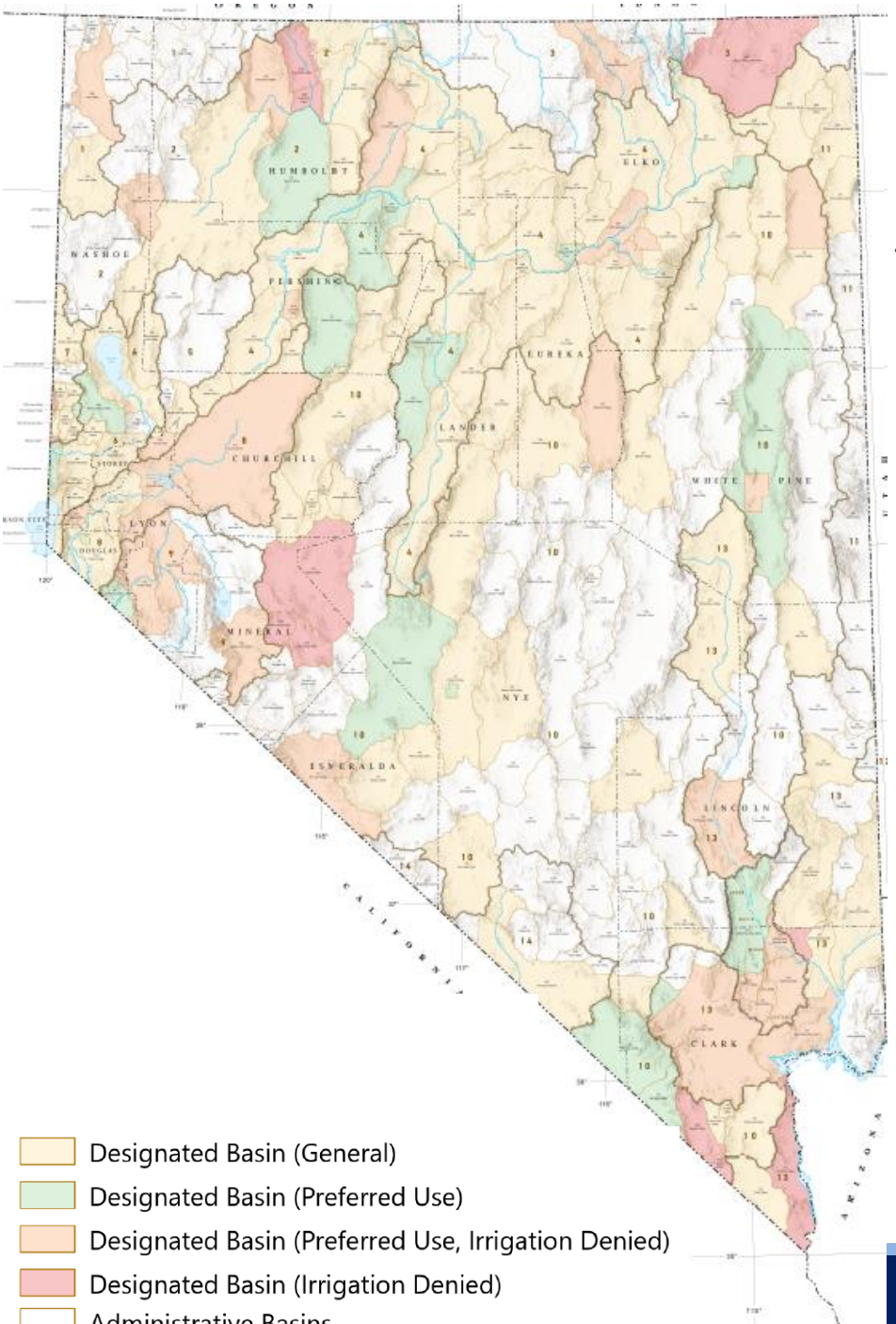


NEVADA DIVISION OF WATER RESOURCES

Nevada Department of CONSERVATION & NATURAL RESOURCES

The Nevada Water Resource Initiative: Moving beyond the Perennial Yield

2023 NWRA Annual Conference

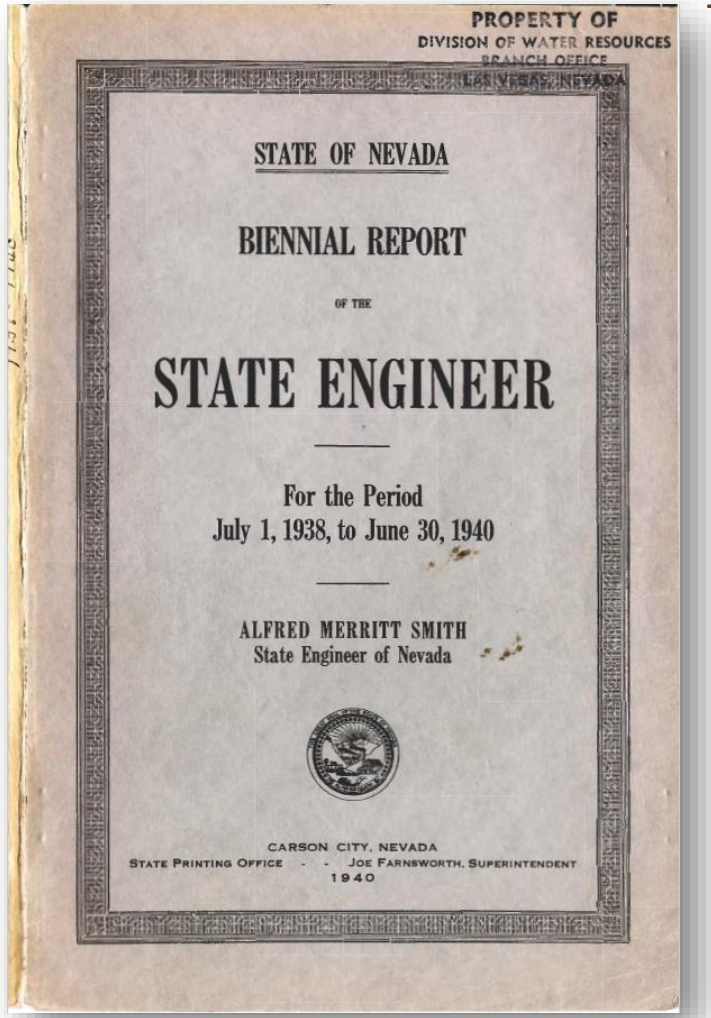
Reno, Nevada
February 2, 2023

Presented By:
Kip Allander, *Hydrogeologist*

ORIGIN OF PERENNIAL YIELD AS BASIS OF MANAGEMENT OF NEVADA GROUNDWATER

Underground Water Law of 1939 – NRS 534

- Clarified that all groundwater (GW), among other waters of the State, belongs to the Public.
- Gave State Engineer (SE) authority to manage groundwater.
- Established concept of basins, but did not define or delineate the basins.
- Did not establish Perennial Yield (PY) as basis for GW management.



