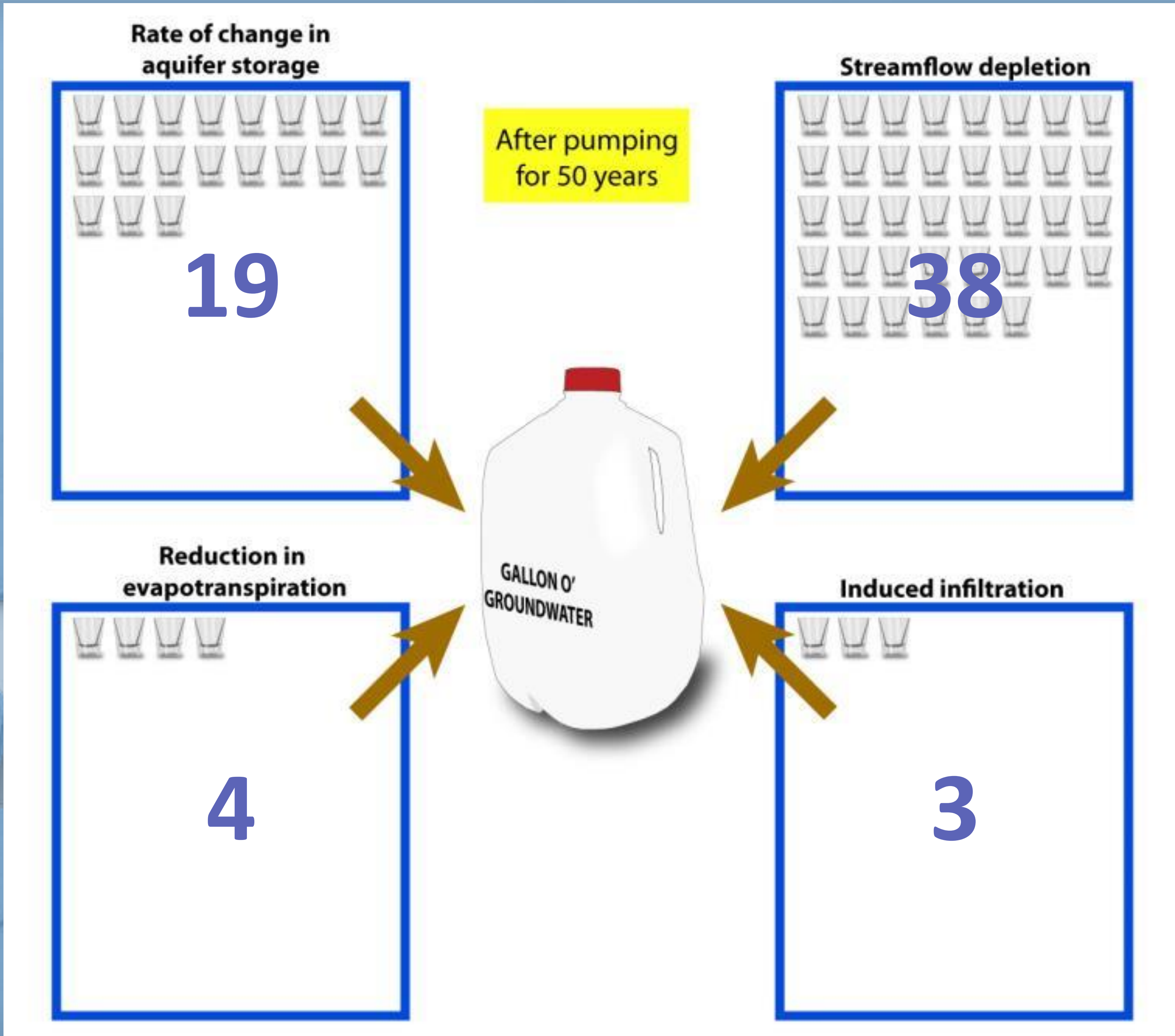


Rate of change in aquifer storage
64
When pumping starts
Streamflow depletion
0
Reduction in evapotranspiration
0
GALLON O' GROUNDWATER
Induced infiltration
0
64
0
0
0
64


Rate of change in aquifer storage
31
Streamflow depletion
28
After pumping for 10 years
GALLON O' GROUNDWATER
Reduction in evapotranspiration
3
Induced infiltration
2

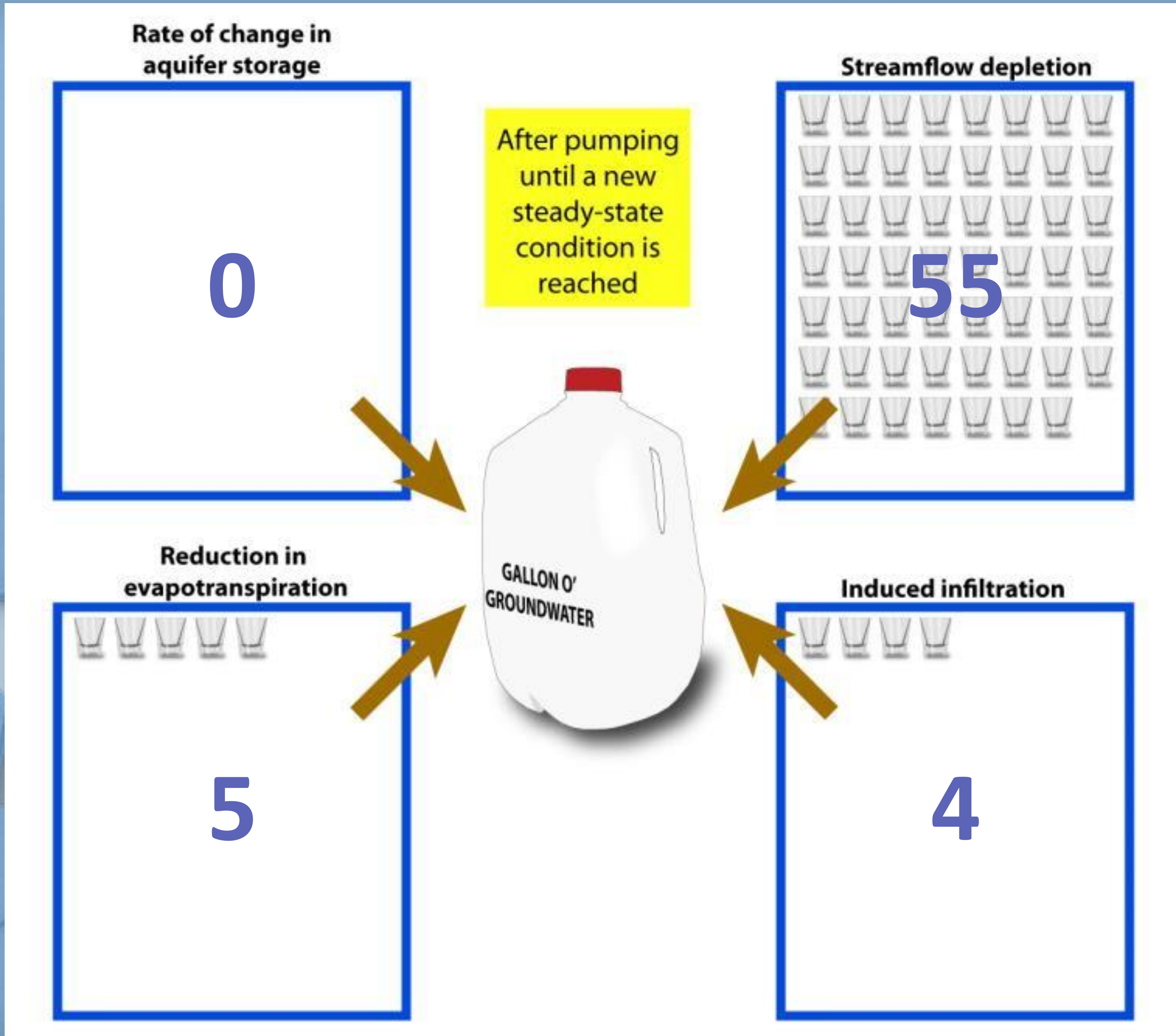
31
28
3
2

64


Rate of change in aquifer storage
After pumping for 50 years
Streamflow depletion
19
38
GALLON O' GROUNDWATER
Reduction in evapotranspiration
Induced infiltration
4
3

19
38
4
3

64



Rate of change in aquifer storage
0
Streamflow depletion
55
After pumping until a new steady-state condition is reached
GALLON O' GROUNDWATER
Reduction in evapotranspiration
5
Induced infiltration
4

0

55

5

4

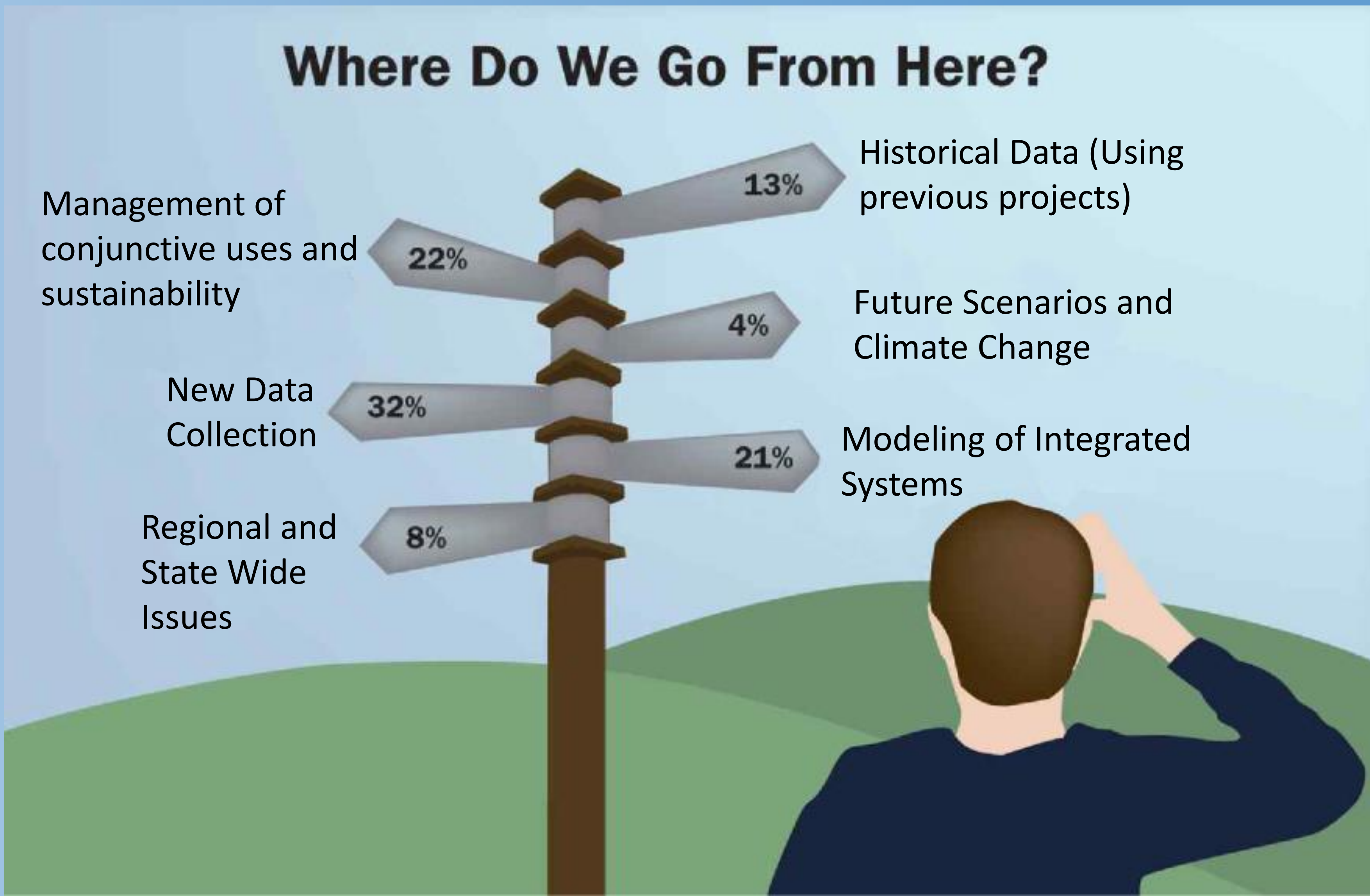
64

Important Concepts

- All groundwater pumped by wells must be balanced with sources of that water in the system. There is a "gallon for gallon" relationship between groundwater pumped and sources, when all sources are considered.
- Water cannot be created out of nothing.
- Water cannot disappear into nothingness.
- The overriding principle is "conservation of mass" or overall mass balance.
- Sources of pumped groundwater are dynamic until the system reaches a new equilibrium or steady-state condition.
- Analysis of sources of pumped groundwater in a complex system requires a groundwater model.

