Water Resources of the Basin and Range Carbonate Aquifer System in White Pine County, Nevada, and adjacent areas in Nevada and Utah

‘BARCASS’

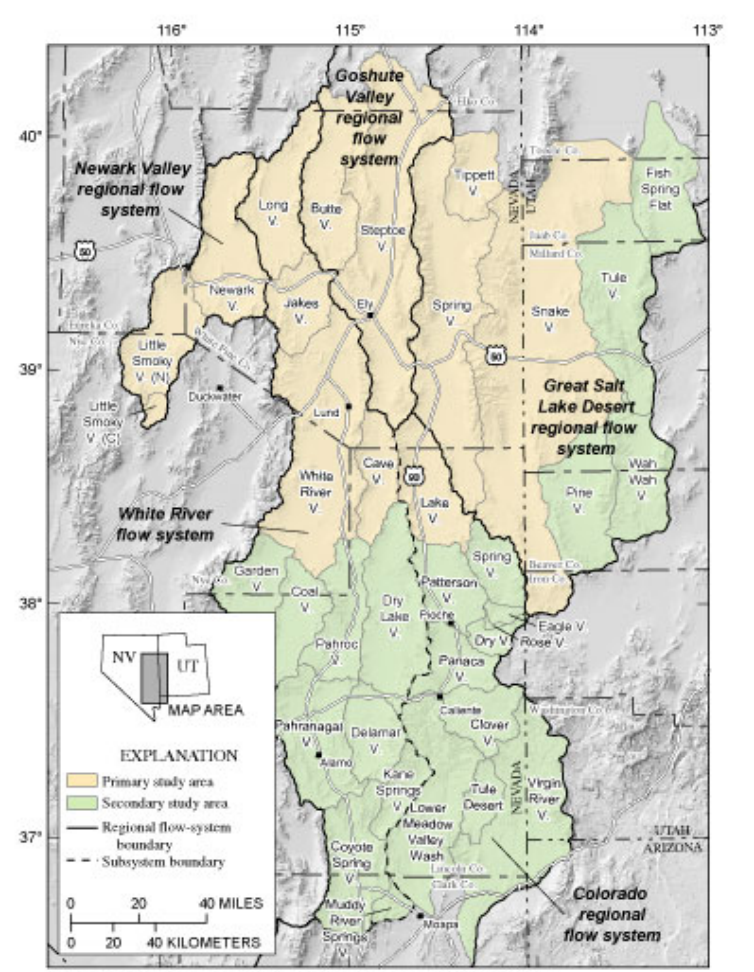
U.S. Department of the Interior
U.S. Geological Survey

Lincoln County Land Act

- The extent, thickness, and hydrologic properties of aquifers,
- The volume and quality of water stored in aquifers,
- The delineation of subsurface geologic structures controlling ground-water flow,
- Determining ground-water flow direction and gradients,
- The distribution of recharge and discharge areas, and
- Determining representative rates of recharge and discharge.

Why not develop a computer model?

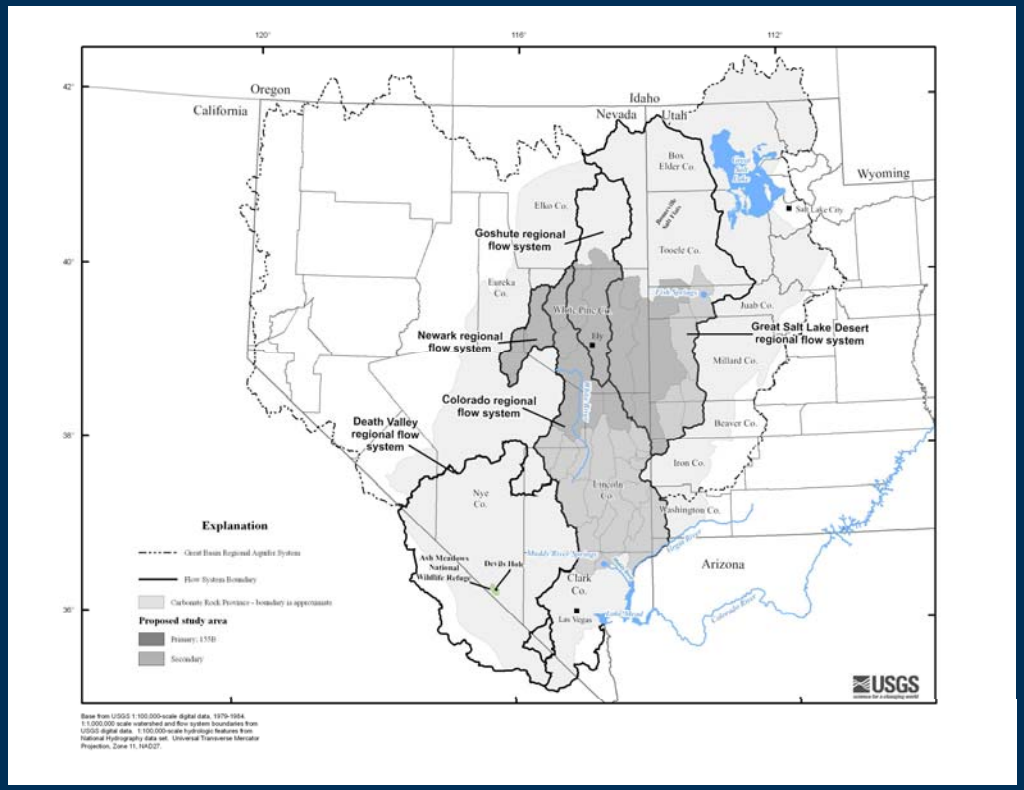
- Benefits of modeling
  - Synthesize data
  - Test conceptual understanding of aquifer systems
  - Simulate changes in ground-water flow
- Modeling needs
  - Sufficient time
  - Available data
  - Confidence in conceptual understanding of aquifer systems



Base from U.S. Geological Survey 1:100,000-scale digital data, 1979-1984. Universal Transverse Mercator Projection, zone 11, North American Datum of 1927. Shaded-relief base 30-meter Digital Elevation Model; sun illumination from northwest at 30 degrees above horizon. Watershed boundaries from 1:1,000,000-scale U.S. Geological Survey digital data.

USGS DRI

RASA Ground-Water Model

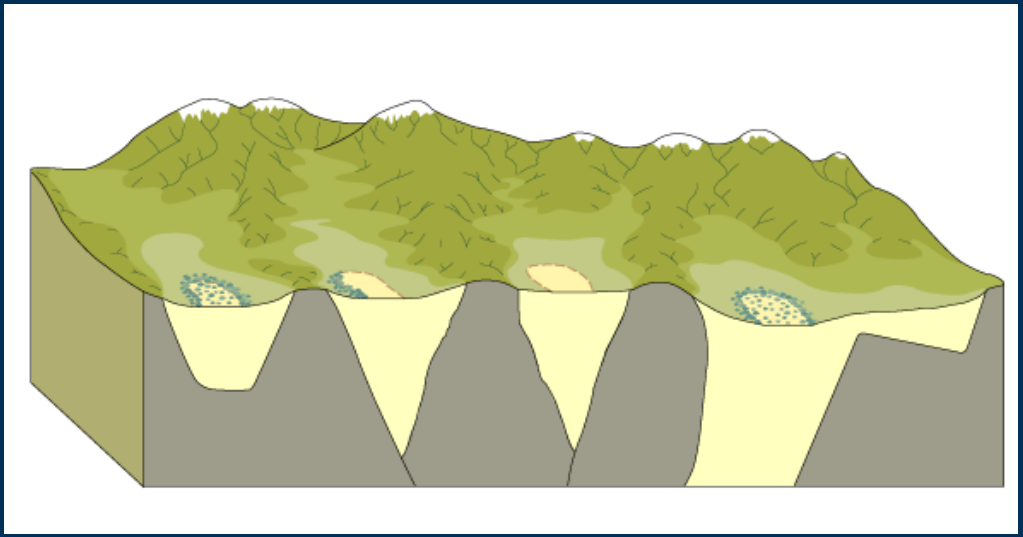


- "The ground-water flow model of the carbonate-rock province is highly generalized because of the complex geology, scarcity of water-level data, uncertainty in the thickness and extent of aquifers, and uncertainty in estimates of ground-water recharge and evapotranspiration."