(SE Biennial Report 1938-40, 1940, pg 89)

THE ORIGIN OF PERENNIAL YIELD AS BASIS OF GW MANAGEMENT

The concept of PY was understood at the time by SE Alfred M. Smith

The underground waters of Nevada, except flood waters, which may hereafter be stored by construction of expensive reservoirs, now form practically our only potential water supply. Obviously, all underground waters have only one original source—rainfall—and any draft on the supply must be made good annually or such supply will be exhausted. As early as 1913 the Nevada statutes recognized the appro-

(SE Biennial Report 1940-42, 1942)

Originally referred to as 'Safe Yield'

in Washoe County. The study in Smith Valley will be completed early in the coming biennium. The reports based on detailed studies give information on the estimated quantity of ground water that may be developed annually without exceeding the safe yield, quality of the water, characteristics of the water-bearing beds, probable depth to which wells must be drilled to obtain water, depth to the water level,

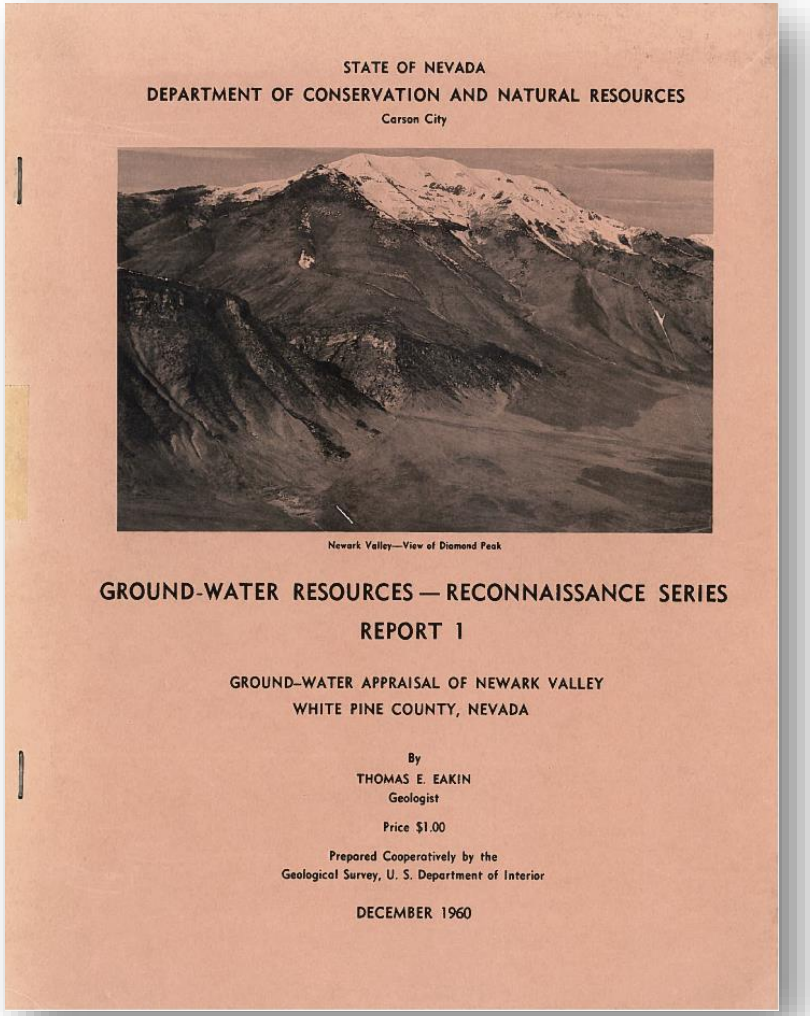
(SE Biennial Report 1946-48, 1948, pg 32)

The term Perennial Yield First appeared in 1960

But it was already the conceptual basis for limit of GW appropriations.

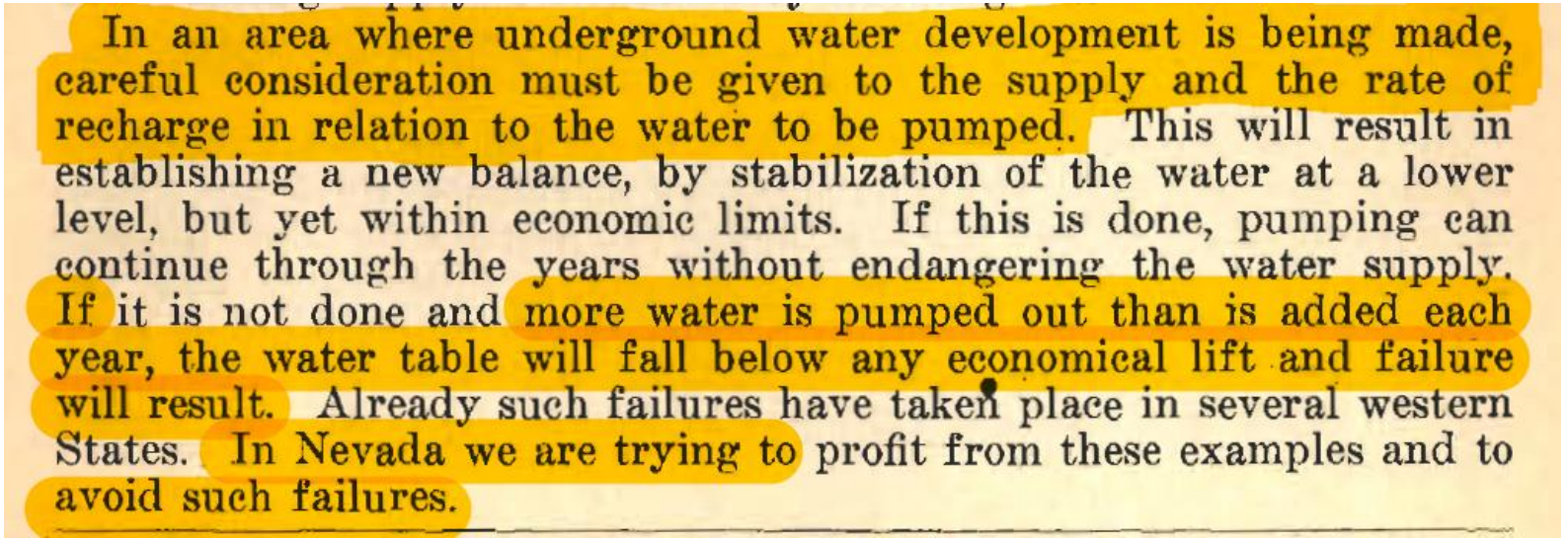
Perennial Yield

The perennial yield of a ground-water system is ultimately limited by the average annual recharge and discharge circulating into and out of the system. It is the upper limit of the amount of water that can be withdrawn for an indefinite period of time from a ground-water system without permanent depletion.

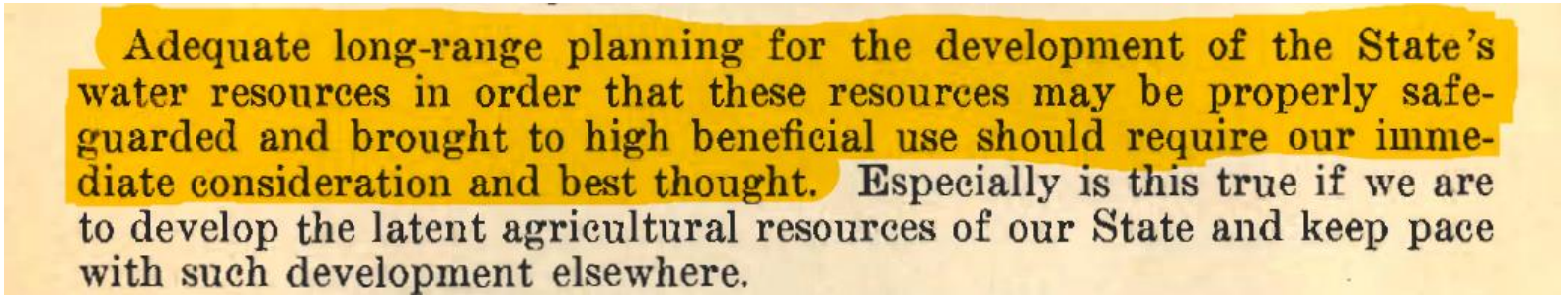


(GW Reconnaissance Report 1, 1960, pg 16)