Lets take a break

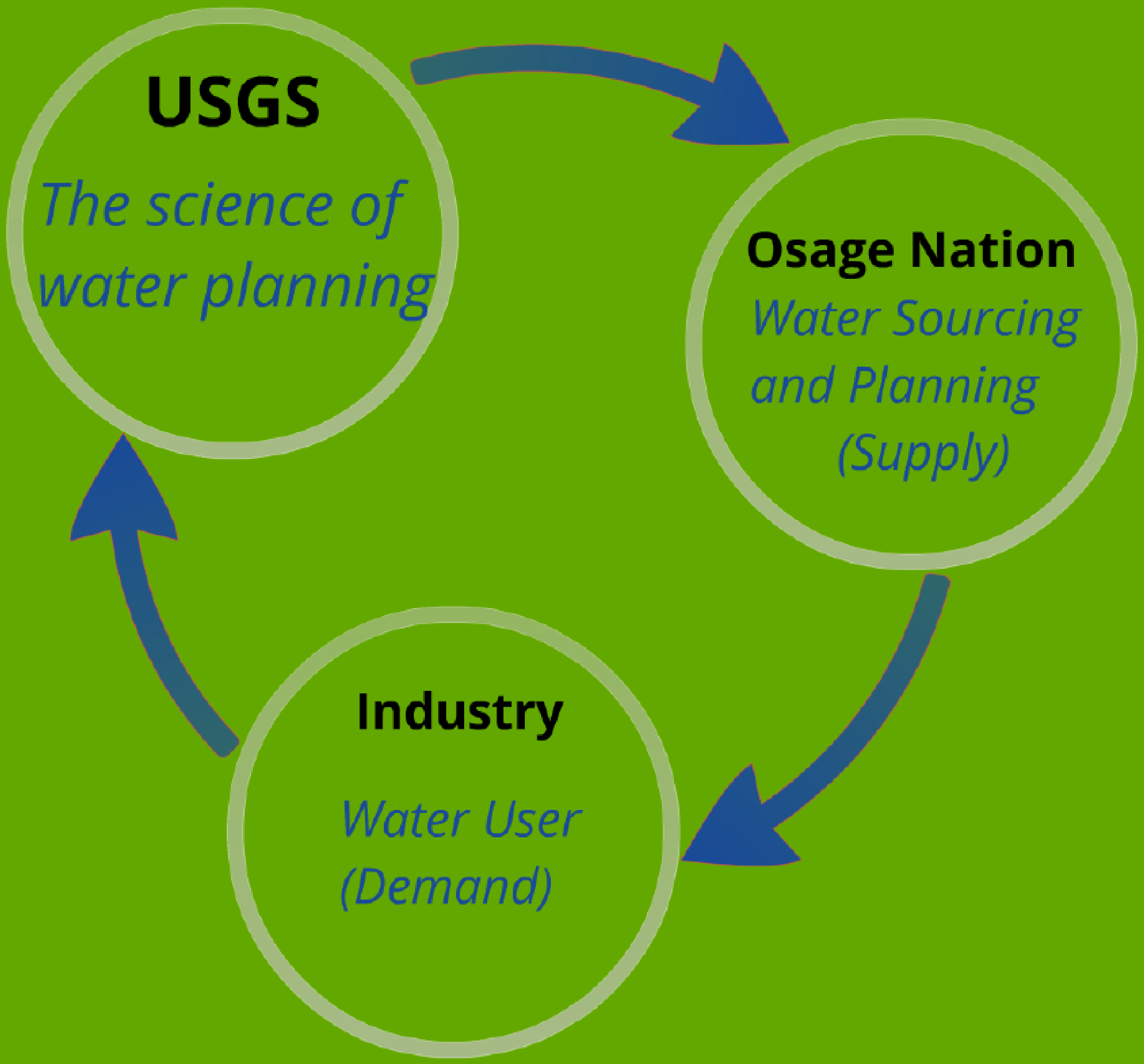
Implementation of Resources Dollars



Current USGS Projects for Tribal Water Planning (#2)

- The U.S. Geological Survey Oklahoma Water Science Center is working in collaboration with the Osage Nation to evaluate the water resources of the Osage Nation and gaps in existing data that, if filled, would provide more complete information about water resources.
- Results of this project will be used by the Osage Nation to produce a comprehensive Tribal water plan that will describe the quality and quantity of water resources in the Osage Nation and describe future sustainable development of those resources.
- A Tribal water plan will help to provide a better future for Tribal members and their neighbors, while preserving water resources for the benefit of the surrounding environment and future generations.

Holistic Path to Water Planning



Why is this important to the Osage Nation?

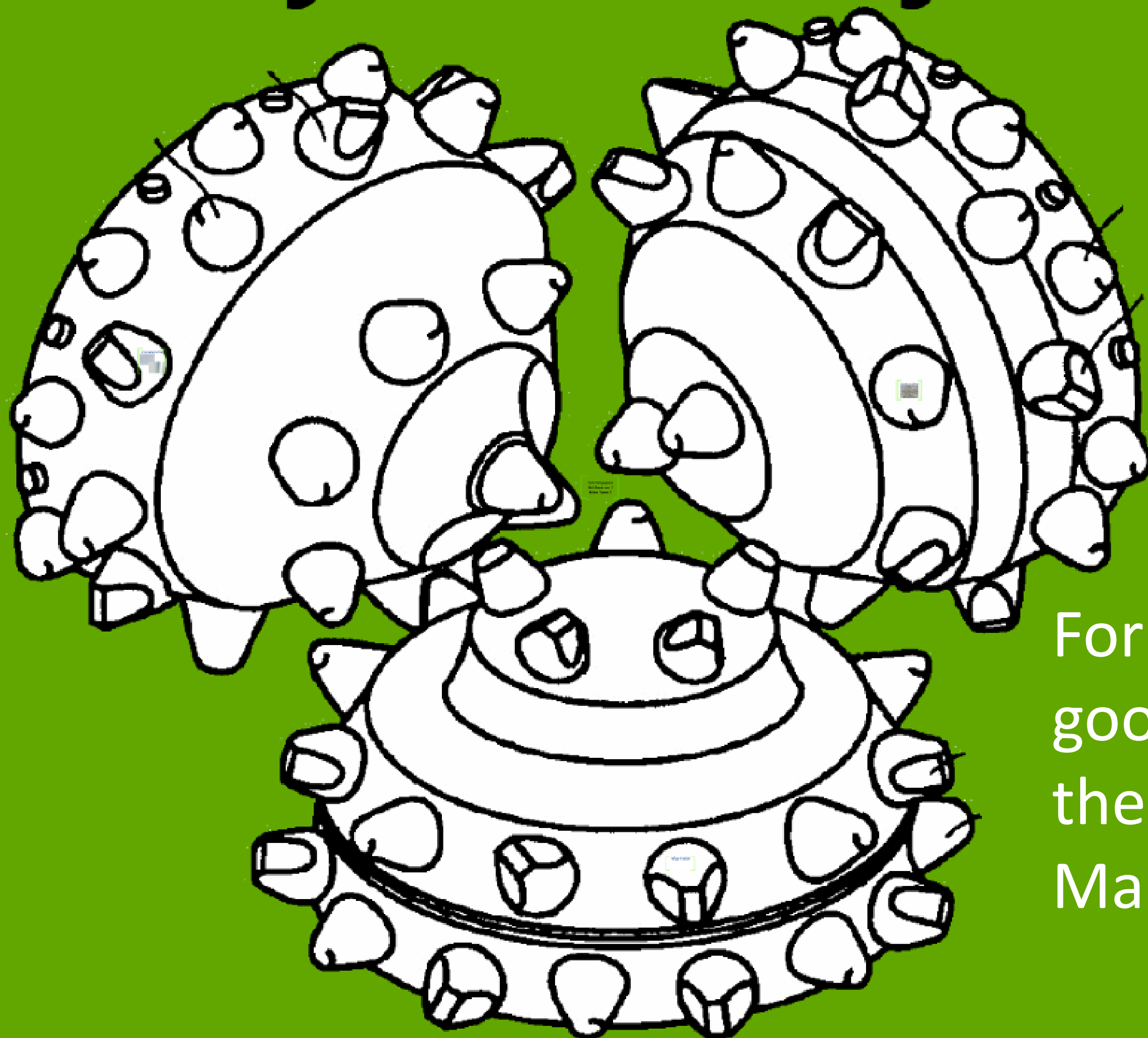
For water planning!

Here is a system where water-use data can help with water planning

- The Osage Nation is interested in water planning
- The USGS can do the science for water planning
- Multiple Water Use Demand sectors need water security

Integrated water-resource management can be mutually beneficial.