- USGS Professional Paper 1409-A

Conceptual Aquifer System

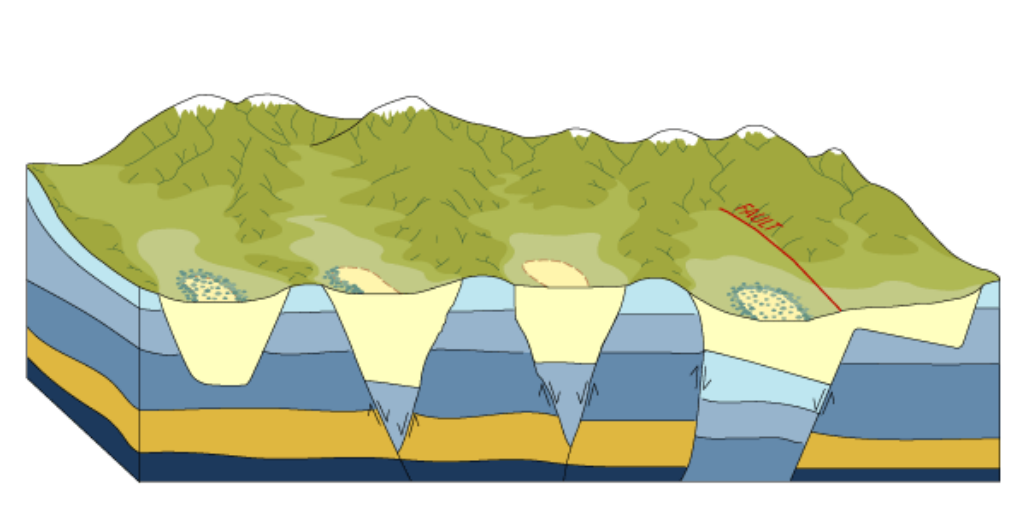
- Compile-format data
- Improve data coverage
- Consistent interpretations
- Reduce uncertainty
- Develop conceptual understanding of regional ground-water flow



Conceptual Aquifer System - Continued

Geology

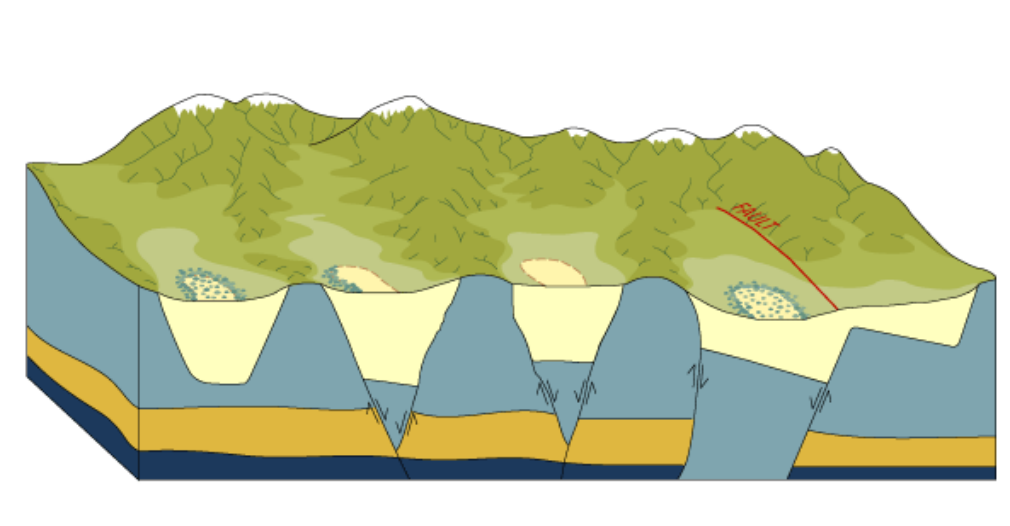
- Geologic units
- Areal extent and thickness
- Structure



Conceptual Aquifer System - Continued

Geology

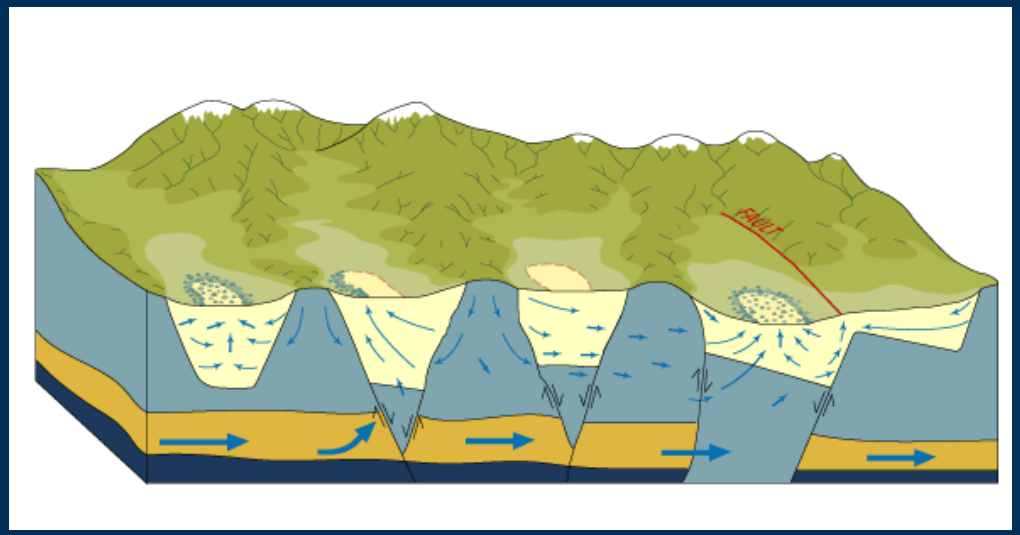
- Aquifer properties
- Hydrogeologic units



Conceptual Aquifer System - Continued

Ground-water flow

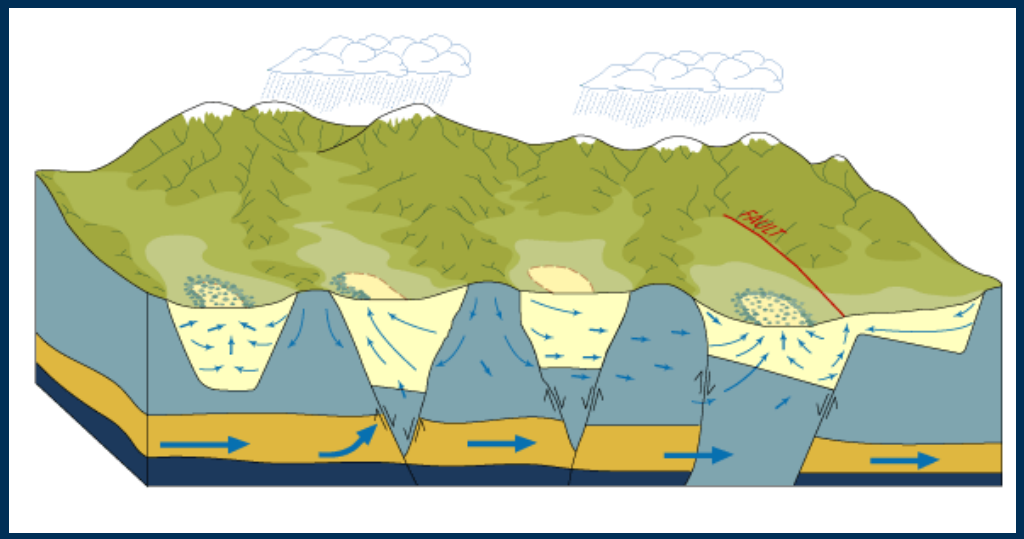
- Local
- Regional



Conceptual Aquifer System - Continued

Recharge

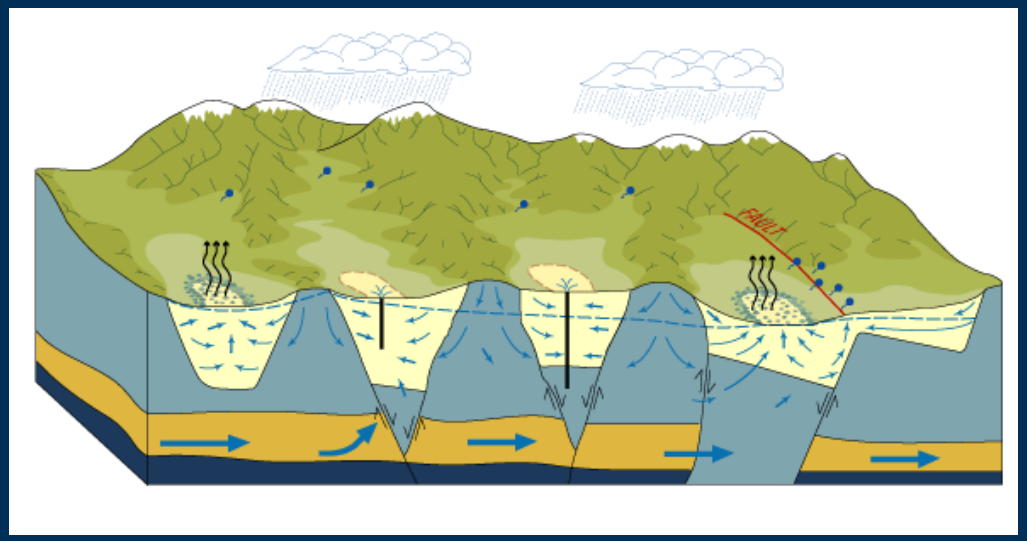
- Rainfall
- Snowmelt
- Interbasin flow



Conceptual Aquifer System - Continued

Discharge

- Springs
- Evapotranspiration (ET)
- Interbasin flow
- Water withdrawals



Objectives and Work Packages

Objectives:

1. Develop an improved understanding of the conceptual aquifer system
2. Verify or revise basin water budgets
3. Report documenting results of study
4. Monitoring networks

Six work packages:

1. Geology
2. Recharge/Discharge
3. Ground-water flow
4. Geochemistry
5. Data synthesis and evaluation
6. Data dissemination

USGS DRI

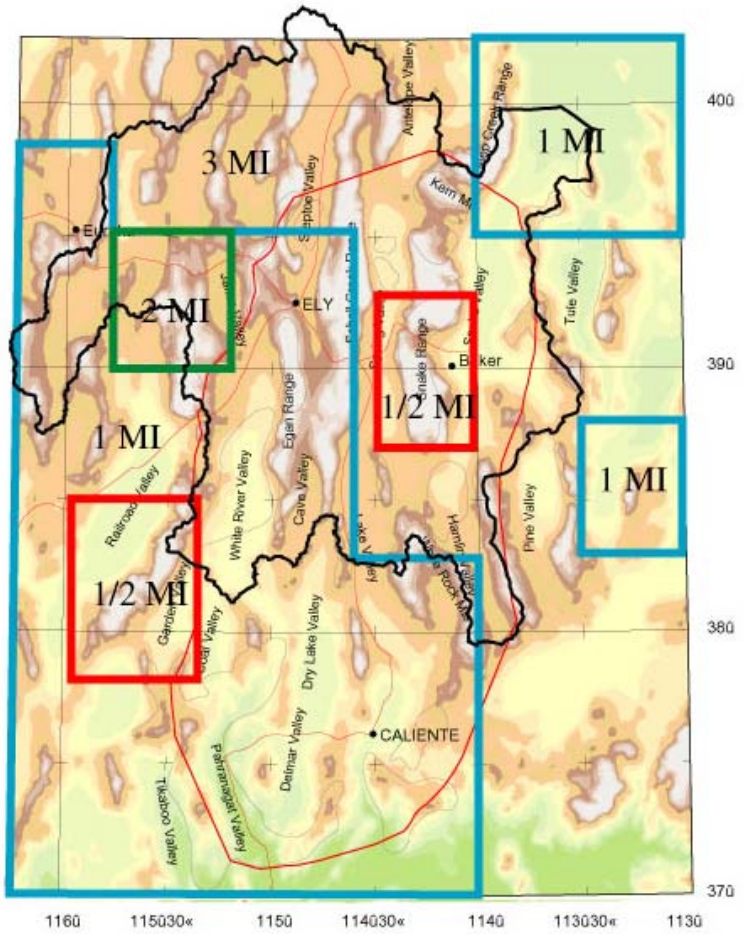
Geology

PURPOSE:

- **Three-dimensional geometry and aquifer properties of regional aquifer system**
  - Define aquifer units
  - Extent
  - Thickness
  - Permeability, storage
- **Delineate controls on regional ground-water flow**
  - Faults
  - Low-permeability units
  - Rock boundaries

Geology - Continued

- **<u>Geophysical studies</u> - aerial extent and thickness of aquifers; geologic structures**
  - Existing and new data for regional and detailed analyses
    - Gravity
    - Magnetic
    - Electromagnetic

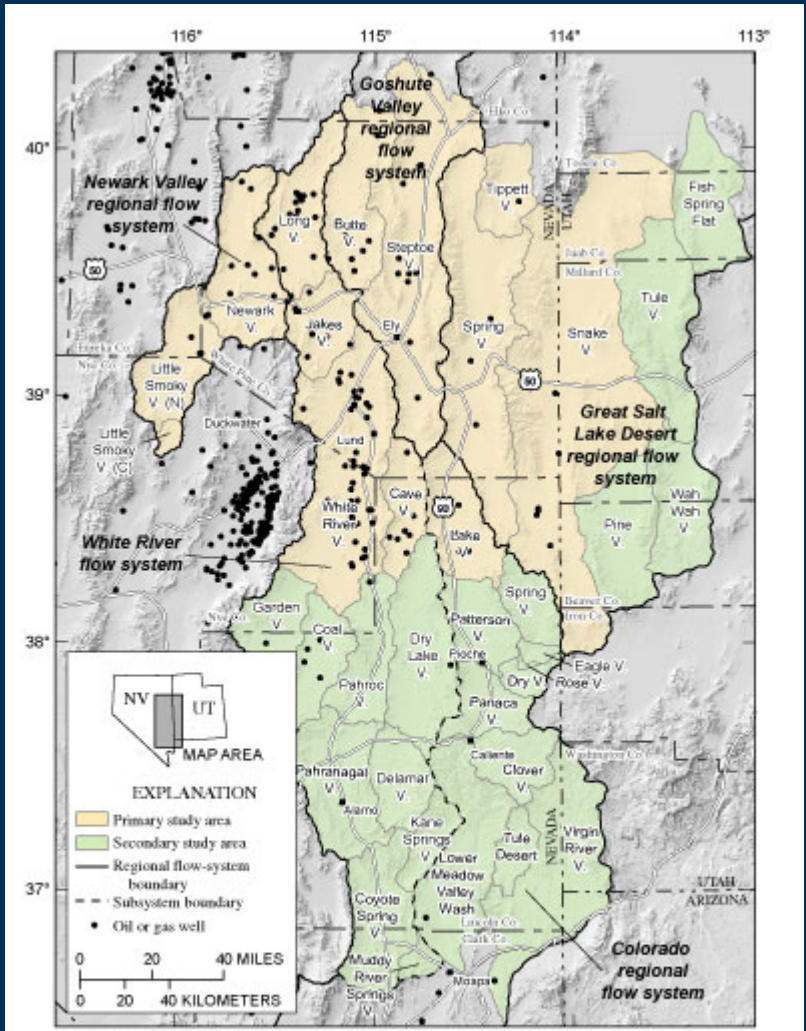


Aeromagnetic coverage of eastern Nevada showing flight-line spacing that ranges from fair (1/2-mi spacing) to poor (3-mi spacing). For comparison, high resolution modern surveys are flown at a spacing of 1/8 to 1/4 mile.