THE SE UNDERSTOOD THE NEED FOR SCIENTIFIC STUDY FOR SAFE DEVELOPMENT OF NV GROUNDWATER RESOURCES



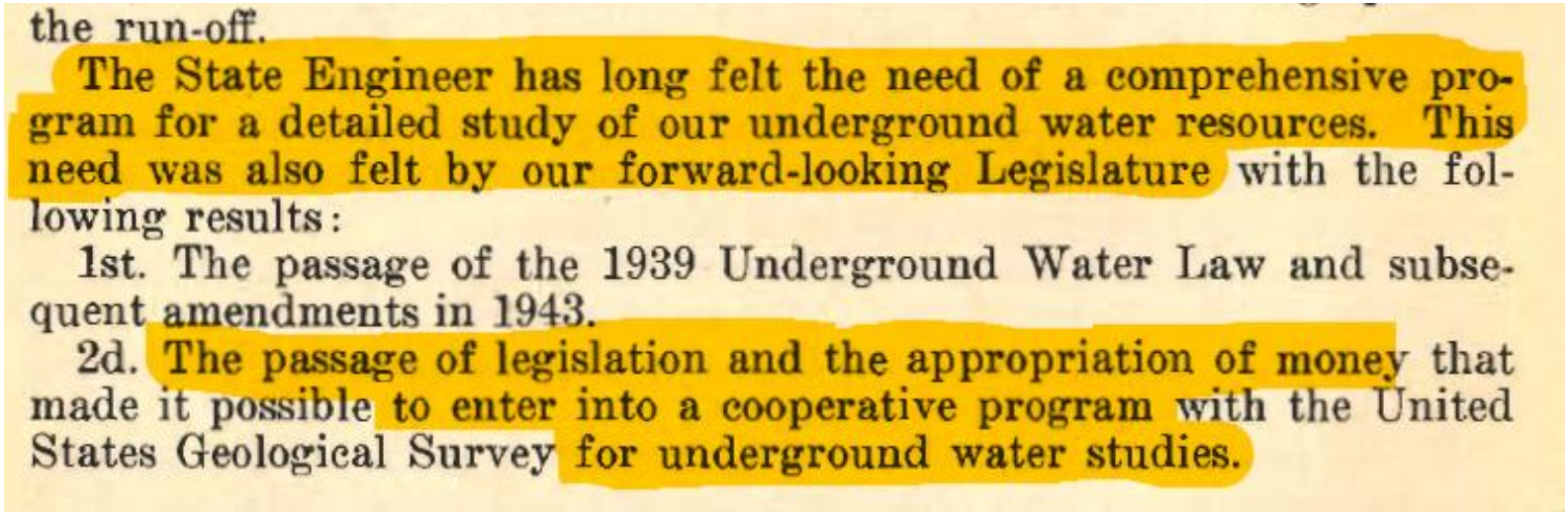
In an area where underground water development is being made, careful consideration must be given to the supply and the rate of recharge in relation to the water to be pumped. This will result in establishing a new balance, by stabilization of the water at a lower level, but yet within economic limits. If this is done, pumping can continue through the years without endangering the water supply. If it is not done and more water is pumped out than is added each year, the water table will fall below any economical lift and failure will result. Already such failures have taken place in several western States. In Nevada we are trying to profit from these examples and to avoid such failures.



Adequate long-range planning for the development of the State's water resources in order that these resources may be properly safeguarded and brought to high beneficial use should require our immediate consideration and best thought. Especially is this true if we are to develop the latent agricultural resources of our State and keep pace with such development elsewhere.

(SE Biennial Report 1944-46, 1946)

The SE and NV Legislature thus initiated the Nevada Ground Water Program with the USGS in 1945



the run-off.

The State Engineer has long felt the need of a comprehensive program for a detailed study of our underground water resources. This need was also felt by our forward-looking Legislature with the following results:

1st. The passage of the 1939 Underground Water Law and subsequent amendments in 1943.

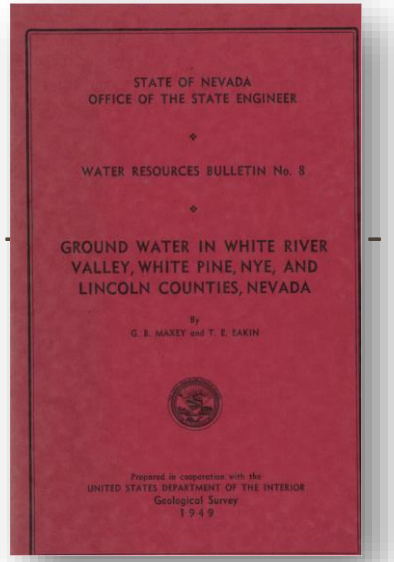
2d. The passage of legislation and the appropriation of money that made it possible to enter into a cooperative program with the United States Geological Survey for underground water studies.

(SE Biennial Report 1944-1946, 1946)

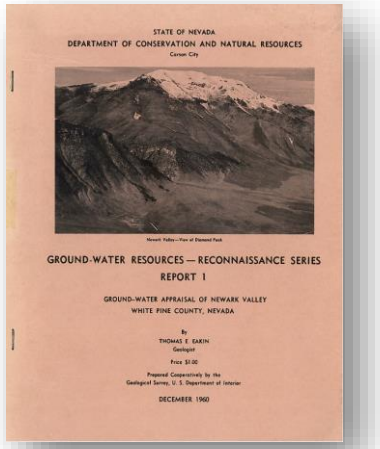
THE EARLY NEVADA GROUNDWATER PROGRAM

The Nevada Groundwater Program

- 1945 – Systematic investigation of Nevada GW began.
- 1946 – Beginning of Water Resources Bulletin Series
- 1960 – Beginning of Groundwater Resources – Reconnaissance Series



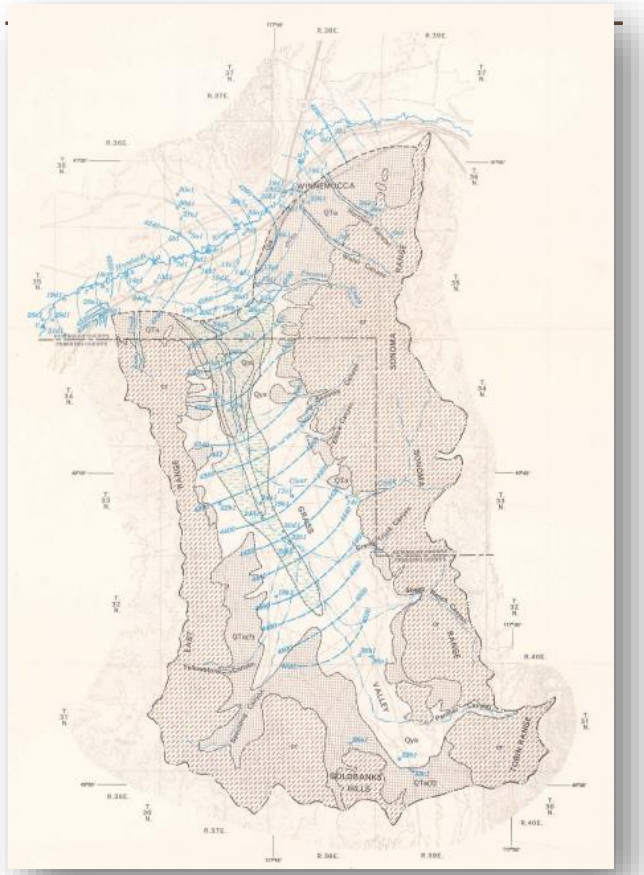
http://water.nv.gov/bulletins.aspx



http://water.nv.gov/reconreports.aspx

EARLY METHODS OF ESTIMATING GROUNDWATER BUDGETS

Discharge



(Cohen, 1964)