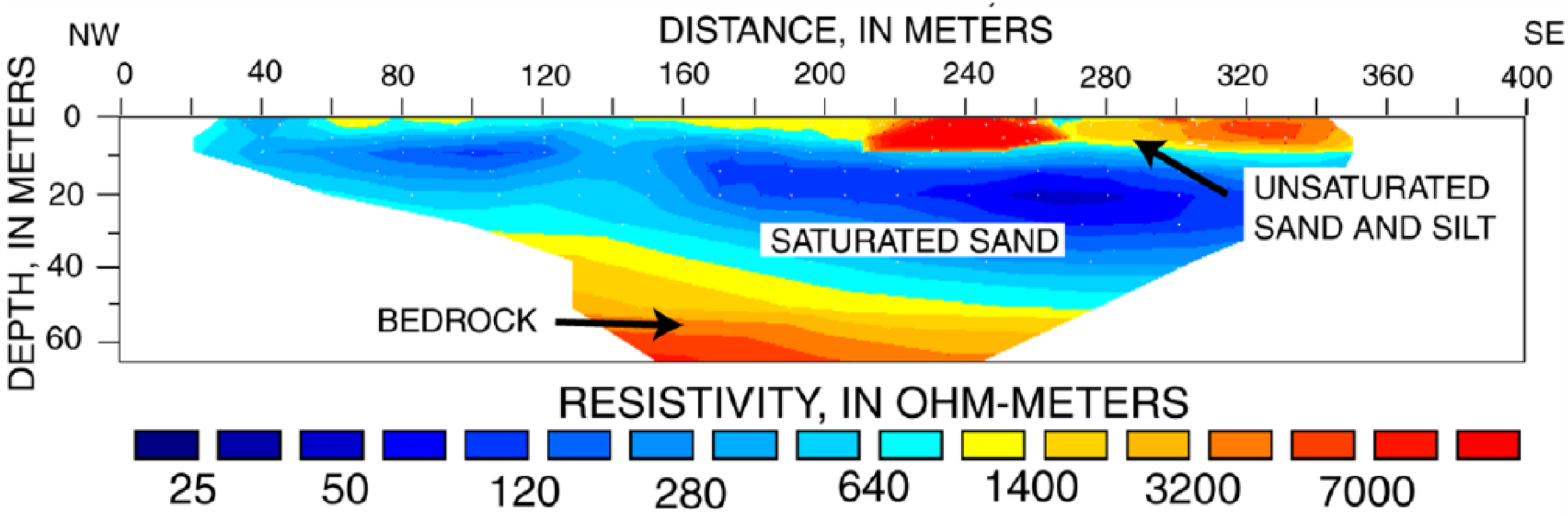
Every Great Project



For every good Bit there are 3 Main Cones !

Is Done One Bit at a Time

Map Water



NW
DISTANCE, IN METERS
SE
0
40
80
120
160
200
240
280
320
360
400
DEPTH, IN METERS
0
20
40
60
UNSATURATED
SAND AND SILT
SATURATED SAND
BEDROCK
RESISTIVITY, IN OHM-METERS
25
50
120
280
640
1400
3200
7000

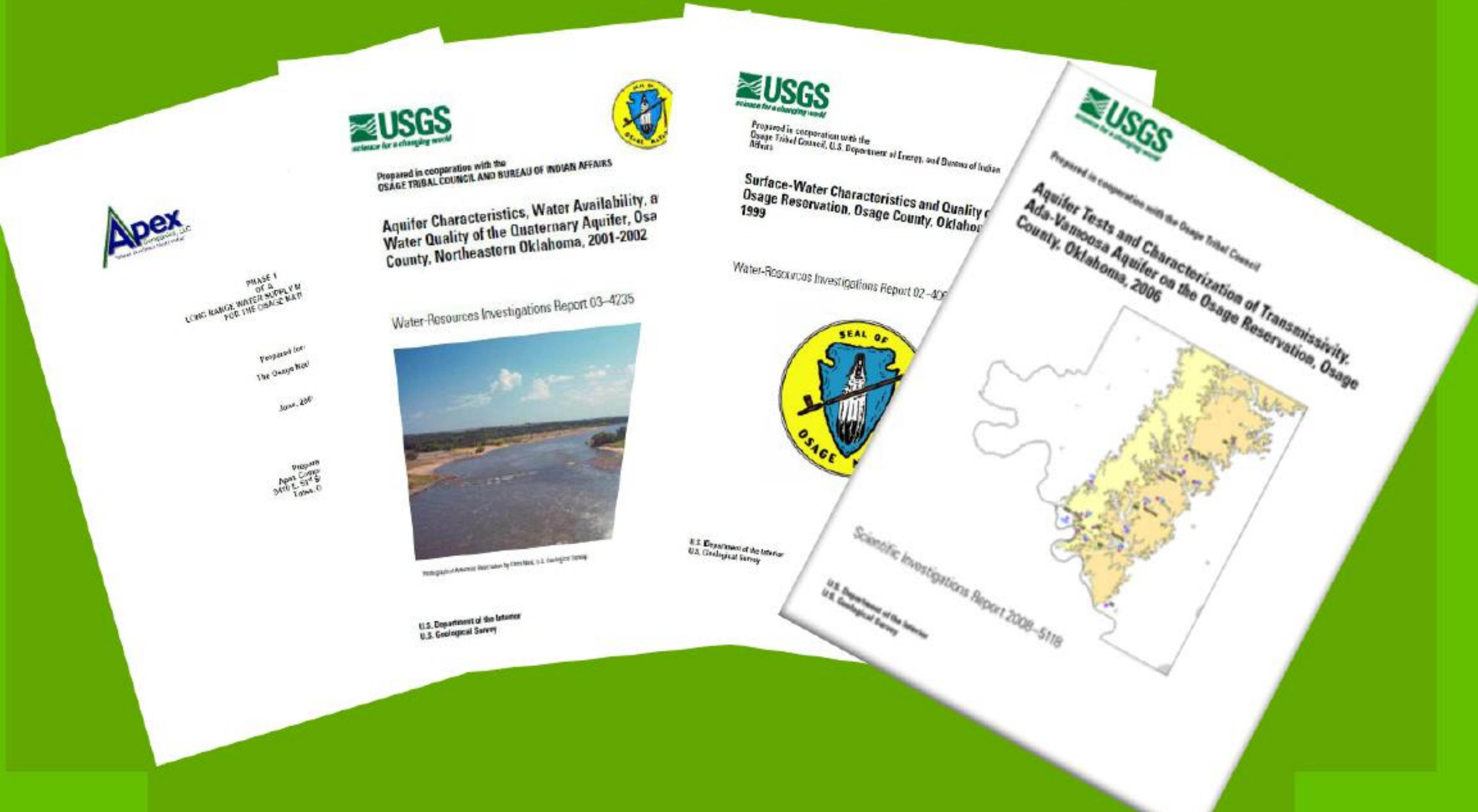
Measuring Water

Monitor Water

USGS Program Outline

- Task 1 - Data Compilation
- Task 2 - New Data Acquisition
- Task 3 - Model Development
- Task 4 - Water Availability Analysis
- Task 5 - Report and Web

Task 1 - Data Compilation from reports



Task 2 - New Data Acquisition

- Mapping Water
  - Using Hi-Tech Remote Devices
- Measuring Water from Drilling
  - Characterize aquifers
  - Characterize Groundwater/Surface Water Interactions

USGS and XRI efforts to "Map Water"

- Map the extent of Marginal and Fresh Water
- Define Water Availability
- Delineate the transition zone of saline to fresh water
- Plan for future water use and development

Airborne Electromagnetic (AEM)

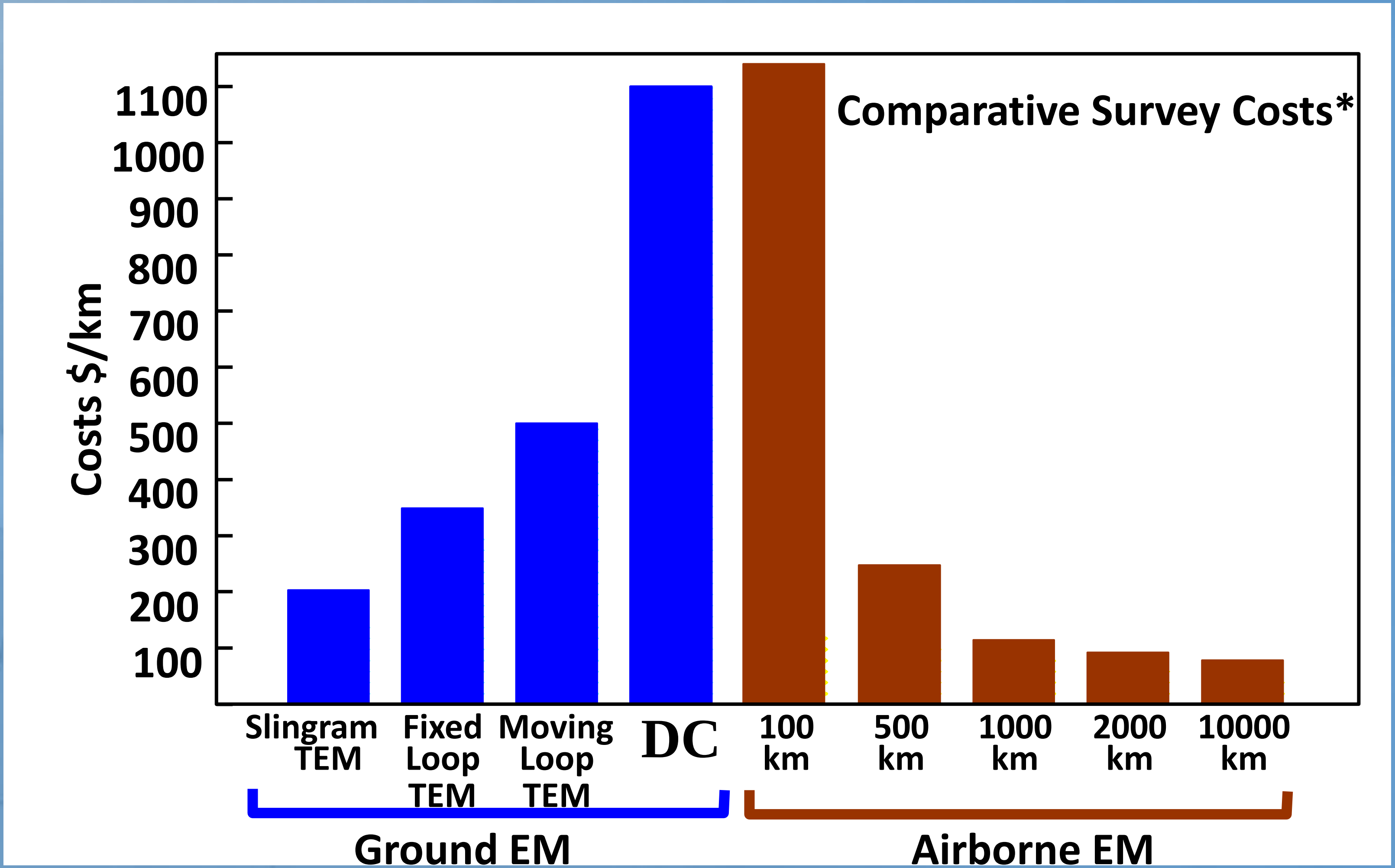
Background Airborne Methods

- Airborne Geophysics began following WWII
- Airborne magnetic surveys were the first airborne geophysics
- Mining exploration stimulated development of methods to map ore bodies including magnetic, radiometric, and EM techniques
- Gravity and magnetic methods have traditionally been used in petroleum exploration
- More recently airborne geophysical methods have been used for groundwater, environmental, engineering and agricultural purposes.