USGS DRI

Geology - Continued

- <u>Oil and gas data -</u> deeper aquifer units
  - Existing data
    - Borehole geophysical logs
    - Lithologic logs
    - Material properties of rocks
      - Permeability
      - Storage



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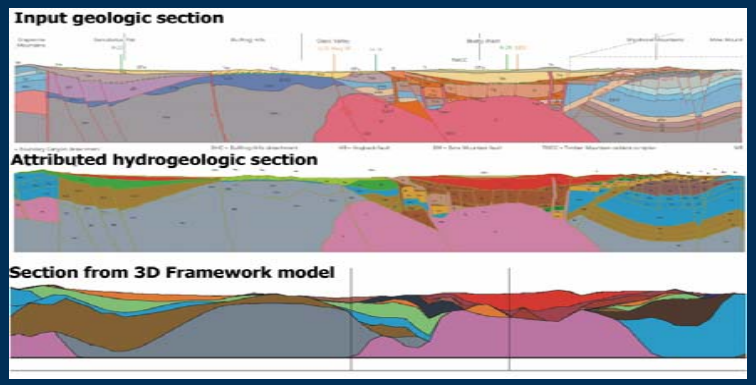
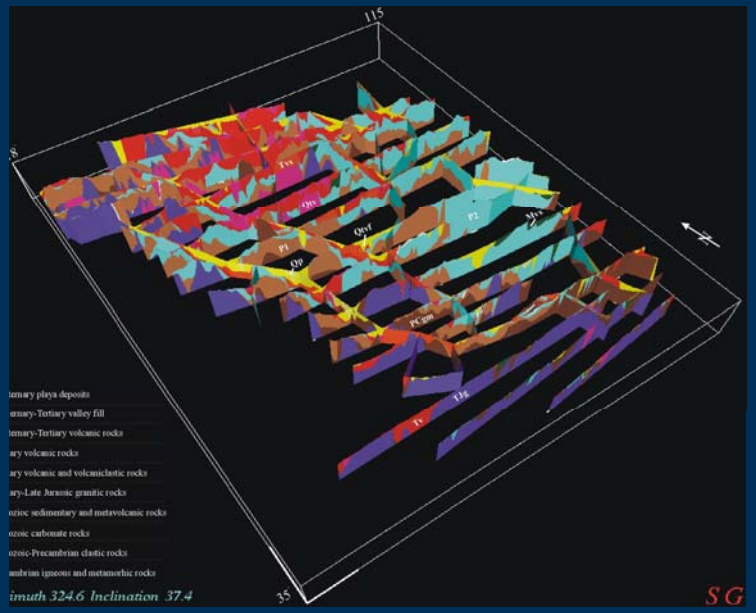
Geology - Continued

- <u>Geologic studies</u> – hydrogeologic interpretations
  - Incorporate geophysical and oil-gas data
  - Surface geologic mapping
    - Delineate aquifer units
    - Regional changes in permeability and storage
    - Controls on ground-water flow
    - Cross sections and aquifer system framework





USGS DRI

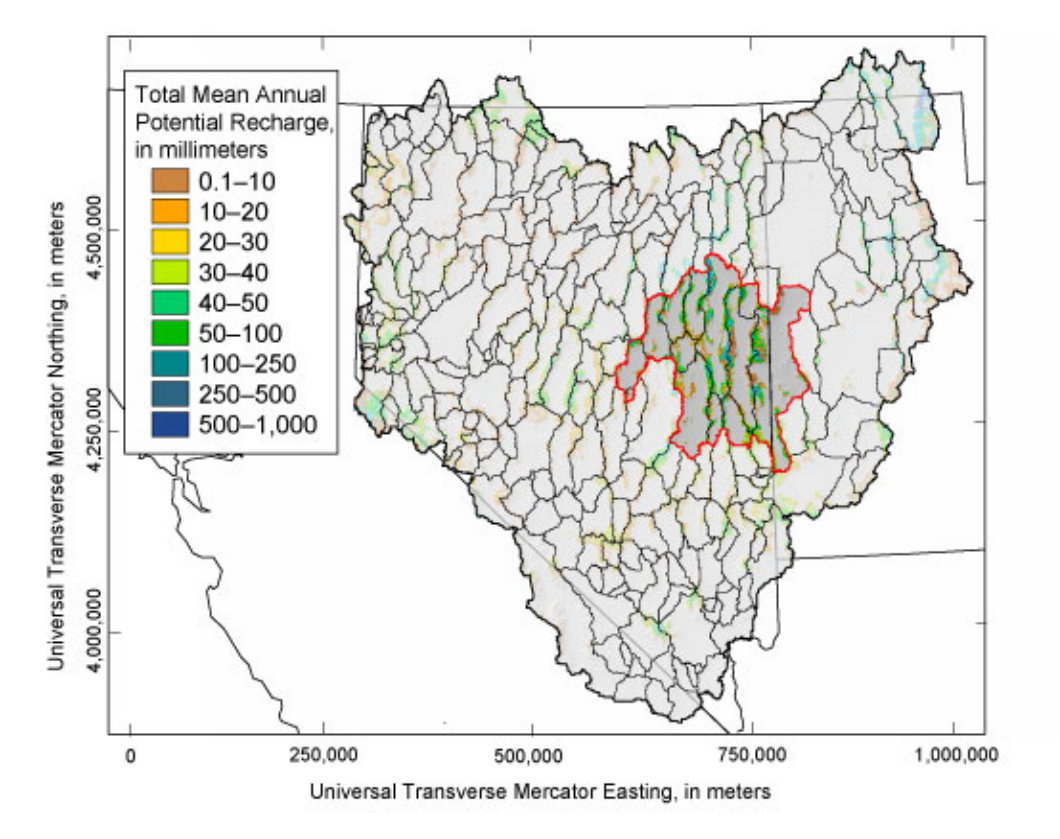
Recharge and Discharge

- **Purpose:**
  - **Mean-annual rates of basin recharge and discharge**
    - Ranges of values
    - Develop basin water budgets
  - **Distributions of recharge and discharge**
    - Develop water-level map
    - Improve conceptual understanding of aquifer system

USGS DRI

Recharge

- **Methods:**
  - **Quantify recharge from precipitation**
    - Basin Characterization model
    - Rainfall-runoff model
  - **Attempt to quantify**
    - Irrigation-return flow
    - Interbasin ground-water flow

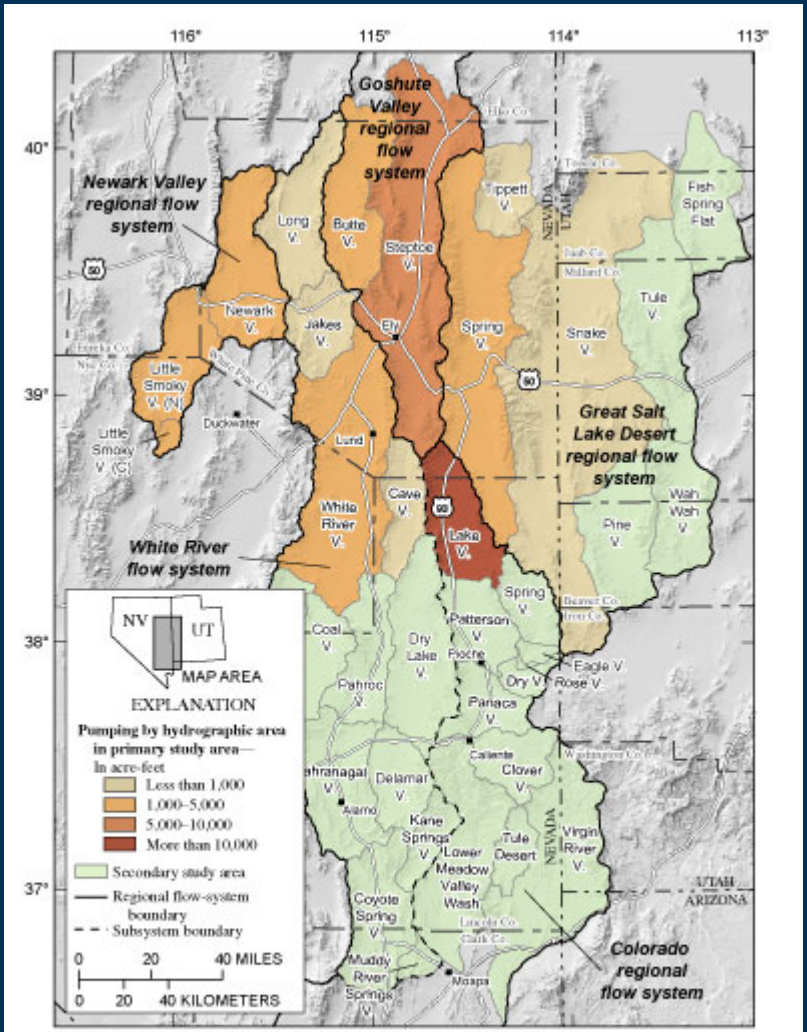


Discharge

- **Methods:**
  - Ground-water pumping
  - Springs
  - Evapotranspiration (ET)
  - Interbasin flow (data evaluation)

Discharge - Continued

- Water withdrawals
  - Total basin pumpage for agriculture, domestic, public supply, and commercial
  - Data from NV pumpage inventories
    - Application rates
    - Field interviews
  - Not compiled for entire pumpage history