Recharge

- Initially assumed equal to discharge
- Maxey – Eakin (M-E) method developed in 1949
- M-E method used extensively to independently estimate recharge

Discharge area x ET_g rate = Discharge volume (ac-ft/yr)

ET_g is Groundwater Evapotranspiration

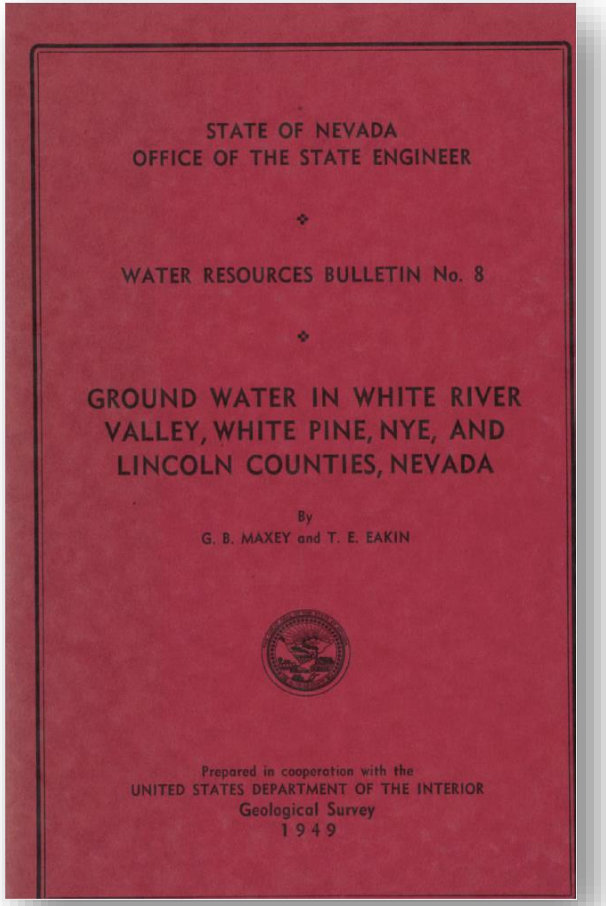
Maxey–Eakin method of estimating recharge

Introduced in Bulletin 8

$$R = \sum_{i=1}^{N} \beta_i \cdot \bar{P}_i \cdot A_i$$

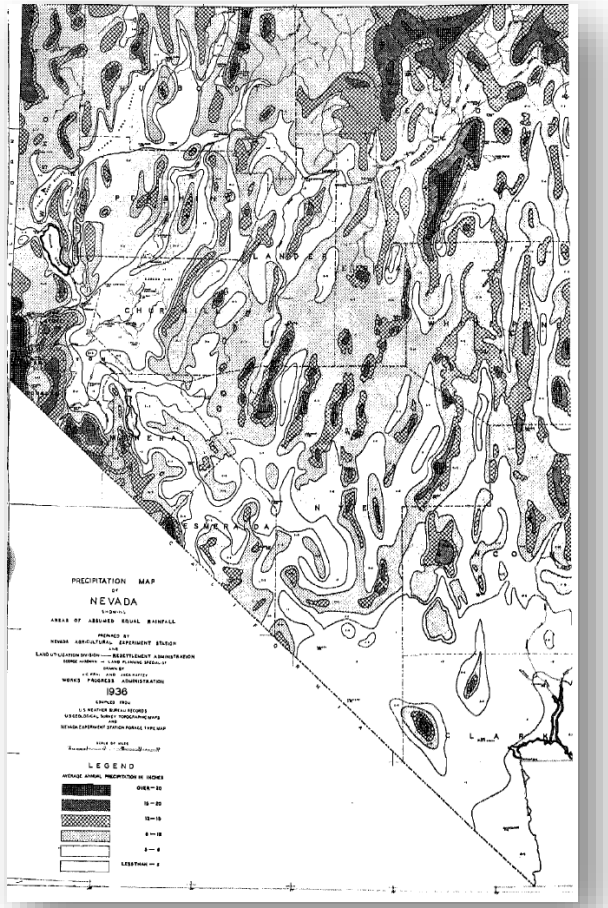
Where:

R is M-E recharge,
P_i is annual precipitation band
A_i is area of precipitation band
and
β_i is M-E coefficient



(Maxey and Eakin, 1949)

Hardman Precipitation Map



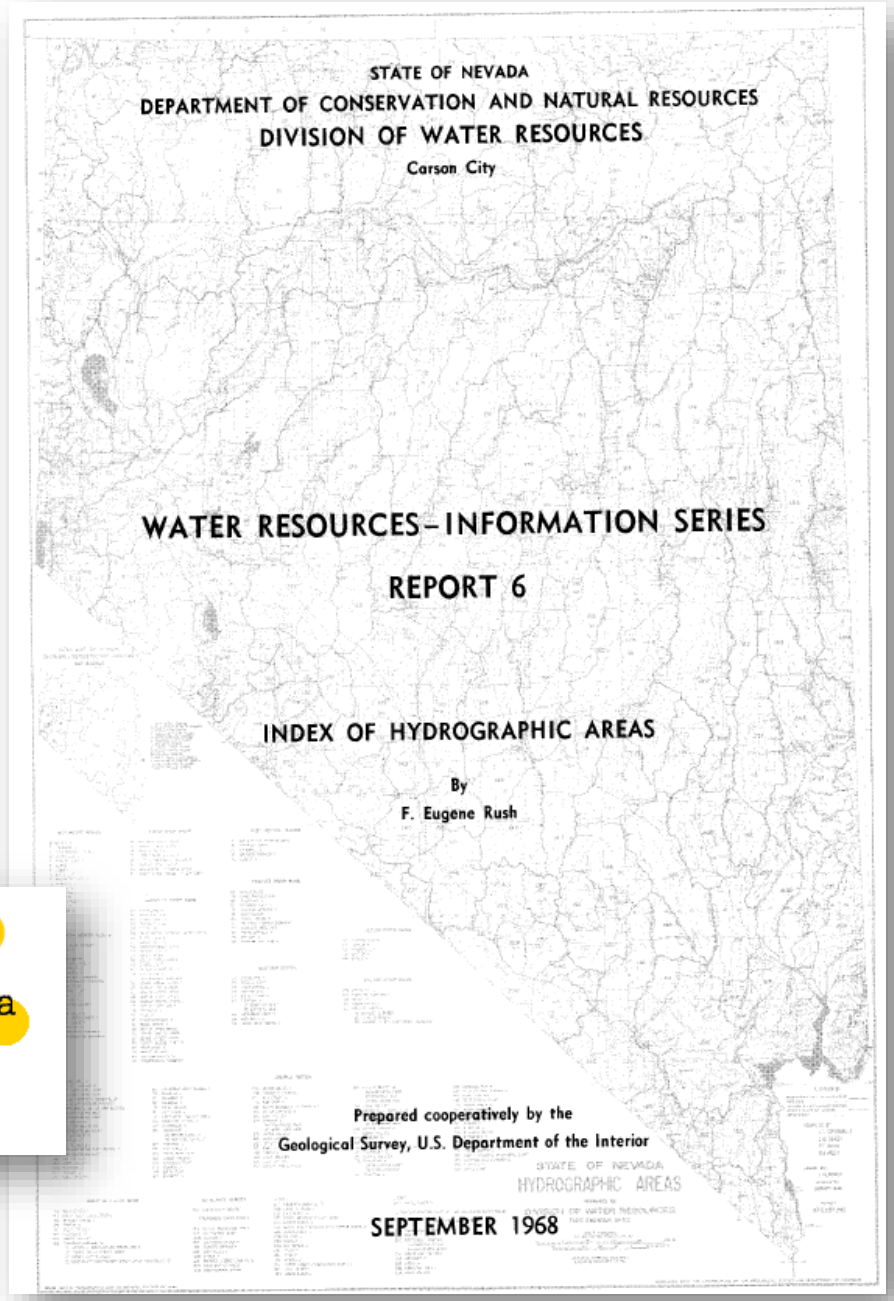
(Hardman, 1936)

ESTABLISHMENT OF HYDROGRAPHIC BASINS AND PERENNIAL YIELD

Nevada's Hydrographic Basin's

- Drawn and formalized in 1968.
- Formerly referred to as 'Hydrographic Area's'.
- Much GW development has already occurred by 1968.
- Many of the Bulletin and Reconn GW investigations already completed.