Ground vs. Airborne $

Ground TEM acres of coverage/day
75 @ 300 ft spacing

Airborne TEM acres of coverage/day
30,000 @ 300 ft spacing

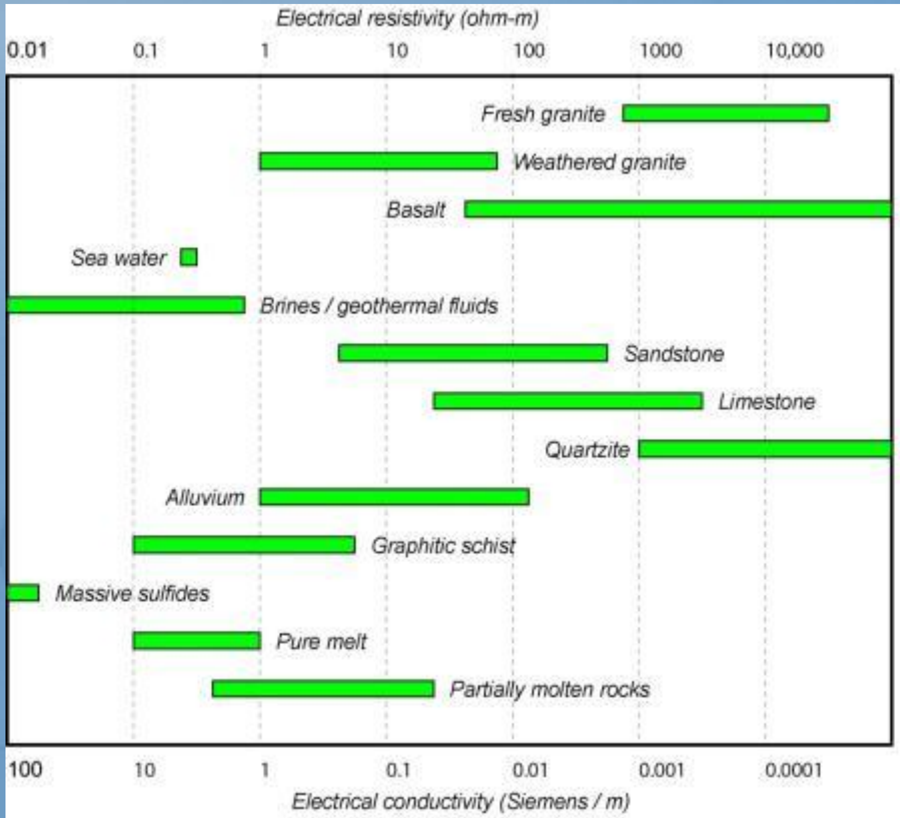


* Costs are representative only, and do not constitute a contract!

In a Nutshell - Physics of EM Induction Methods

- Current in Tx loop produces a magnetic field.
- Turning off or varying the current (dB/dt) induces a horizontal current system in earth.
- Induced current system diffuses outward and downward with time.
- Interaction of current system and ground controlled by earth *resistivity.*
- We measure a secondary magnetic field on one or more receivers.

Resistivities of Rocks



Factors that **DECREASE** resistivity:

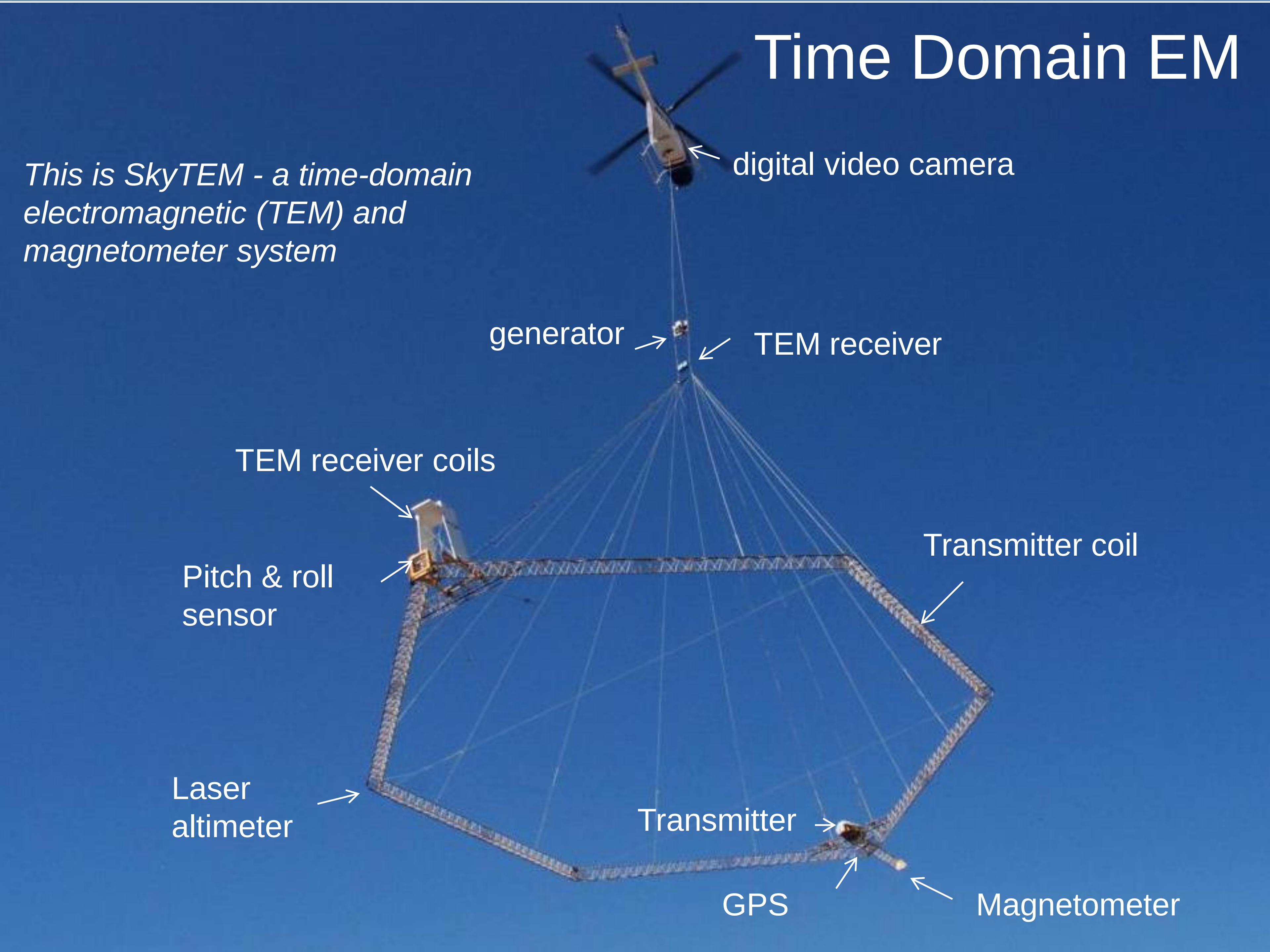
- Add more pore fluid
- Increase salinity of pore fluid
- Fracture rock to create extra pathways
- Add clay minerals
- Keep fluid content constant, but improve interconnection between pores

Factors that **INCREASE** resistivity

- Remove pore fluid
- Lower salinity of pore fluid
- Compaction - less pathways for current flow
- Lithification - block pores by deposition of minerals
- Keep fluid content constant, but decrease connection between pores

Time Domain EM

This is SkyTEM - a time-domain electromagnetic (TEM) and magnetometer system



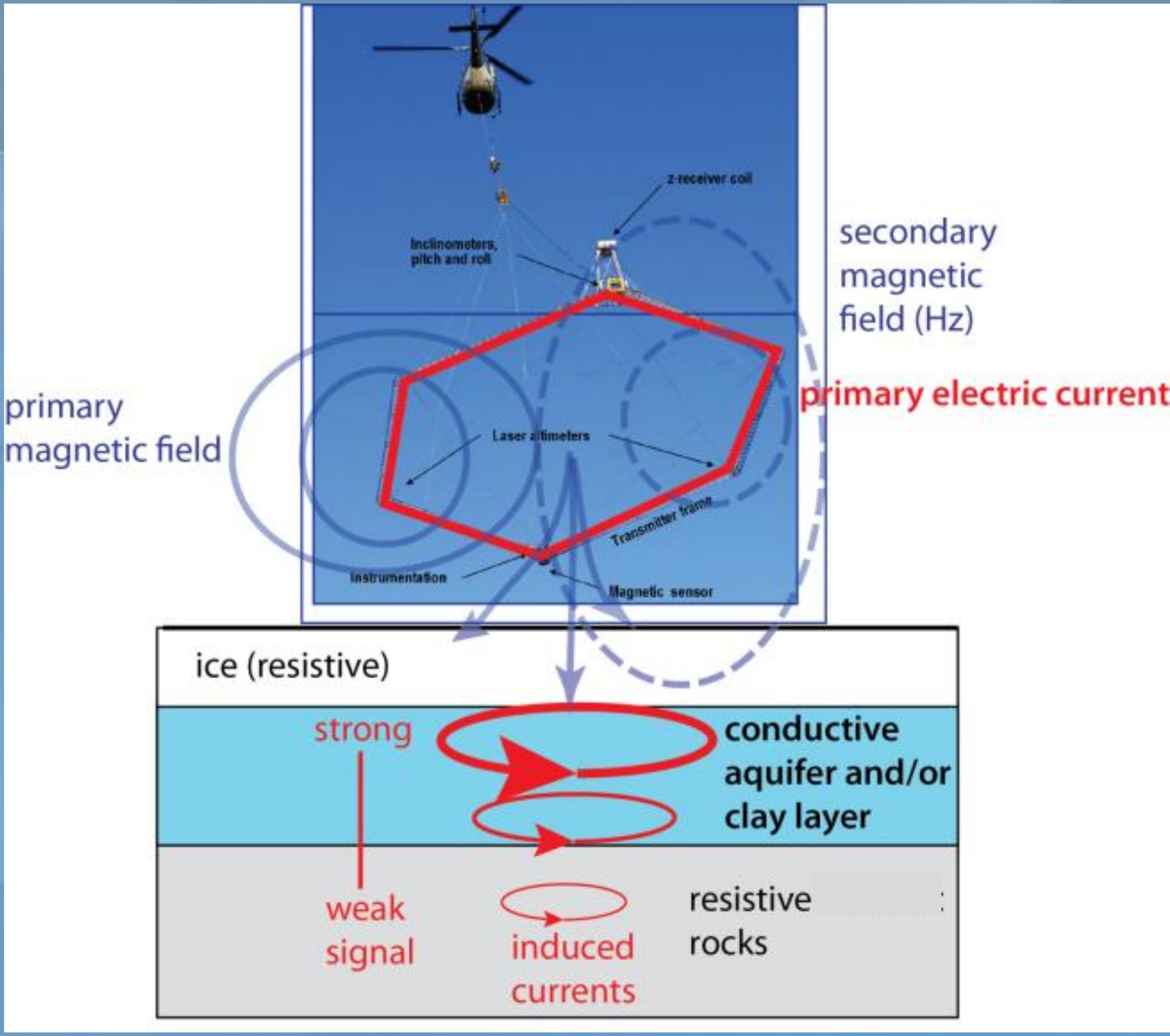
How does TEM work?

Current in transmitter coil generates a magnetic field.

This magnetic field induces currents in the ground. Currents are stronger in (conductive) clays and saline water than sandstones and fresh water (resistive rocks).