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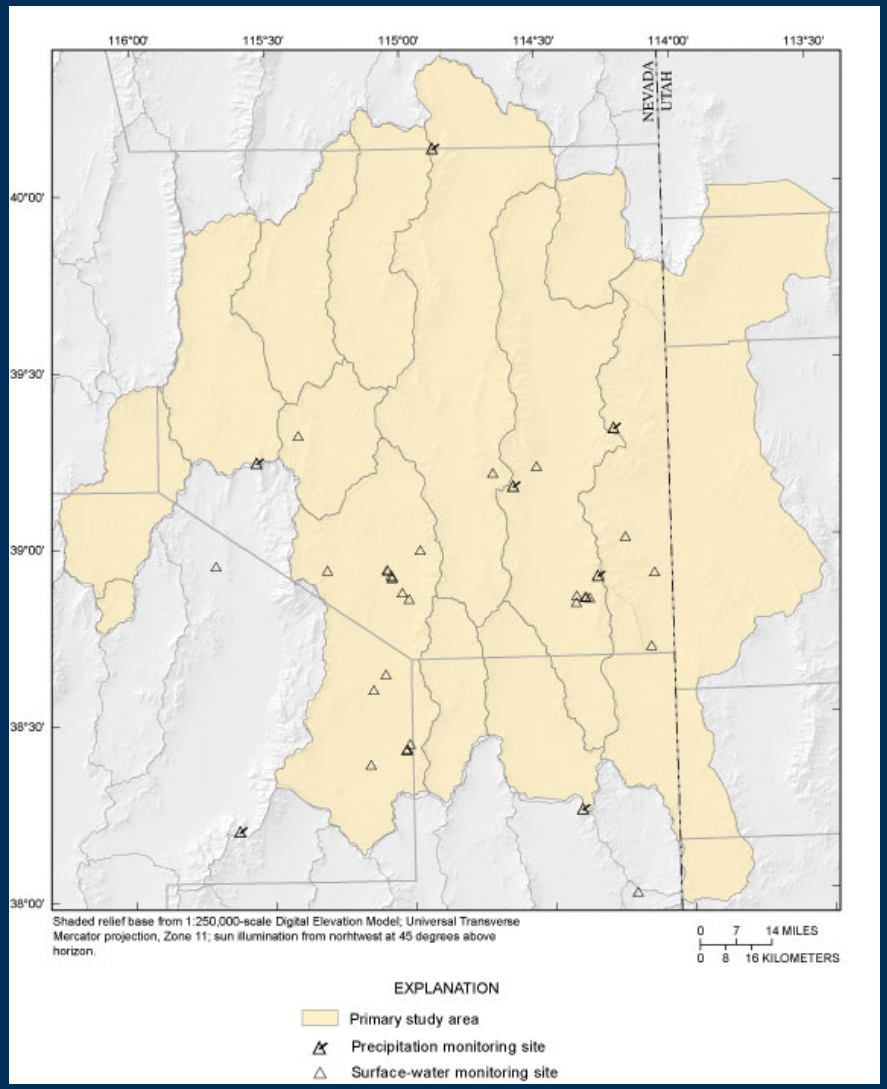
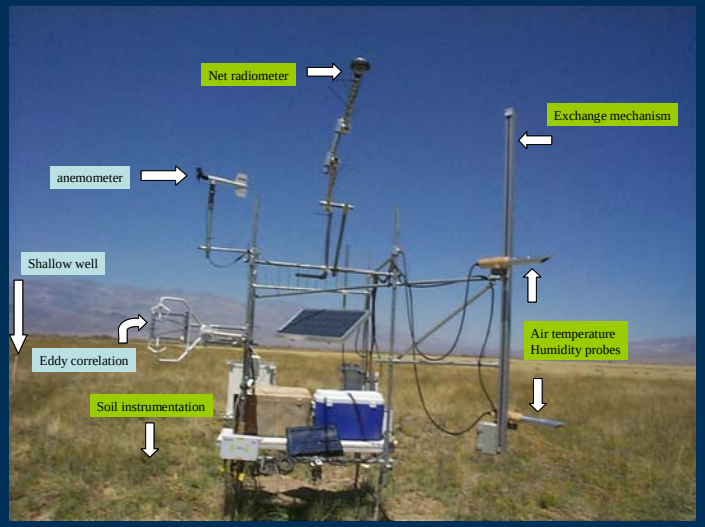
Discharge - Continued

- **Springs:**
  - **Reconnaissance of larger, valley-floor springs**
  - **Needed so no double accounting of total discharge**
    - ET
    - Irrigation



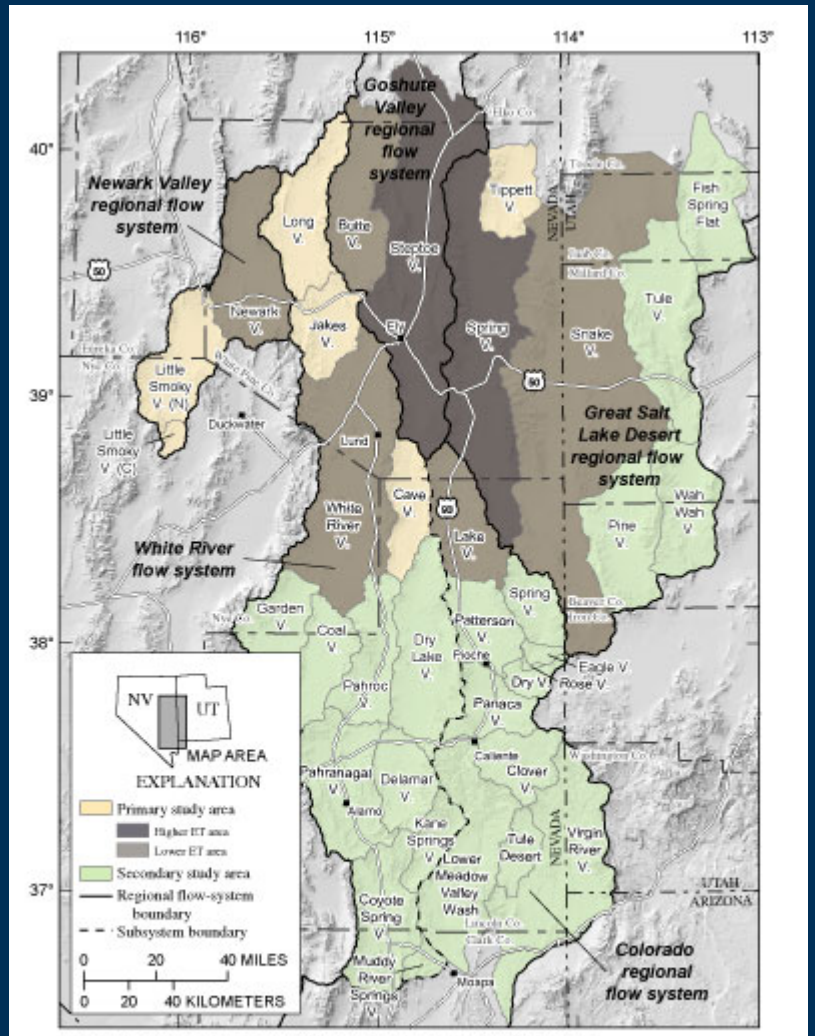
Discharge - Continued

- **Evapotranspiration**
  - **Compile existing data on phreatophytic ET rates and volumes**
  - **Field measurements - two methods to reduce uncertainty**
    - Open system
      - Temporal coverage
    - Closed system (Dome)
      - Spatial coverage



Discharge - Continued

- **Extrapolation of field-measured ET rates**
  - Satellite imagery
  - ET Unit delineation
  - Develop relations between field ET rates, vegetation type/density, and remote sensing parameters