For the study, research, development, management, and administration of water resources, a need for a systematic identification of "valleys," or preferably "hydrographic areas," of Nevada was recognized by both the U.S. Geological Survey and the State Engineer's office. Because of the long-term cooperative program of water-resources evaluation between the Geological Survey and



(Water Resources-Information Series Report 6, 1968)

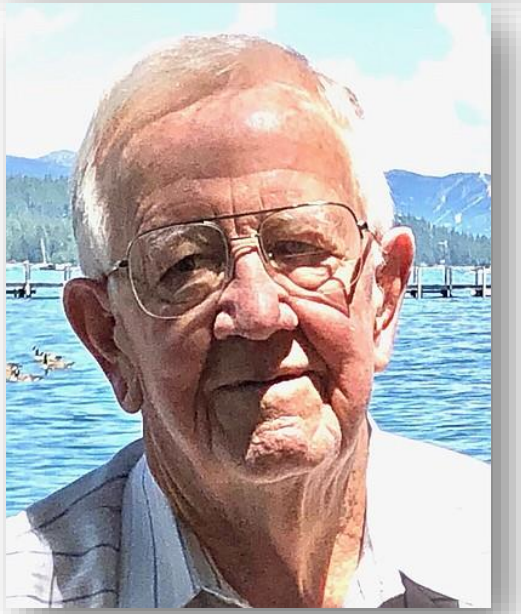
Establishment of Perennial Yield for Hydrographic Basins

This report constitutes an inventory of the water resources of the State and represents the water supply presently available to Nevada.

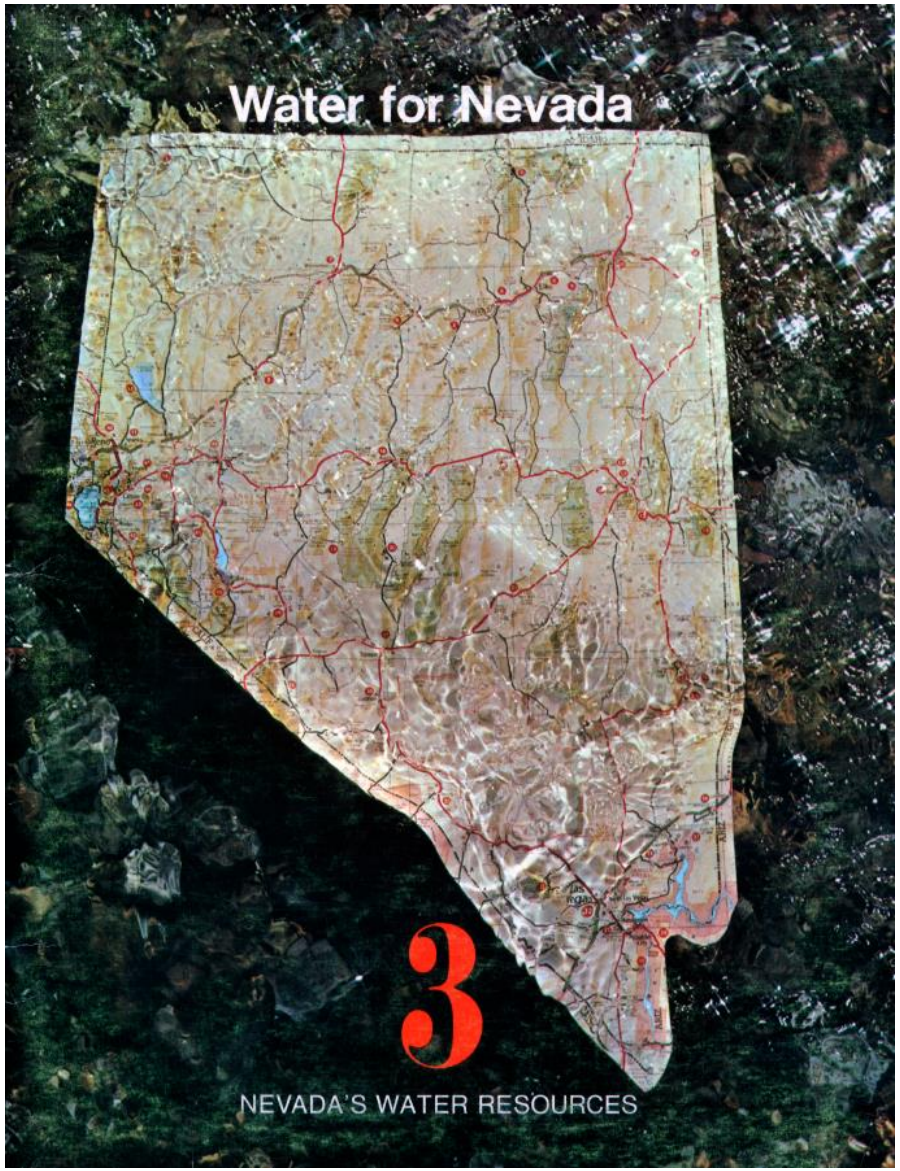
Respectfully,

Roland D. Westergard

Roland D. Westergard
State Engineer



Roland D. Westergard (1934-2022)



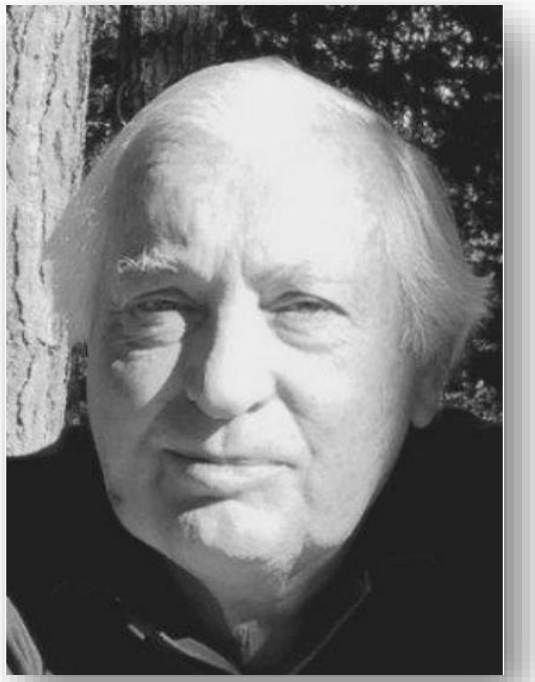
([Nevada's Water Resources, Planning Report 3, 1971])

LIMITATIONS OF PERENNIAL YIELD FOR GROUNDWATER MANAGEMENT

LIMITATIONS OF PERENNIAL YIELD AS BASIS OF GW MANAGEMENT

focus on a common misconception to illustrate the point.