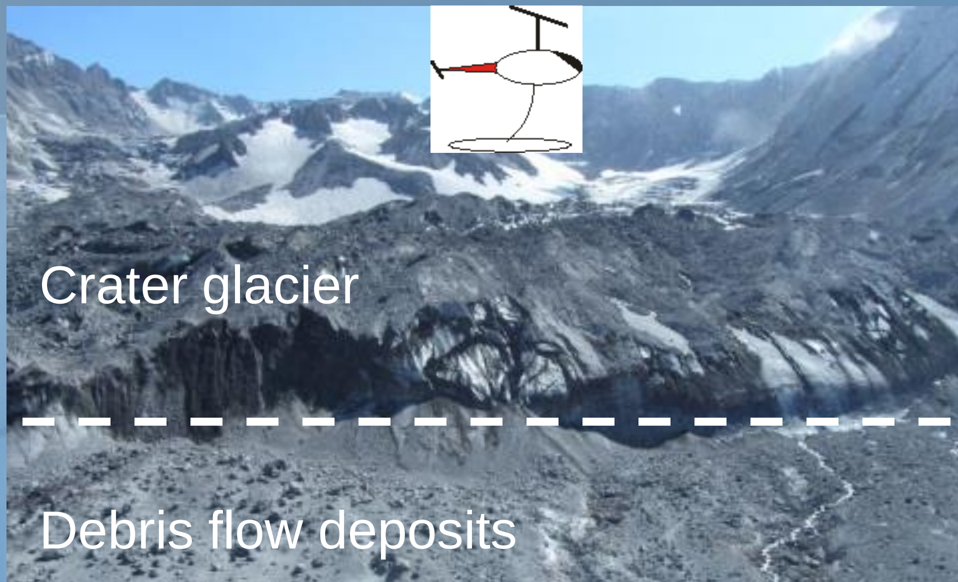
These currents generate a secondary magnetic field measured by the receiver coil.

The strength and decay of the secondary magnetic field tells us about the resistivity of the ground.



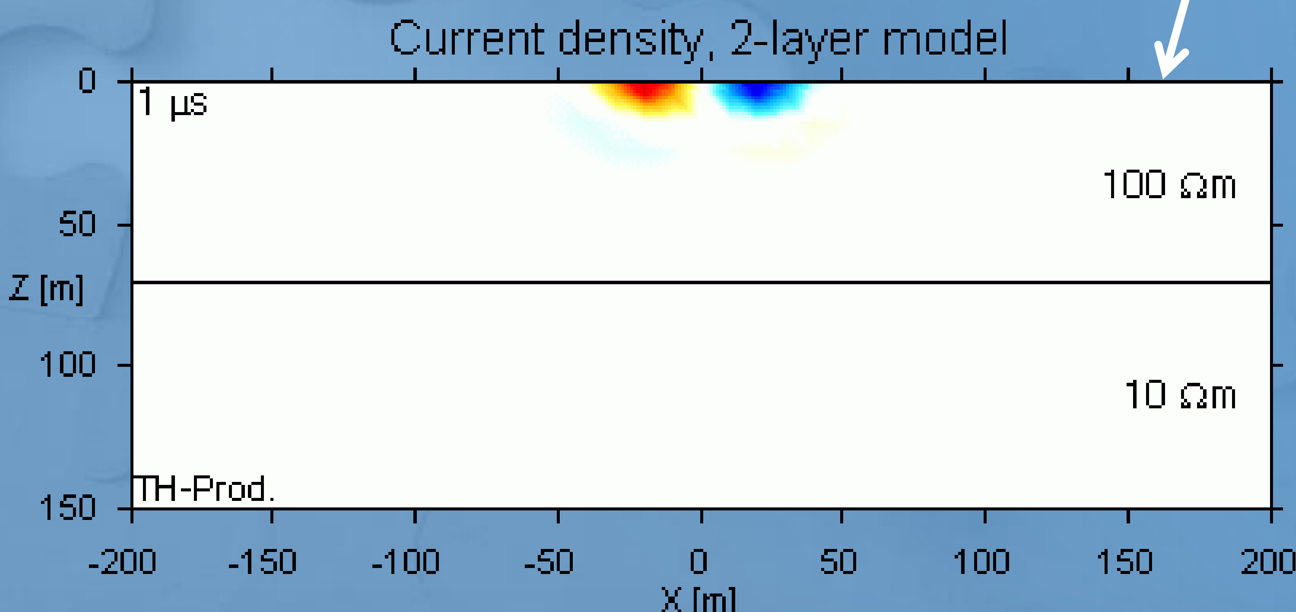
Modified from Bedrosian 2012

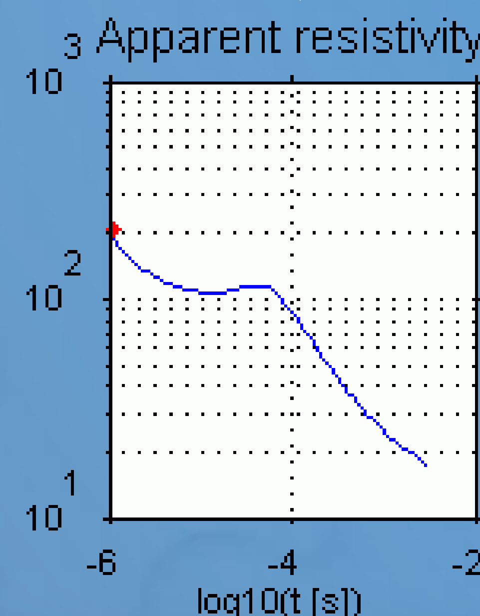
Imaging with TEM



The current induced in the earth diffuses downward and outward

What we measure in the receiver coil





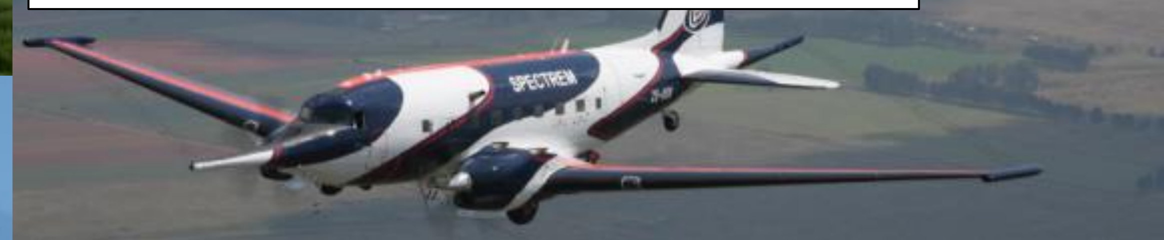
Source Bedrosian USGS, Auken University of Aarhus