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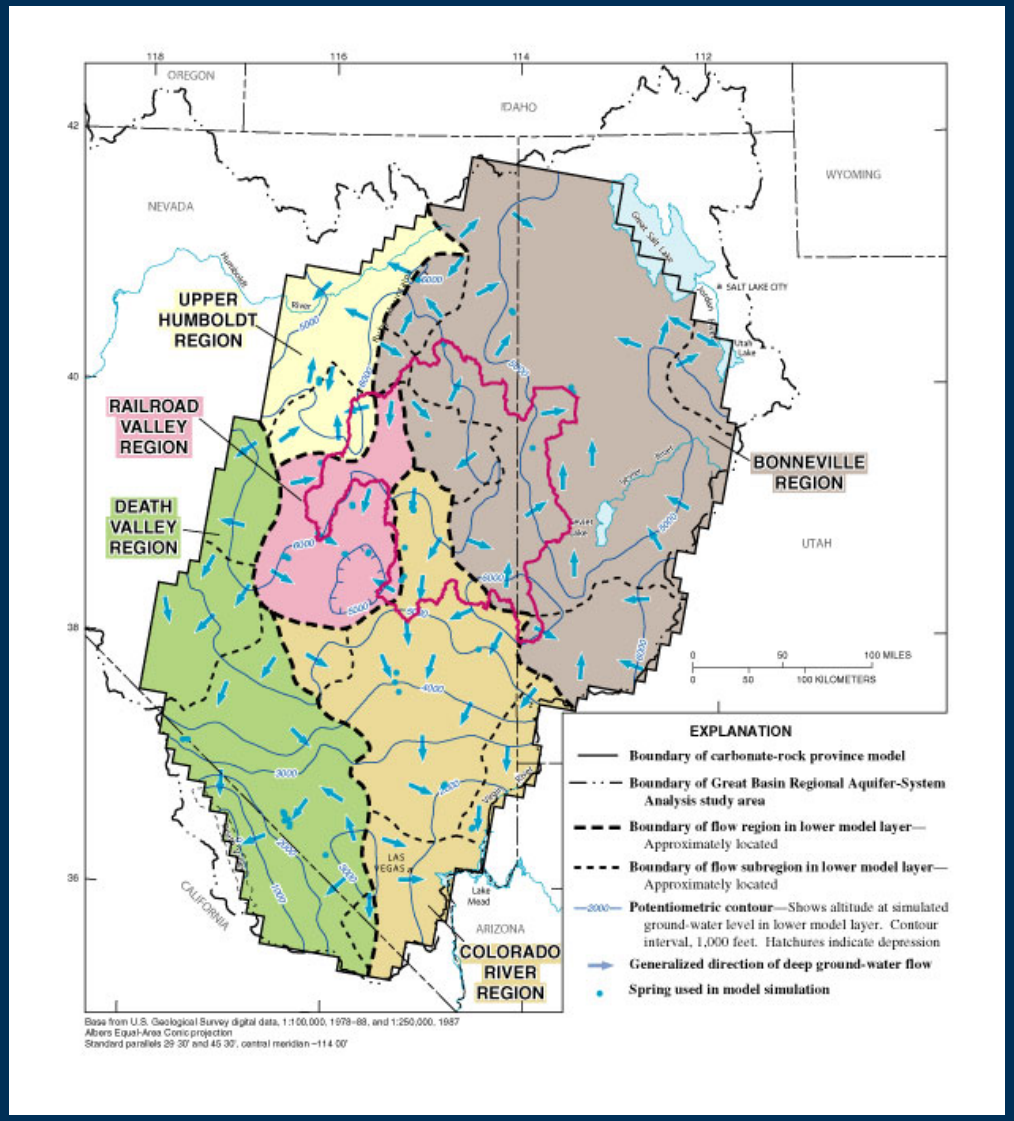
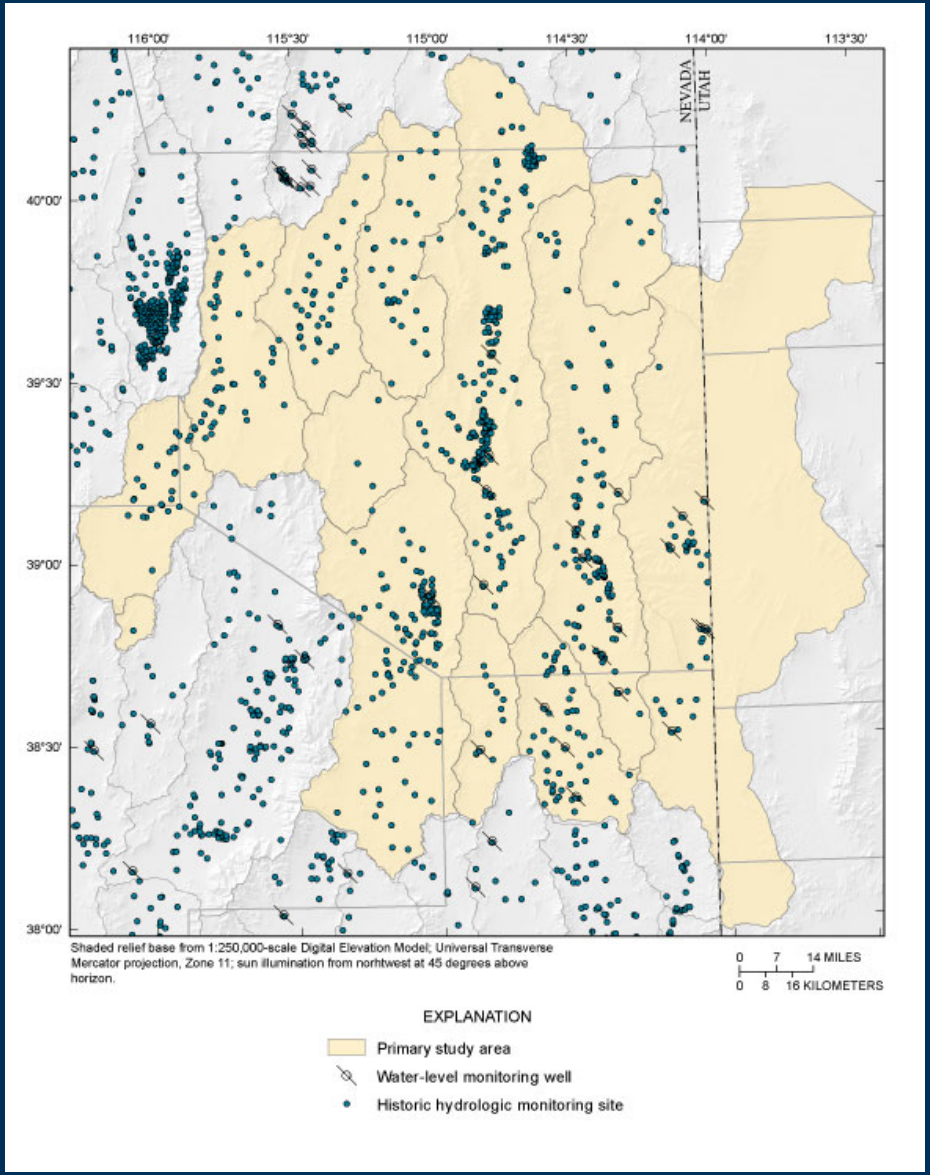
Ground-Water Flow

- **Purpose:**
  - Determine principal ground-water flow paths in regional aquifer system
  - Work closely with geology, recharge & discharge, geochemistry, and data synthesis teams



Ground-Water Flow - Continued

- Well completed in carbonate aquifer are sparse
- Determine if water-level measurements for shallower aquifers represent regional ground-water flow
- Develop control points for regional flow system
- Map will represent a composite in space (aquifer) and time



Geochemistry

- **Purpose:**
  - **General water chemistry - Major ions, pesticides, trace metals**
    - Arsenic, cadmium, chromium, copper, lead, mercury, nickel, zinc
- **Support hydrologic evaluations**
  - Principal ground-water flow paths and source areas
  - Recharge areas
  - Recharge rates
  - Interbasin flow