Perhaps the most common misconception in groundwater hydrology is that a water budget of an area determines the magnitude of possible groundwater development. Several well-known hydrologists have addressed this misconception and attempted to dispel it. Somehow, though,



John D. Bredehoeft (1933-2023)

Bredehoeft, J.D., S.S. Papadopulos and H.H. Cooper. 1982. Groundwater: the Water-Budget Myth. In *Scientific Basis of Water-Resource Management*, Studies in Geophysics, Washington , DC: National Academy Press, pp. 51-57.

4

Groundwater: The Water-Budget Myth

JOHN D. BREDEHOEFT
U.S. Geological Survey

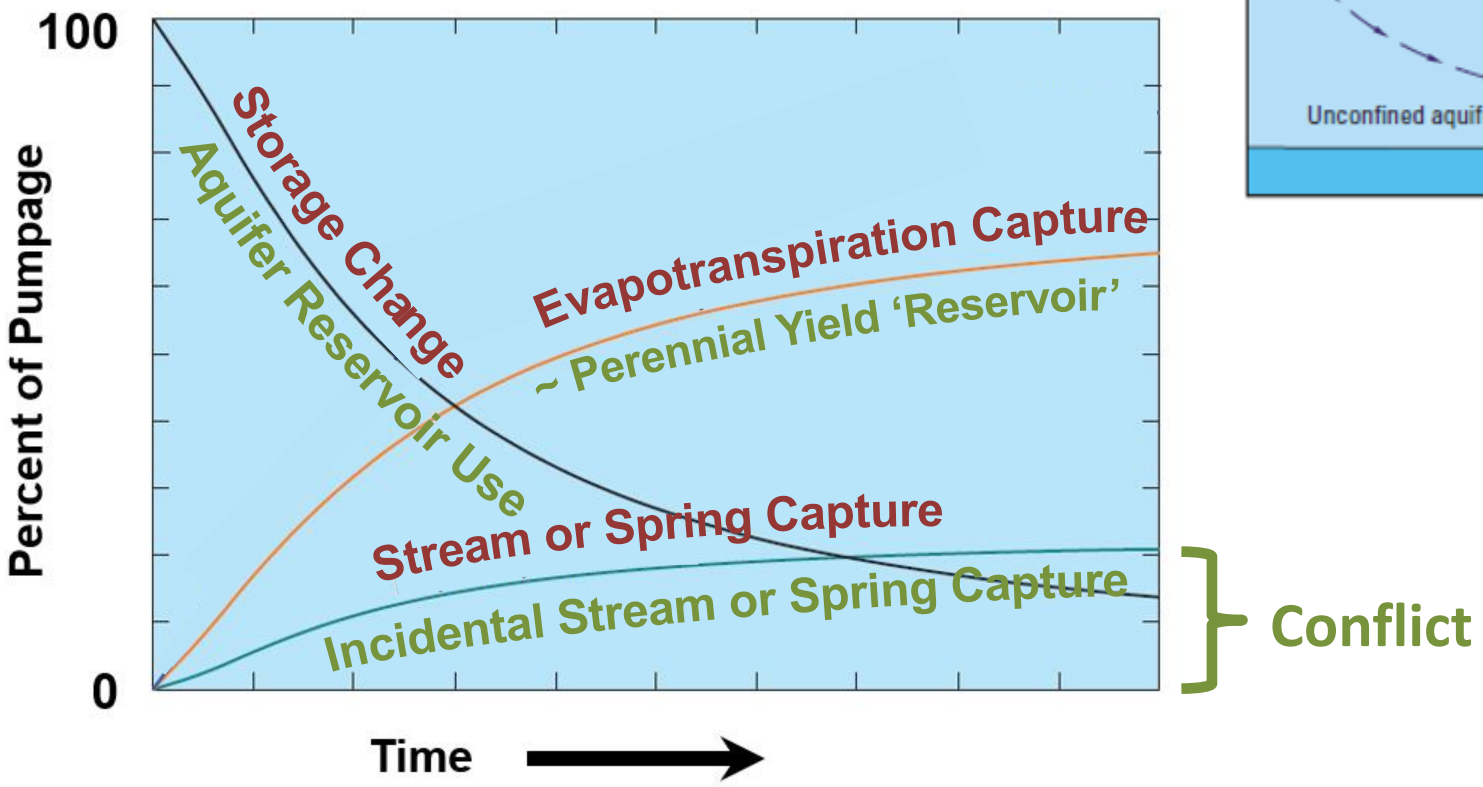
STEPHEN S. PAPADOPULOS
S. S. Papadopulos and Associates, Inc.

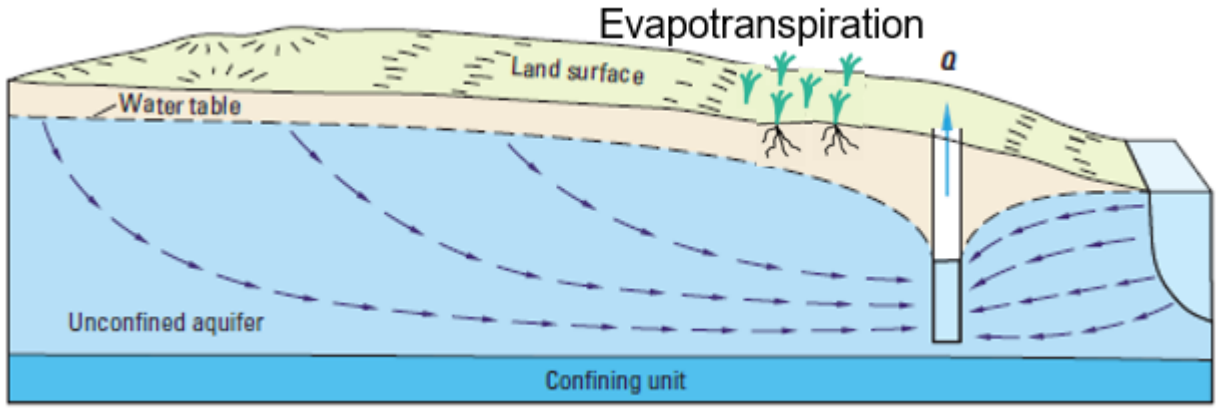
H. H. COOPER, JR.
U.S. Geological Survey