Fixed-Wing Airborne Electromagnetic Systems

Frequency Domain Sander Geophysical FGEM

Time Domain CGG Veritas GeoTEM

Time Domain Spectrem Air Spectrem 2000

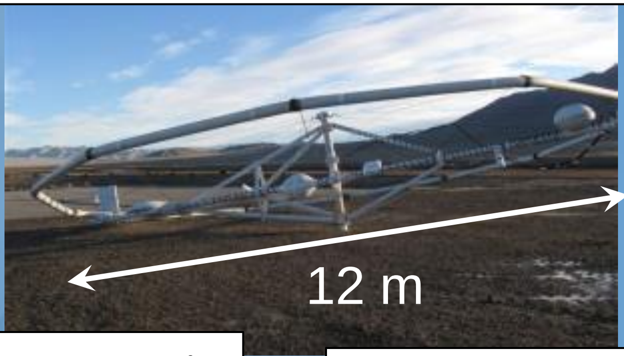


Time Domain CGG Veritas MEGATEM

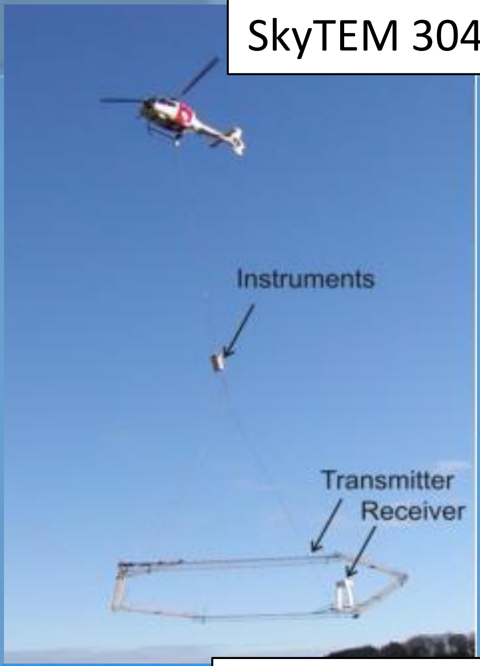
Helicopter AEM Platforms

Frequency Domain
CGG Veritas RESOLVE / DIGEM

Time Domain
Aeroquest/Geotech AeroTEM IV



Time Domain
SkyTEM 304



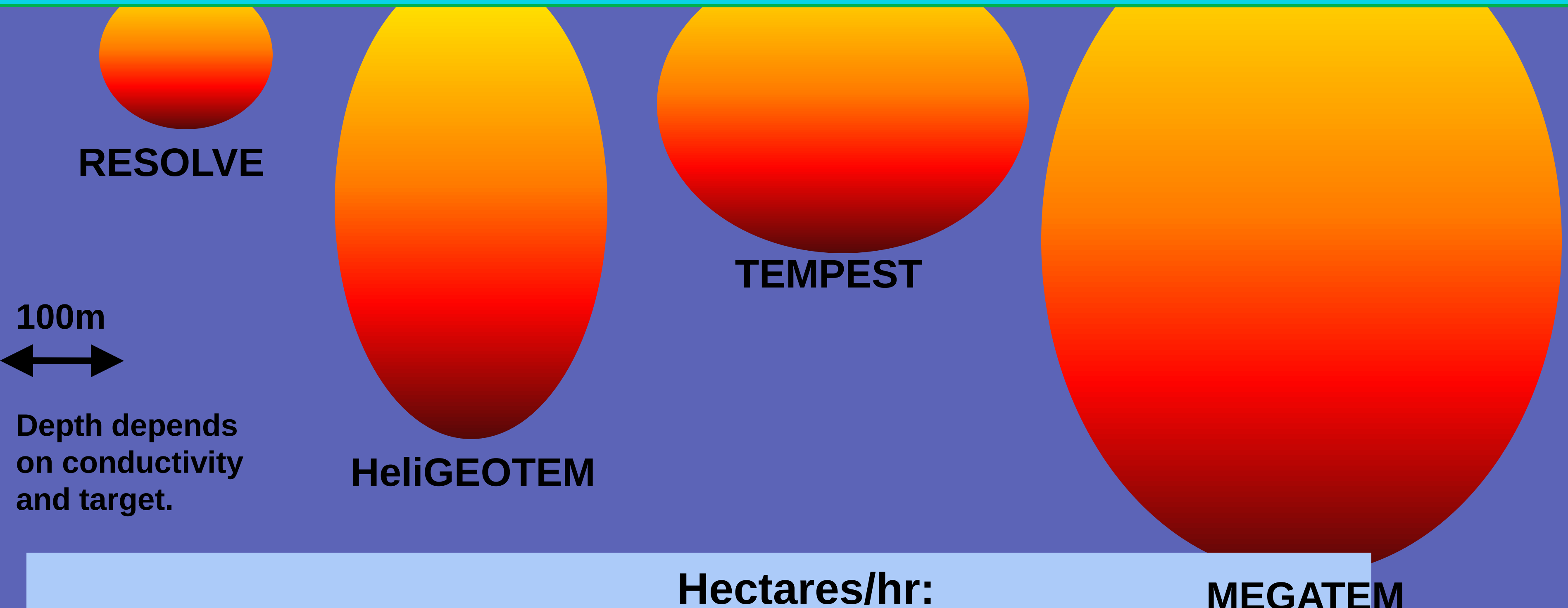
Time Domain
Geotech VTEM

Time Domain
CGG Veritas
HeliTEM

Time Domain
AirTEM 600

Natural Source
Geotech ZTEM

AEM Systems: Relative Footprints



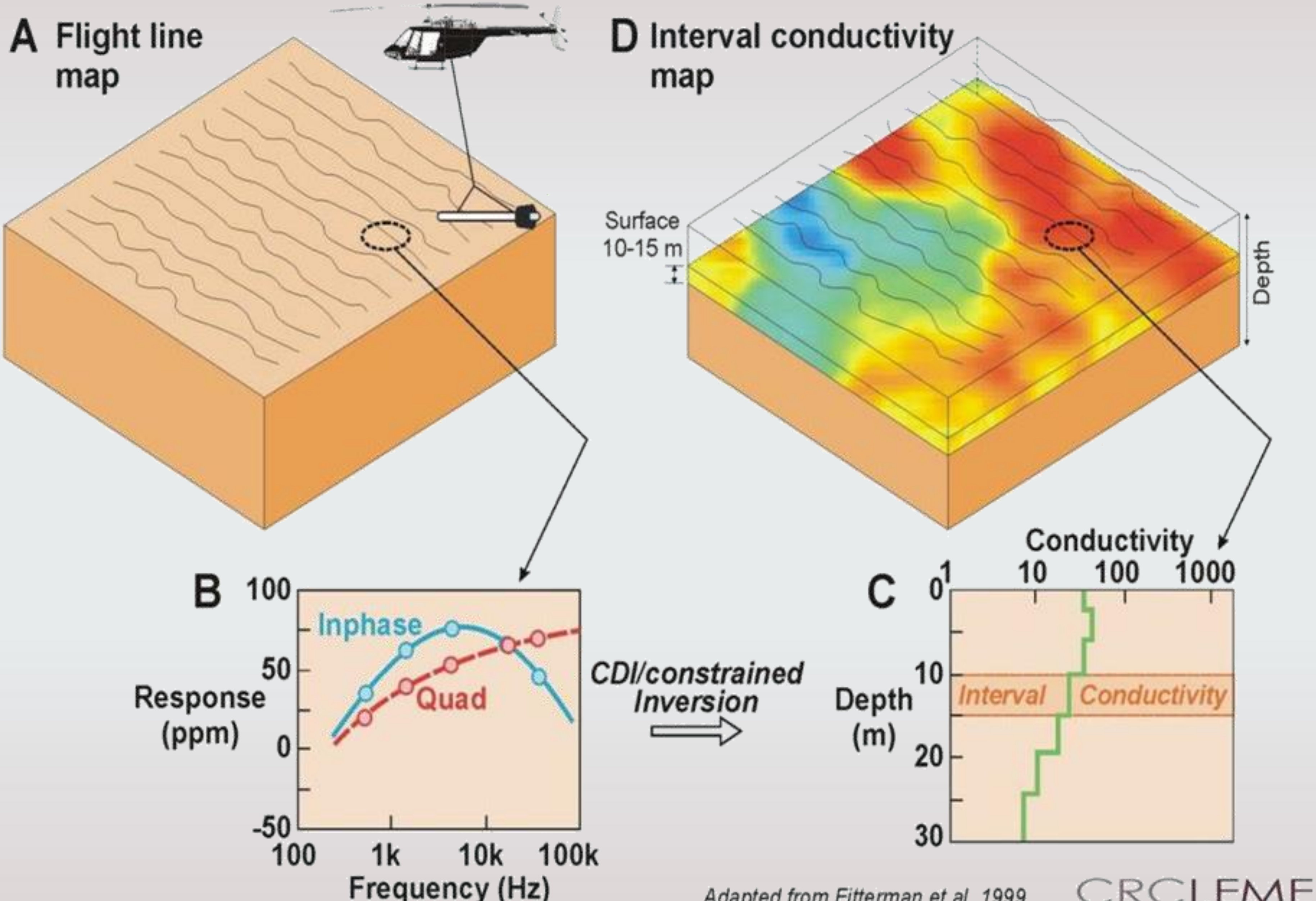
Hectares/hr:

810	720	3200	6500

Airborne EM Survey Production and Cost

- Typical helicopter surveys fly ~ 1,000 line km/day.
- Most contracts are on the order of $250,000.
- Processing and interpretations is a about a 1:1 ratio for data collection.
- In western NE cost are $9.00/acre.

Inversion of AEM data



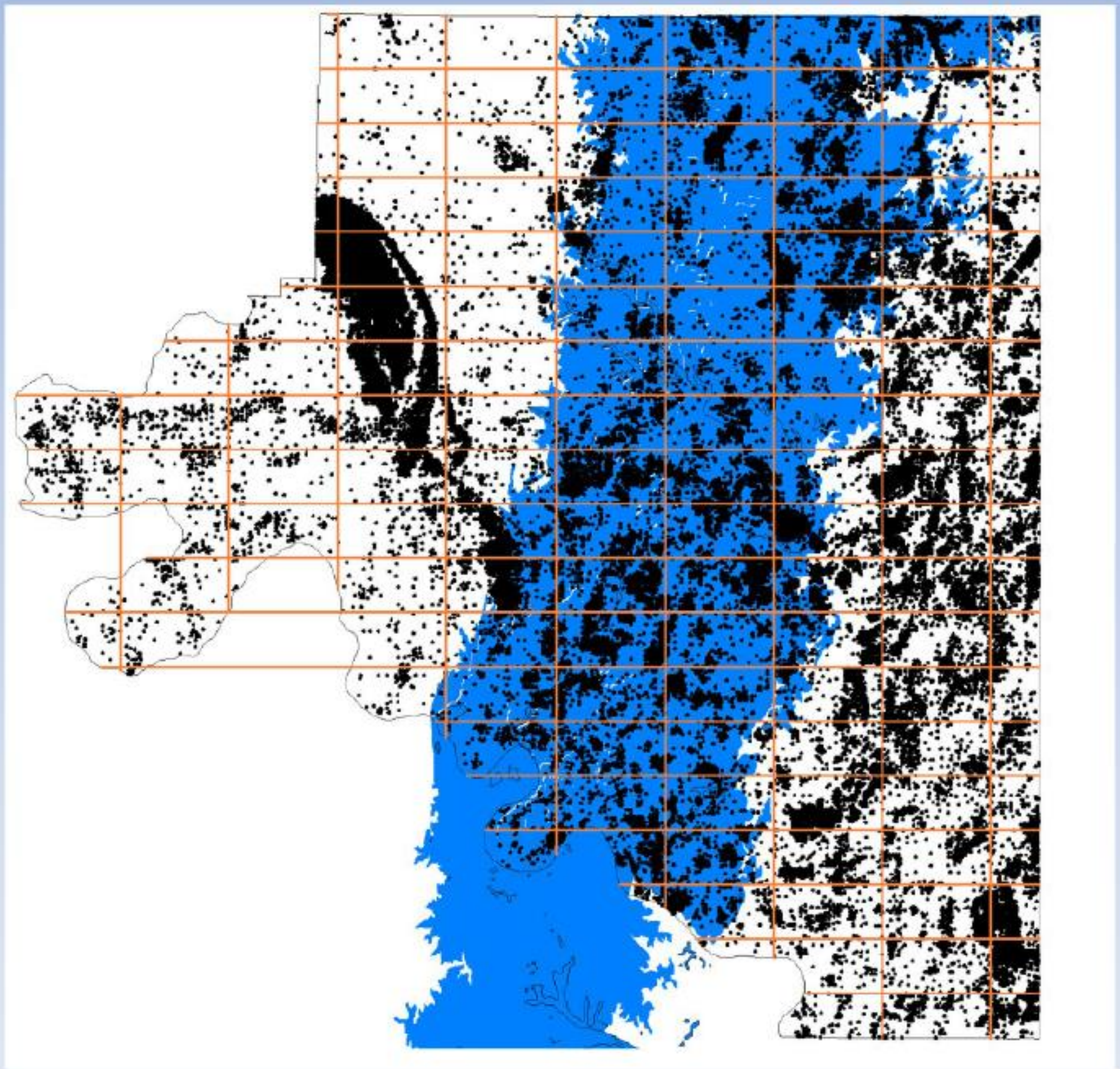
Adapted from Fitterman et al. 1999

CRCLEME

TMs024-03

USGS AEM Surveys

Reconnaissance Survey of Osage County



Osage working with Industry & USGS

Locates Area for High Water Use (in-fill flying)

USGS - "Measures the Water"