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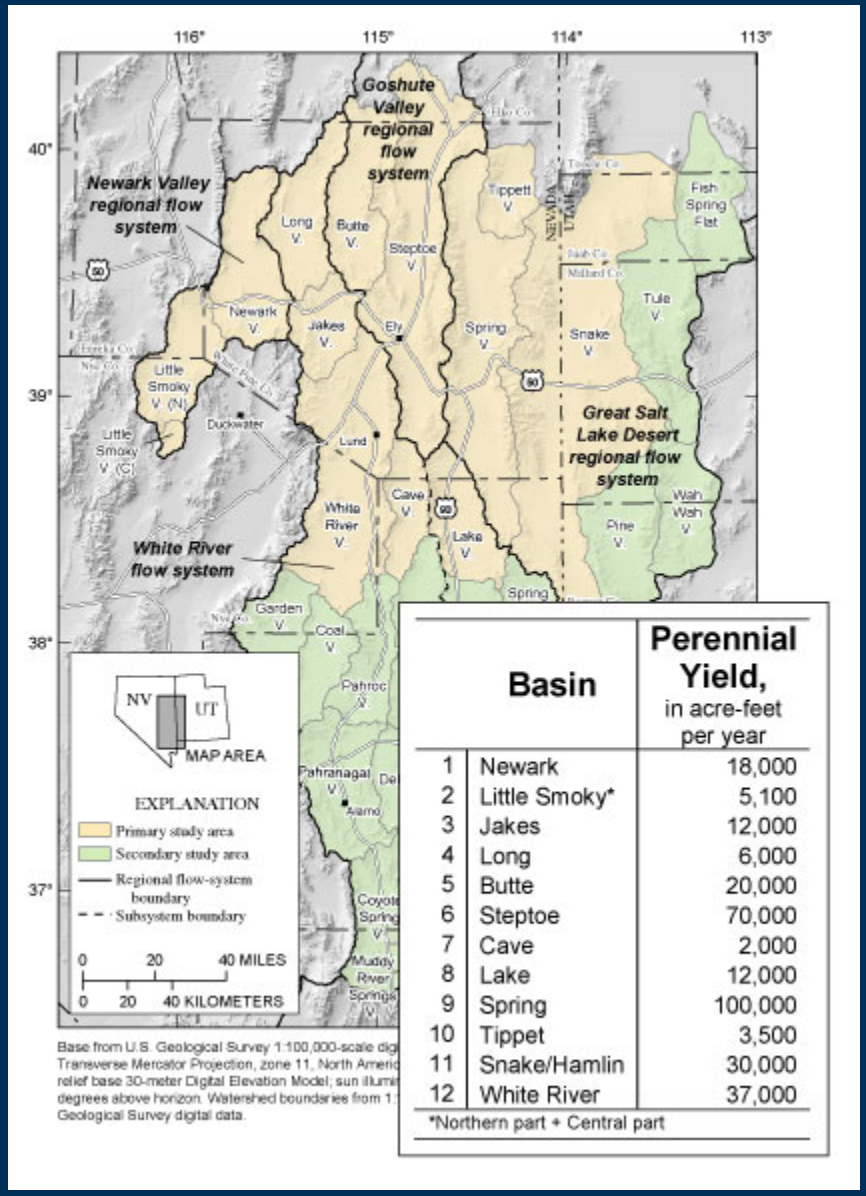
Data Synthesis and Evaluation

- **Basin water budgets**
  - Compile previous water-budget estimates
  - Synthesize recharge-discharge results
  - Range of values



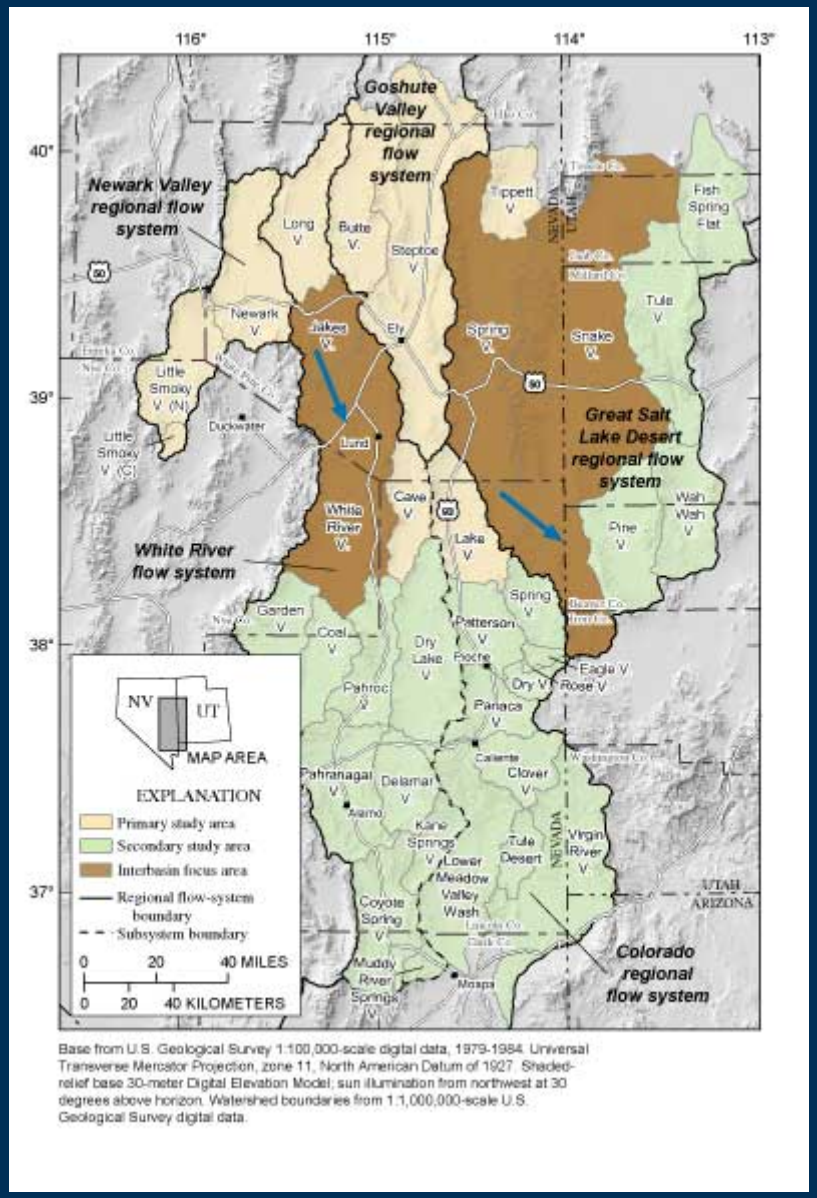
	Basin	Perennial Yield, in acre-feet per year
1	Newark	18,000
2	Little Smoky*	5,100
3	Jakes	12,000
4	Long	6,000
5	Butte	20,000
6	Steptoe	70,000
7	Cave	2,000
8	Lake	12,000
9	Spring	100,000
10	Tippet	3,500
11	Snake/Hamlin	30,000
12	White River	37,000

*Northern part + Central part

USGS DRI

Data Synthesis and Evaluation - Continued

- **Basin water budgets**
  - **Attempt to quantify interbasin flow**
    - Geology
    - Water levels
    - Geochemistry
  - **Accounting model**
    - Recharge
    - Discharge
    - Chemistry



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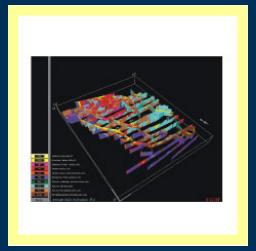
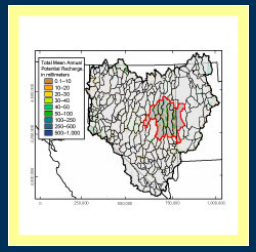
Data Synthesis and Evaluation - Continued

Conceptual 'Model'

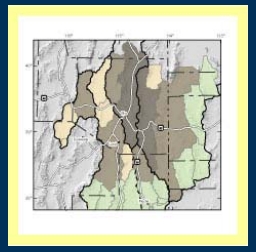
- Hydrogeologic framework model of geology
- Series of maps showing recharge, discharge, and ground-water flow