Limitations of Perennial Yield as Basis of GW management

Source of Water to a Well

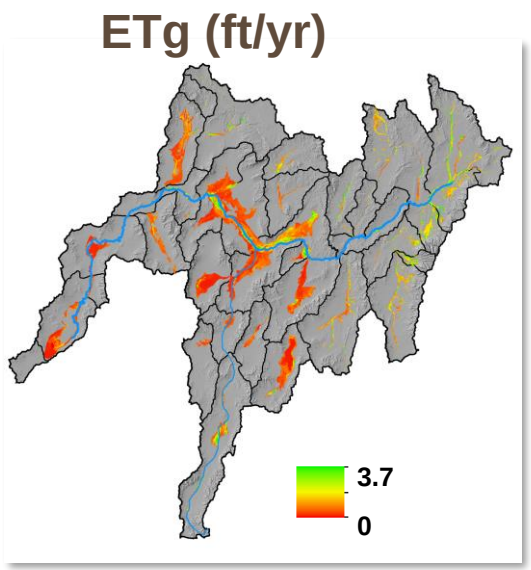
Groundwater Management Perspective

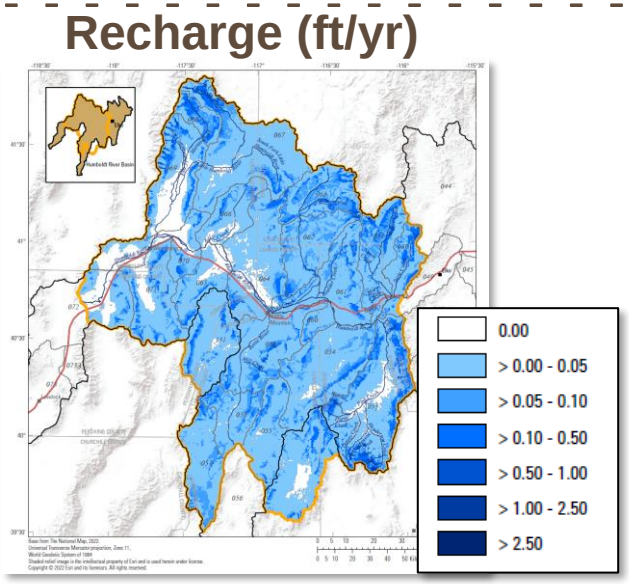


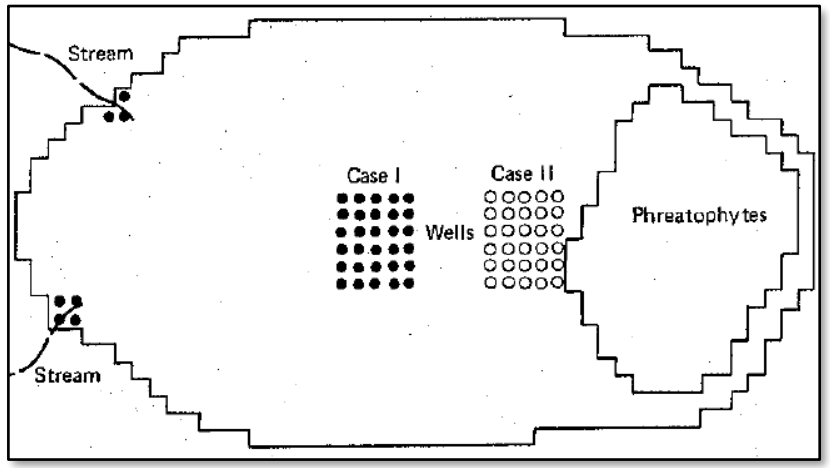


Limitations of Perennial Yield as Basis of GW management

- PY establishes upper limit for GW development.
- To be sustainable, must know:
  - Where recharge and discharge occur.
  - Aquifer properties.
- Pumping needs to be strategically located:
  - To capture available discharge.
  - To avoid conflict with existing rights.







MOVING BEYOND THE PERENNIAL YIELD WITH THE NEVADA WATER RESOURCES INITIATIVE

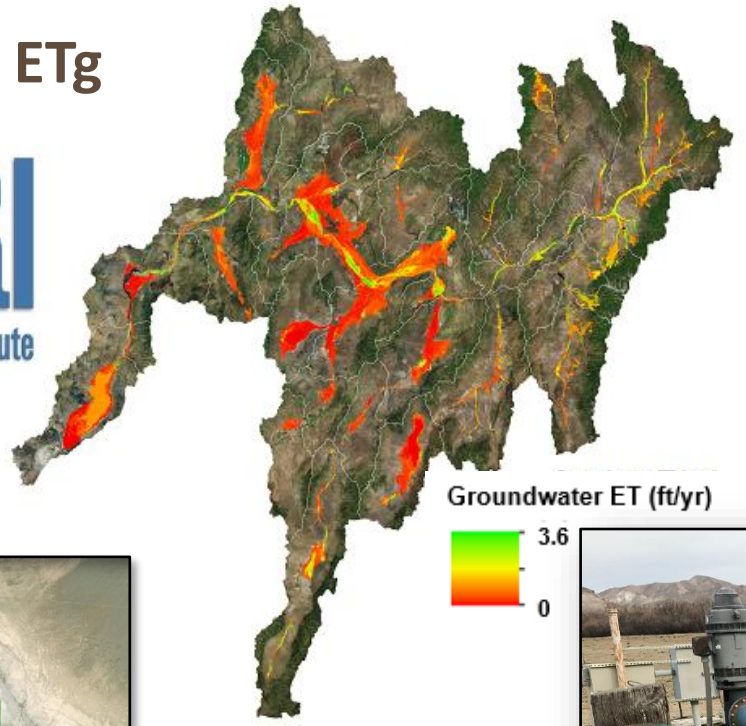
Nevada Water Resource Initiative – overview and vision

- 2020's version of the Nevada Groundwater Program.
- Use new technologies and data to update science and understanding of water resources.
- Re-estimate water budgets
- WHERE water enters and leaves our hydrographic basins.
- Develop the resources and tools for sustainable management.

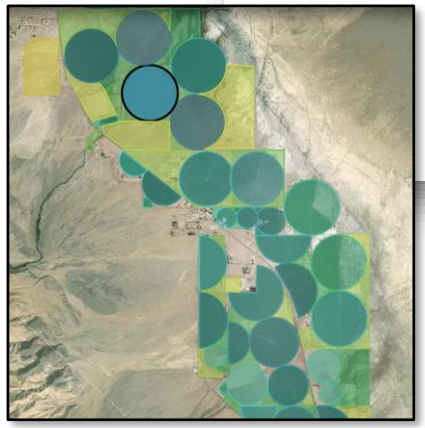
Nevada Water Resource Initiative – Components

Develop Statewide Discharge Datasets:

ETg



Desert Research Institute

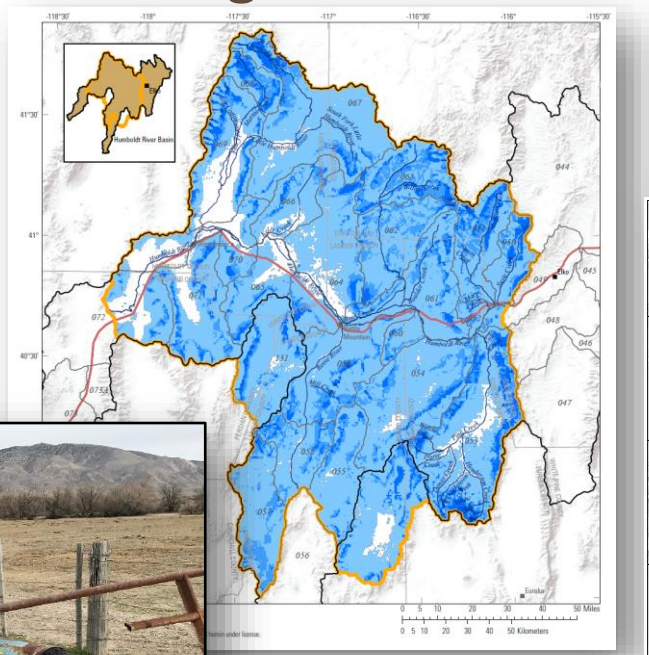


Pumping

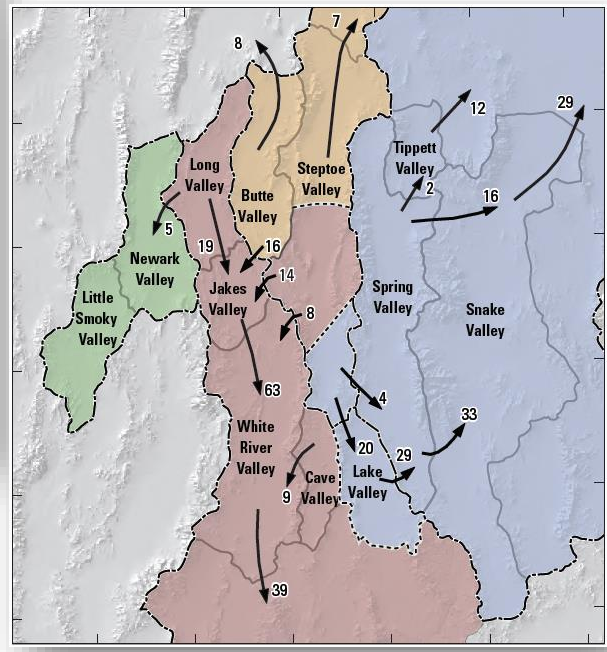
Develop Tools and Approaches for estimating:

USGS science for a changing world

Recharge



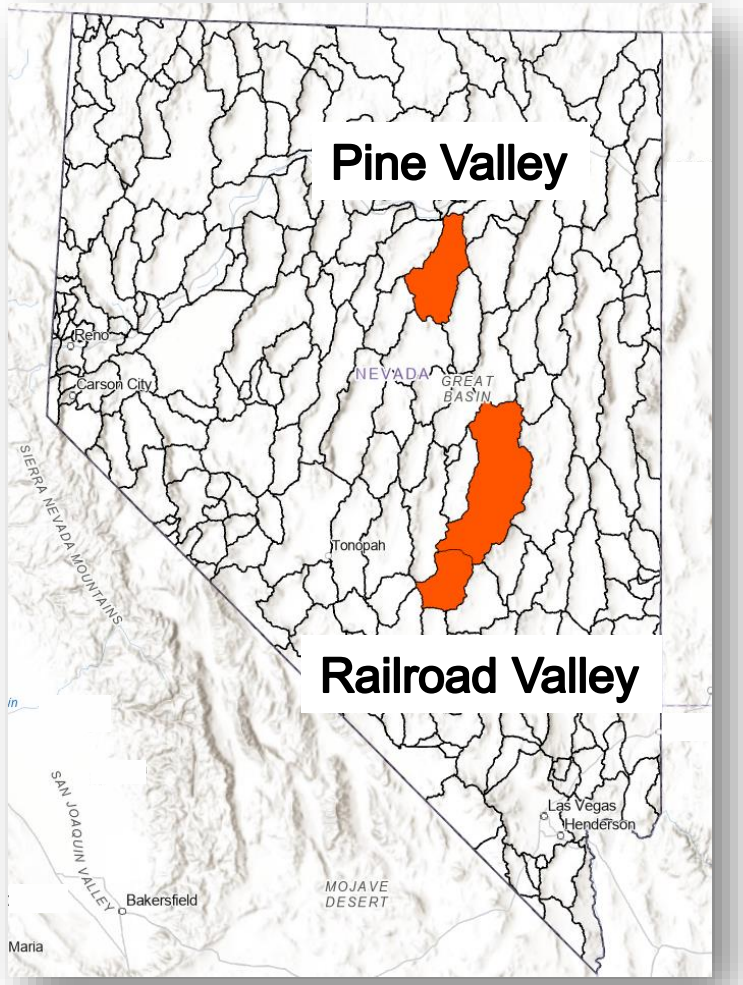
Interbasin Flow



Nevada Water Resource Initiative – Components (continued)

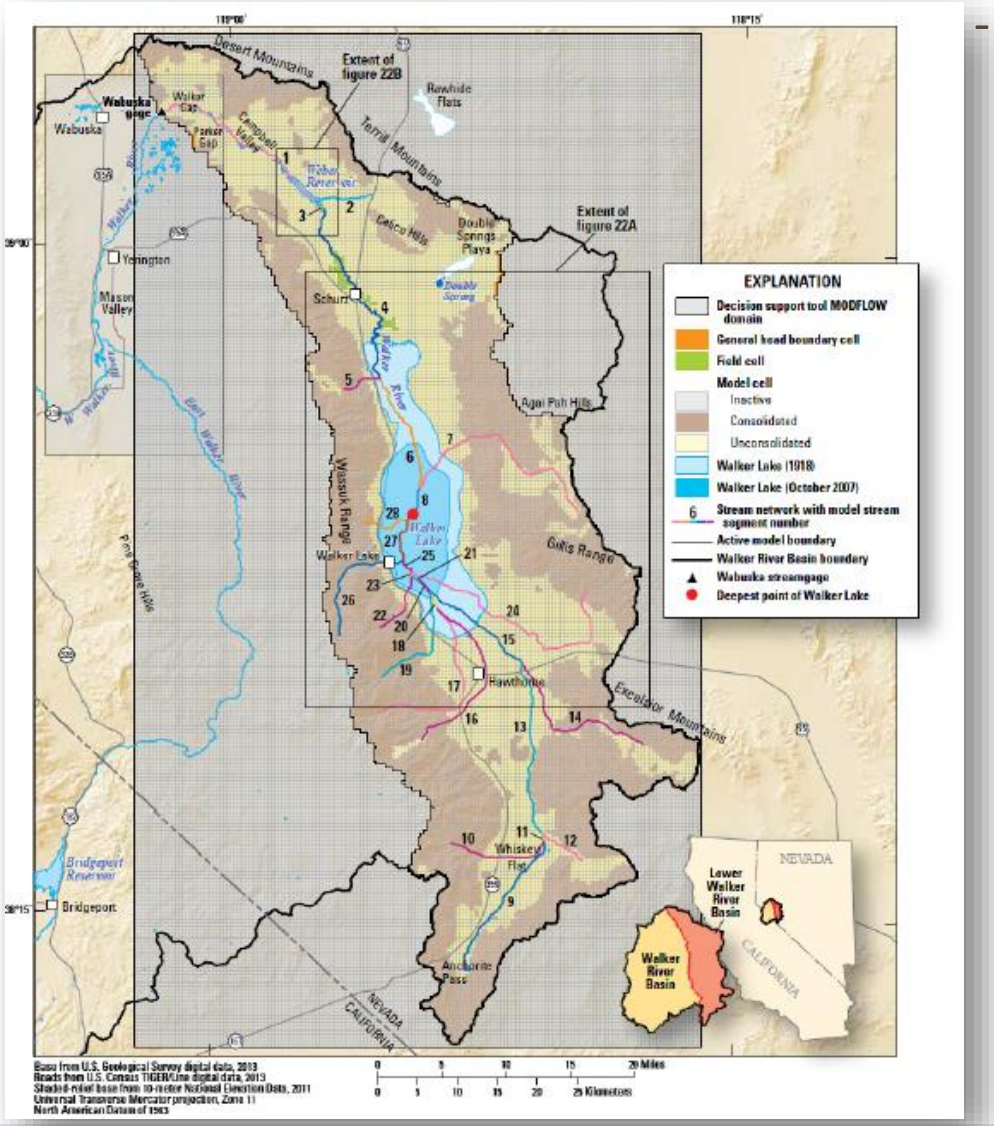
Increased Hydrologic Monitoring

Application of Methods in Demonstration Basins



Nevada Water Resource Initiative – Who Benefits?

- Datasets needed for groundwater models.
- Data and tools will be available to all.
  - Municipalities & Water Authorities
  - Mines & Industry
  - Consultants
  - Irrigators/Irrigation Districts
  - State & Federal Agencies
  - Universities & Schools
  - Non-Governmental Organizations
  - Public



Nevada Water Resource Initiative – Summary

For Water Resource Community

- Updated science and understanding.
- New useful tools and approaches.
- Additional data and resources.

For NDWR

- Perennial Yield will remain important constraint for UG appropriations.
  - Update of PY when warranted.
  - Potential for increase in water availability in some basins.
- More effective management of water resources (water rights)
- Inform/Reduce existing conflict
- Conjunctive Management
- Sustainable Development of our Water Resources

Questions?

Contact

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