Determine Water Well Placement

Drills the Water Wells

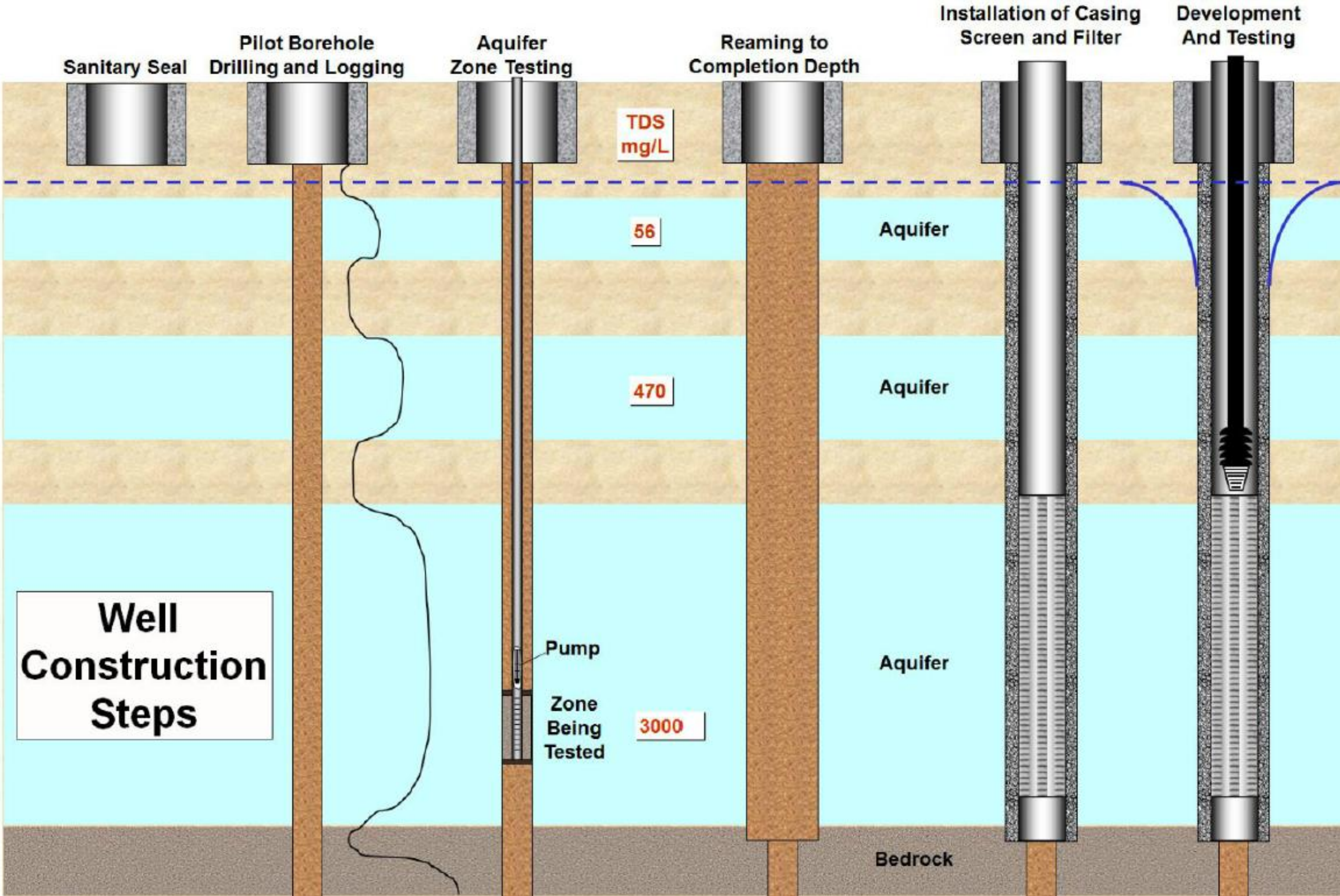
Do The Science of Water

Drilling

Direct mud rotary or air hammer drilling techniques

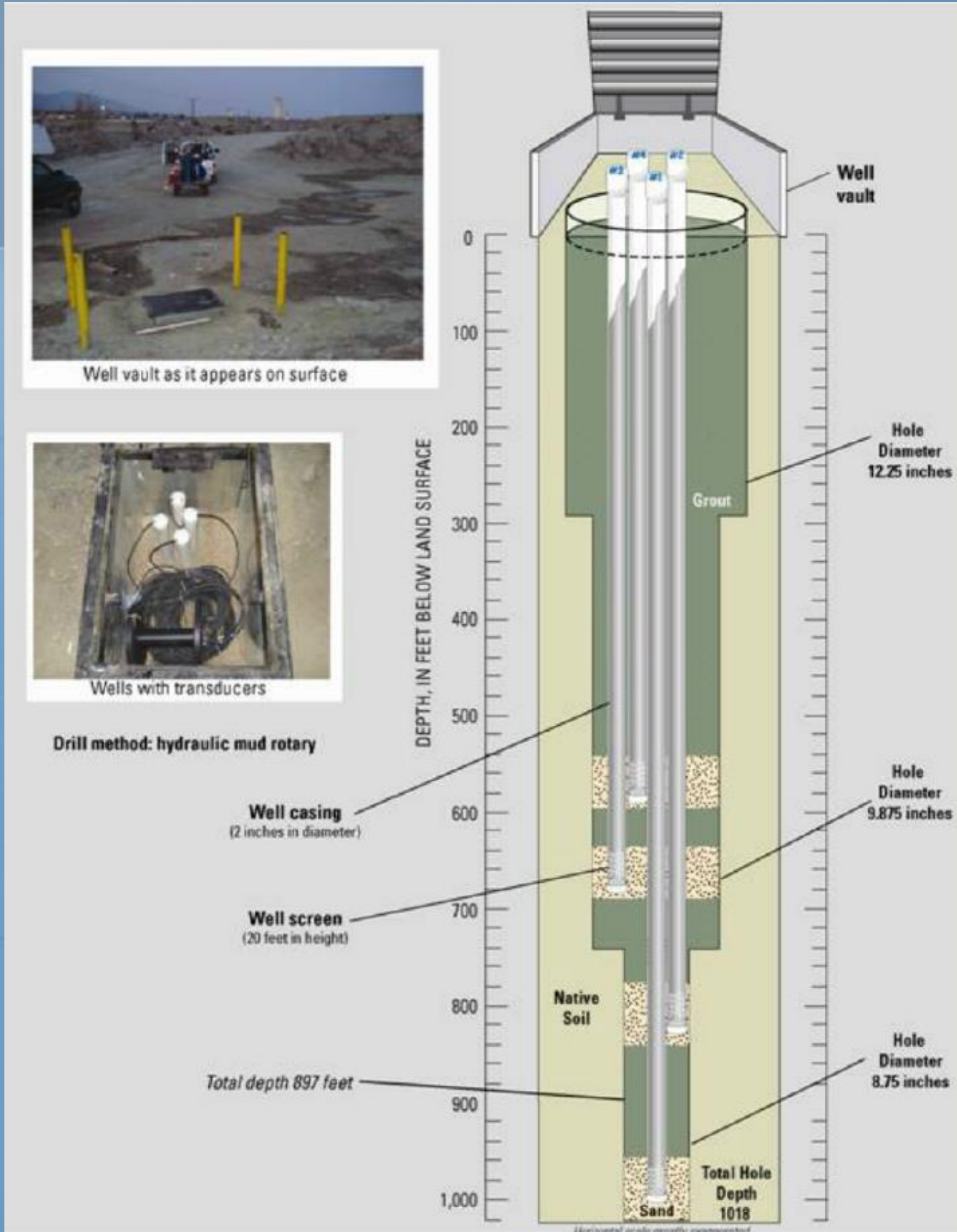
High-quality cuttings at 1 foot intervals

Core material collected at selected intervals for analysis of hydraulic properties


Sanitary Seal
Pilot Borehole
Drilling and Logging
Aquifer
Zone Testing
TDS
mg/L
Reaming to
Completion Depth
Installation of Casing
Screen and Filter
Development
And Testing
56
Aquifer
470
Aquifer
Well
Construction
Steps
Pump
Zone
Being
Tested
3000
Aquifer
Bedrock

Task 3 - Model Development

- USGS will Monitor Water.
- Real-time Data Networking
- Built in flags to monitor well sites
- Defensible Data Base
- Accessibility can be designed to meet all needs
- Quality Assurance & Quality Controlled
- Project leverages in-kind services of National Data Base