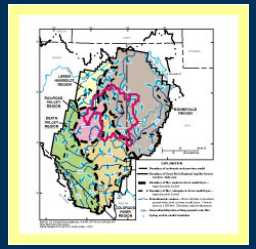
Hydrogeology



Recharge



Discharge



GW Flow

Conceptual Aquifer System

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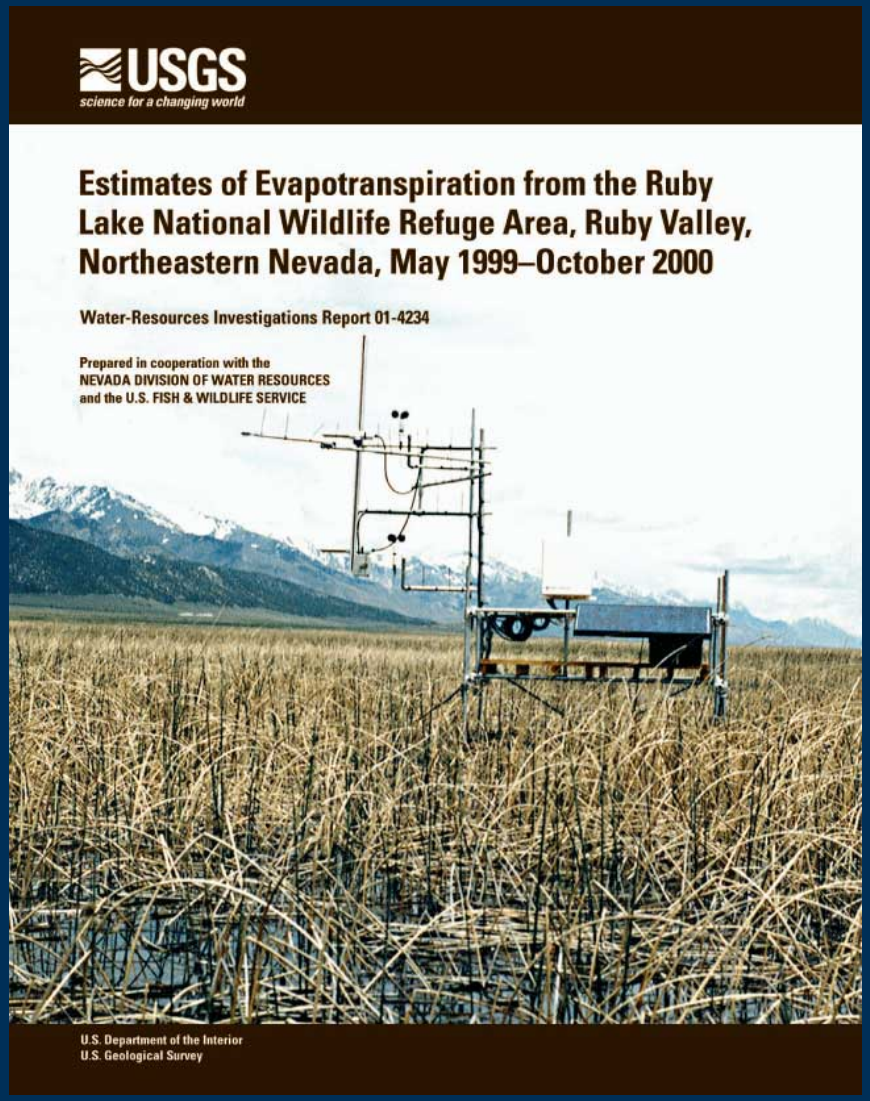
Data Synthesis and Evaluation - Continued

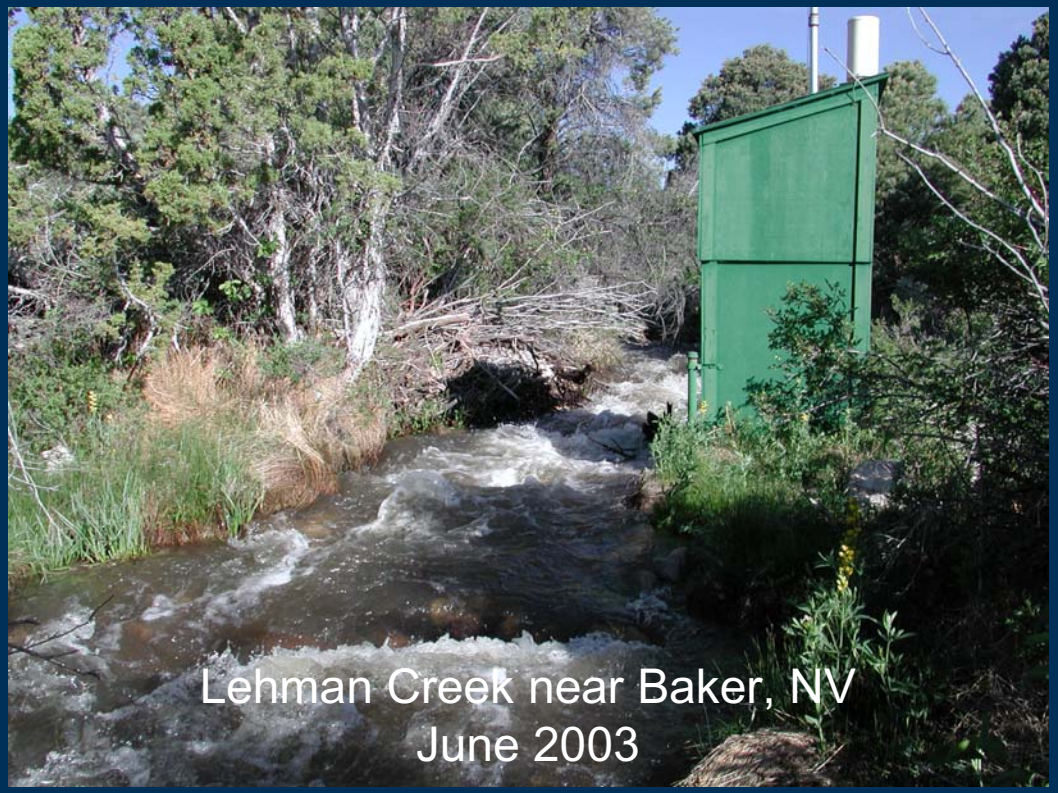
Report

- Document results of study
- USGS, DRI, State of Utah
- Draft due June 2007 to Congress
- Final report due December 2007



Data Synthesis and Evaluation - Continued

- **Recommendations for future monitoring**
  - **Standard data collection**
    - Water levels
    - Discharge
    - Water quality
    - Water use
  - **Non-standard data collection**
    - ET?
    - Gravity?



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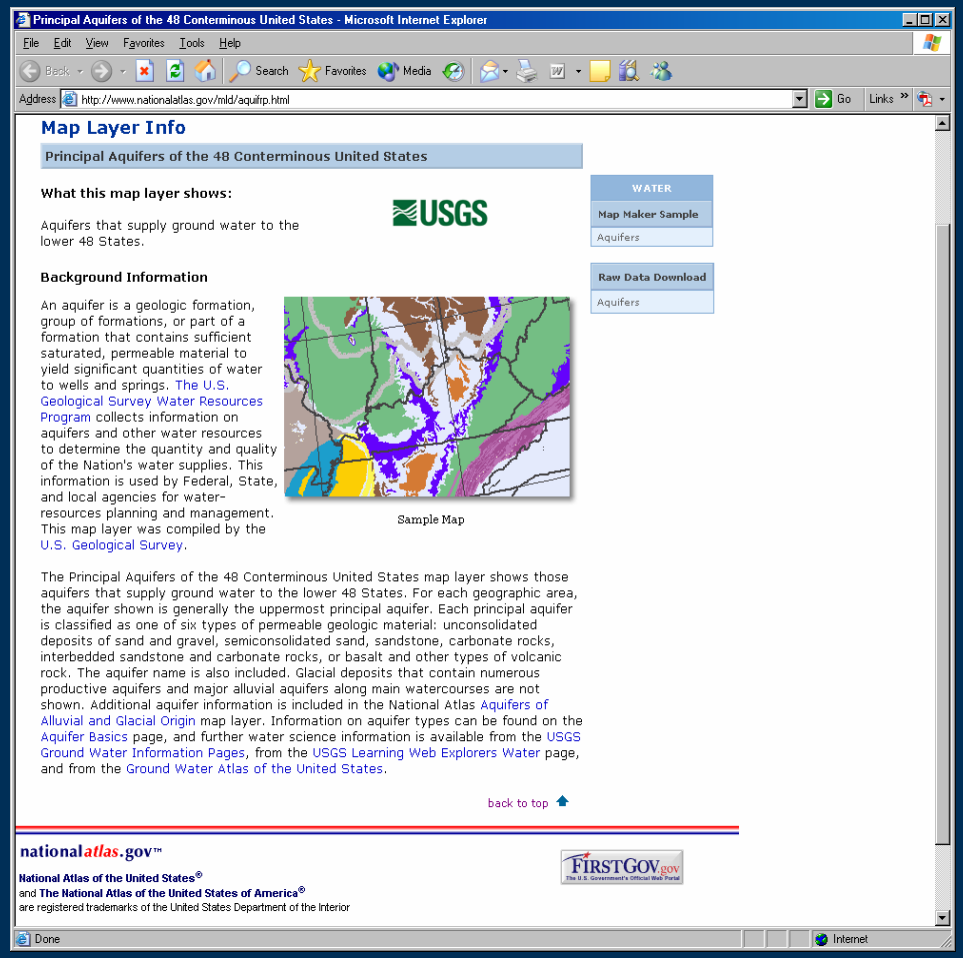
Data Dissemination

- **Web page dedicated to project**
  - Background
  - Progress
  - Quality-assured point and spatial data

http://nevada.usgs.gov/barcass/index.htm

- **Knowledge exchange meetings**
  - Progress
  - Data/knowledge transfer



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