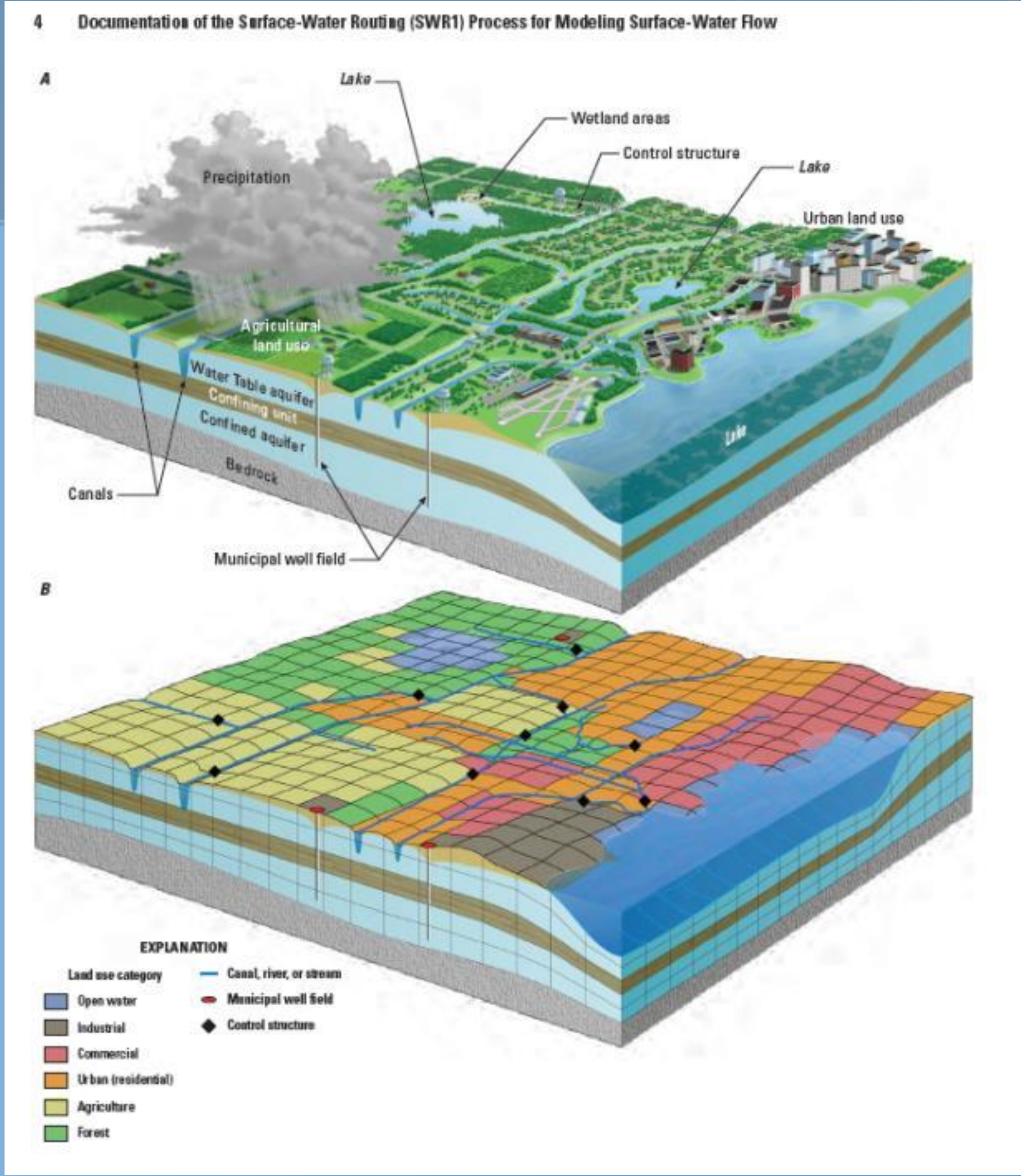
Well vault as it appears on surface

Wells with transducers

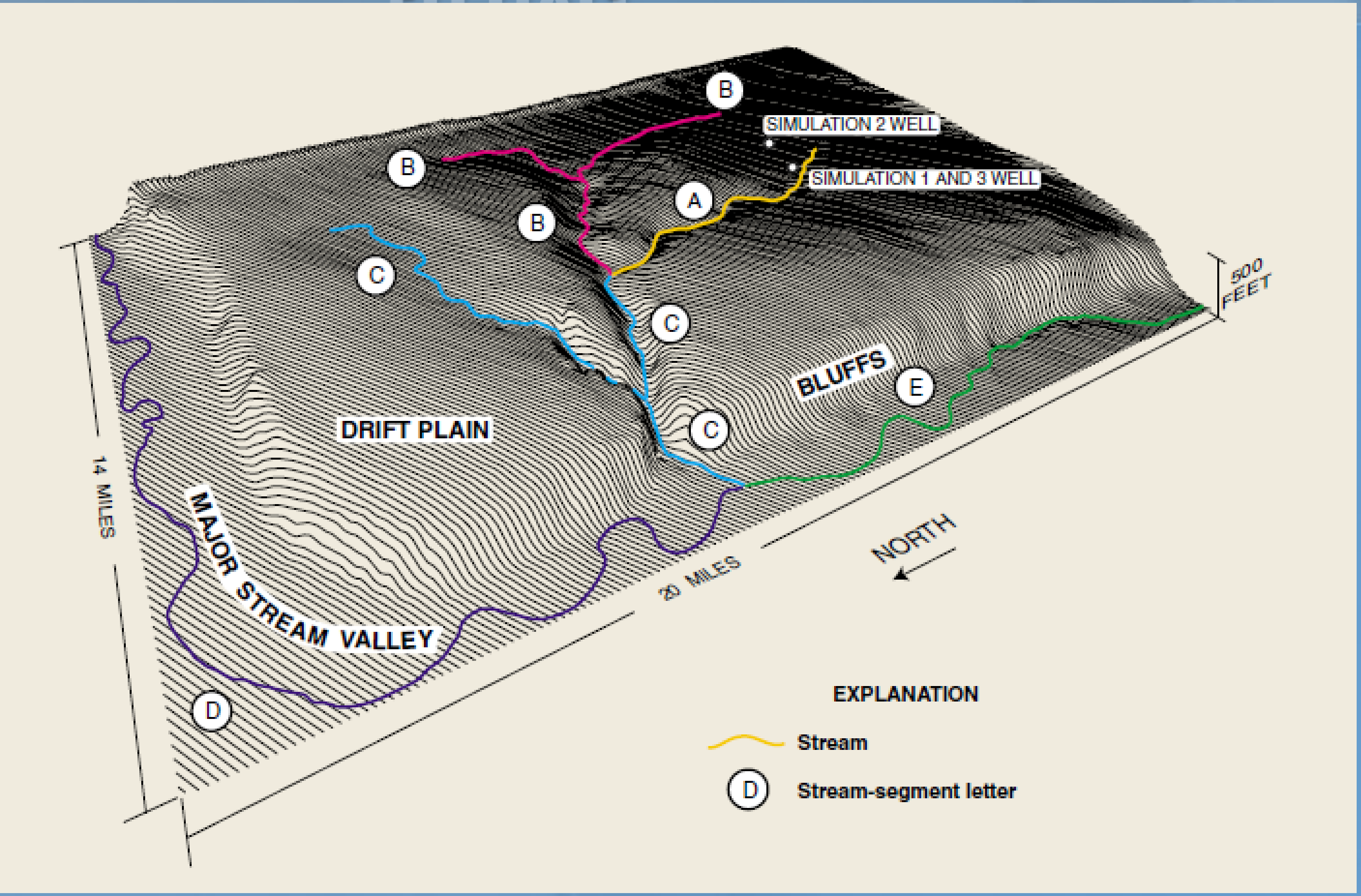
Integrated Hydrologic Model (IHM)

Building the Water Balance Model

- Looks at all water uses
- Uses different water inputs
- Just like a bank account, keeps track of the balance



Integrated Hydrologic Model (IHM)



Three-dimensional perspective view of a hypothetical basin typical of the Osage Nation showing topography, streams, and well locations for pumping simulations. (Modified from Morgan and Jones, 1999.)

Task 4 - Water Availability Analysis

- Different Water-Use Scenarios
- Different Water Supplies
- Look at Climate Variability
- Game Water Supply and Demand

USGS Program Outline

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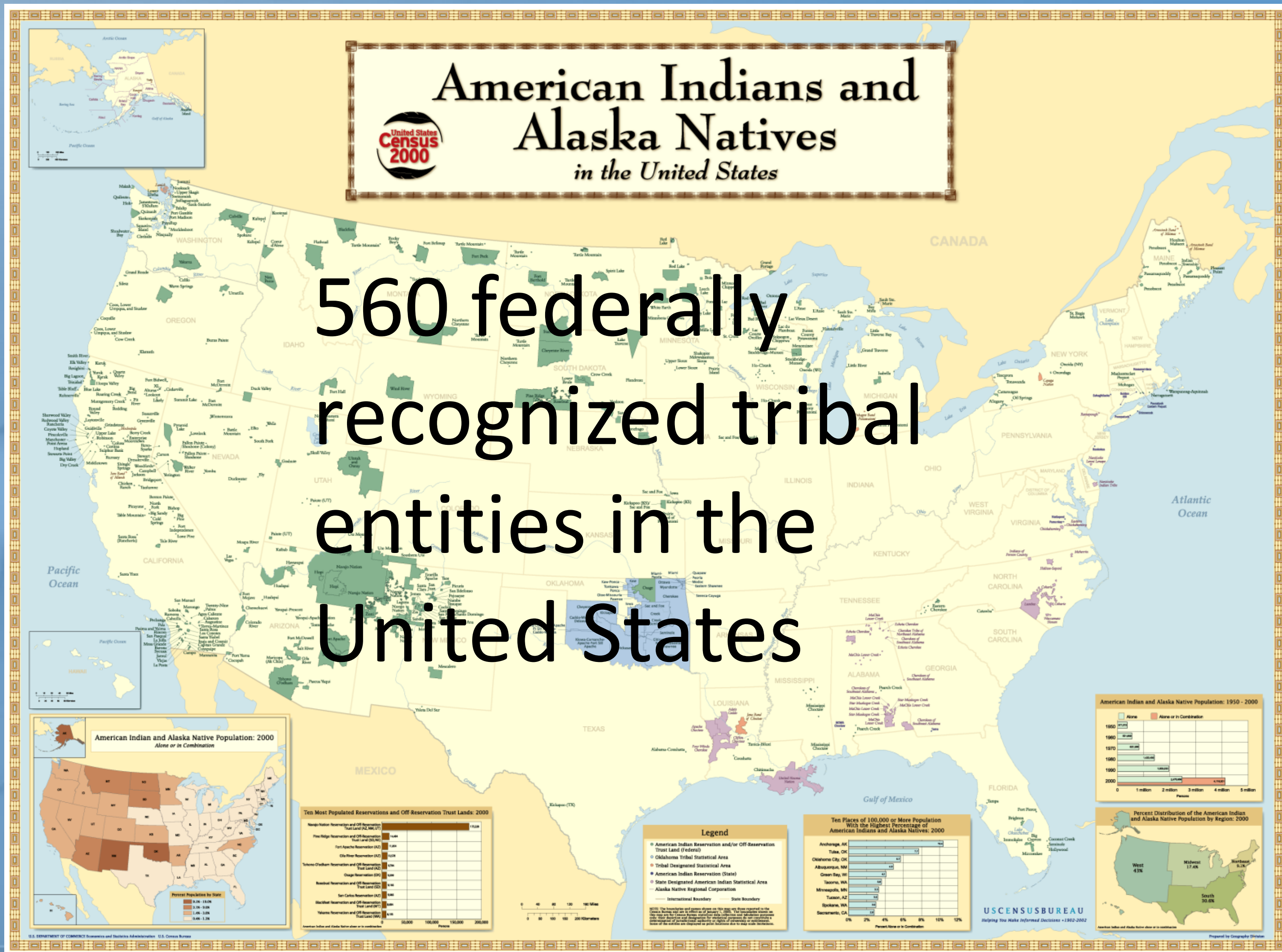
Lets take a break!

Water varies in the U.S.
So do the Native American Nations



560 federally recognized tribal entities in the United States

Native American Water Rights Settlements

- Twenty-nine (29) Native American water rights settlements have been achieved to date in the U.S.
- None in Oklahoma. Why?
- Complicated State Water Laws and Reserved Tribal Water Rights.

Resolving American Indian Water Rights, Are They Better Off?

- Water rights are an important undertaking for the economies, community relations and water management of tribes, states and local communities.
- Determination of any American Indian water right can take decades.
- Court awards only a water right, and the tribe may not have resources to develop and use the right awarded.

Perception Complicates the Problem

- The total claims of Arizona tribes exceed the total water budget for the state.
- The claims of the Navajo on the San Juan River in New Mexico approach 1 billion acre-feet of diversion right per year. (More than is in the San Juan!)
- Many tribes lack access to potable drinking water,
- Others need access to water to support lifestyles involving agriculture, hunting, gathering and fishing,
- And all need access for cultural and spiritual life ways.

American Indian Water Rights Video

- https://www.youtube.com/tv?vq=medium#/watch?v=Q-gGa-ln6WQ

State Water Legal Systems in U.S.

- Appropriation
  - Water treated as a commodity, severed from land or property owned
  - Divert water from surface water course
  - "Beneficial Use" Applies
  - Like mining claims, based on "use it or lose it" or "first in time, first in right"
  - Transferable
  - No Sharing
- Riparian
  - Based on land ownership
  - Reasonable Use
  - Correlative Right, "you own the land you own the right"
  - Not lost through non-use
  - May initiate new use at any time
  - Equitable sharing

Water Laws

- Oklahoma State Water Law
    A. The Riparian Doctrine (Groundwater)
    B. The Appropriation Doctrine (Surface Water)
    C. The Dual-System
- Federal and Indian Reserved Rights
    1. Winters Doctrine — Uncontroversial source of rights.
    Creation: implicit in Indian country and Federal reservation of land
- State Systems
    2. Five Tribes Water Doctrine (may also apply to a few other tribes)
    Creation: conveyed by treaties between tribes and states
    Choctaw Nation v. Oklahoma and the "peculiar circumstances" of the Indian Territory

Sources of Tribal Water Rights in Oklahoma

Federal Laws

Winans	*Winters*
United States v. Winans 198 U.S. 371 (1905)	*Winters v. United States* 207 U.S. 564 (1908)
Implied from Hunting or Fishing Right	Implied from reservation of land
Little Relevance in Oklahoma	Characteristics similar to Oklahoma Tribes

State Laws and Treaties

Five Tribes Water Doctrine	Oklahoma Riparian Rights
Choctaw Nation v. Oklahoma 397 U.S. 620 (1970)	Statehood 1907
Conveyance by Treaty	Federal and tribal users may have rights within state system
Characteristics similar to Oklahoma Tribes	TBD

Federal Reserved Rights

***Basis*:** Reservation of land from public domain for a specific purpose

Created by U.S. Supreme Court rulings:

- *Winters v. U.S.* (1908): Enough water is reserved to effect the purpose of the reservation ("*Winters*" rights)
- *Arizona v. California* (1964): Extended the doctrine to all federal reservations

Federal Reserved Rights Cont.

Measure and Limit:

- **Amount:** quantity necessary to effect purpose/s of reservation—requires court adjudication
- **Purpose:** limited to purpose/s of the reservation
- **Priority:** date reservation was created by Congress
- **Prior Use:** Quantification of prior uses by the Tribal Nation

Federal Reserved Rights Cont.

What's the problem with Federal Reserved Rights (FRR)?

- Contrary to deference to state law
- Un-quantified until adjudicated. Other appropriators on source don't know value of their rights until the FRR is quantified
- How does one quantify water rights then?
- The Better the Science – The Better the Plan!

ADJUDICATIONS

Process by which a state determines existence and nature of all rights in a watershed

- *Confirms existing rights*—does not create rights, enlarge or otherwise modify existing rights
- Can be done by the Board or a court
- Reserved Rights have to follow Federal Courts

ADJUDICATIONS

- Very time consuming and expensive (e.g., SRBA: ongoing after ~20 years)
- AAMODT took over 40 years!
- Usually results in court decree setting forth all rights in watershed (source, amount, purpose, place of use, point of diversion, etc.)

Summary of Tribes and USGS Using Science for Tribal Water Plans

- The U.S. Geological Survey has recognized the importance of Native American Tribes' knowledge and living in harmony with nature as complements to the USGS mission to better understand the Earth.
- Combining indigenous ecological knowledge with empirical studies allows the USGS and Native American governments, organizations, and peoples to increase their mutual understanding and respect for this land.
- USGS provides information to tribes as part of our basic mission of providing unbiased scientific information to the Nation, and as part of the Federal Trust Responsibility to tribes.

Thank you for your time!