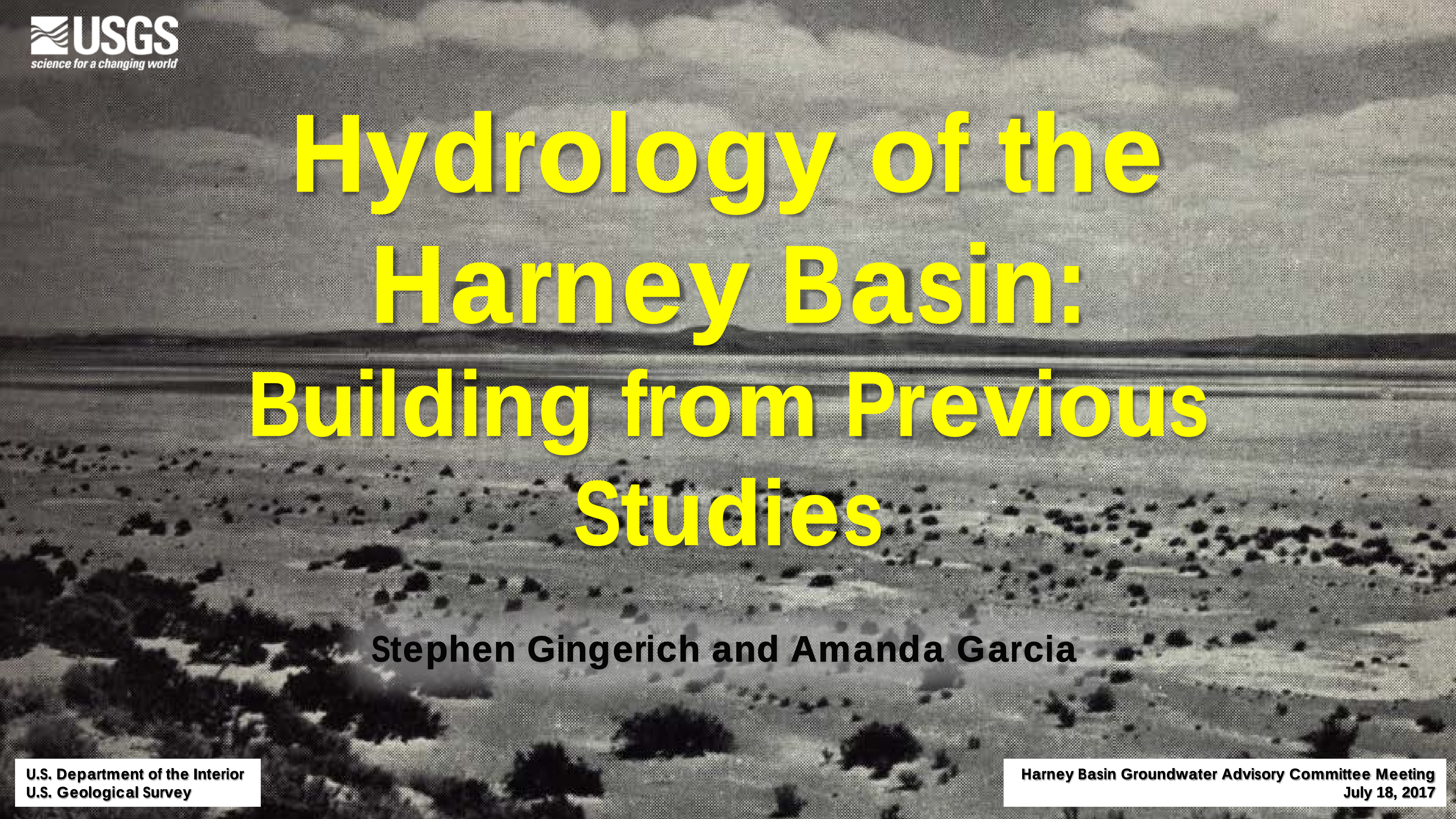

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Hydrology of the Harney Basin: Building from Previous Studies

Stephen Gingerich and Amanda Garcia

Purpose

- Harney Basin hydrology has been a topic of interest since the late 1800s
- A clear understanding of previous studies provides a basis for evaluating the water budget, hydrogeologic controls on groundwater flow, and groundwater/surface water interaction.
- Note: Information presented herein is based on speculation and evidence provided in previous studies. Remarks are not based on insights from the current study unless noted as such.

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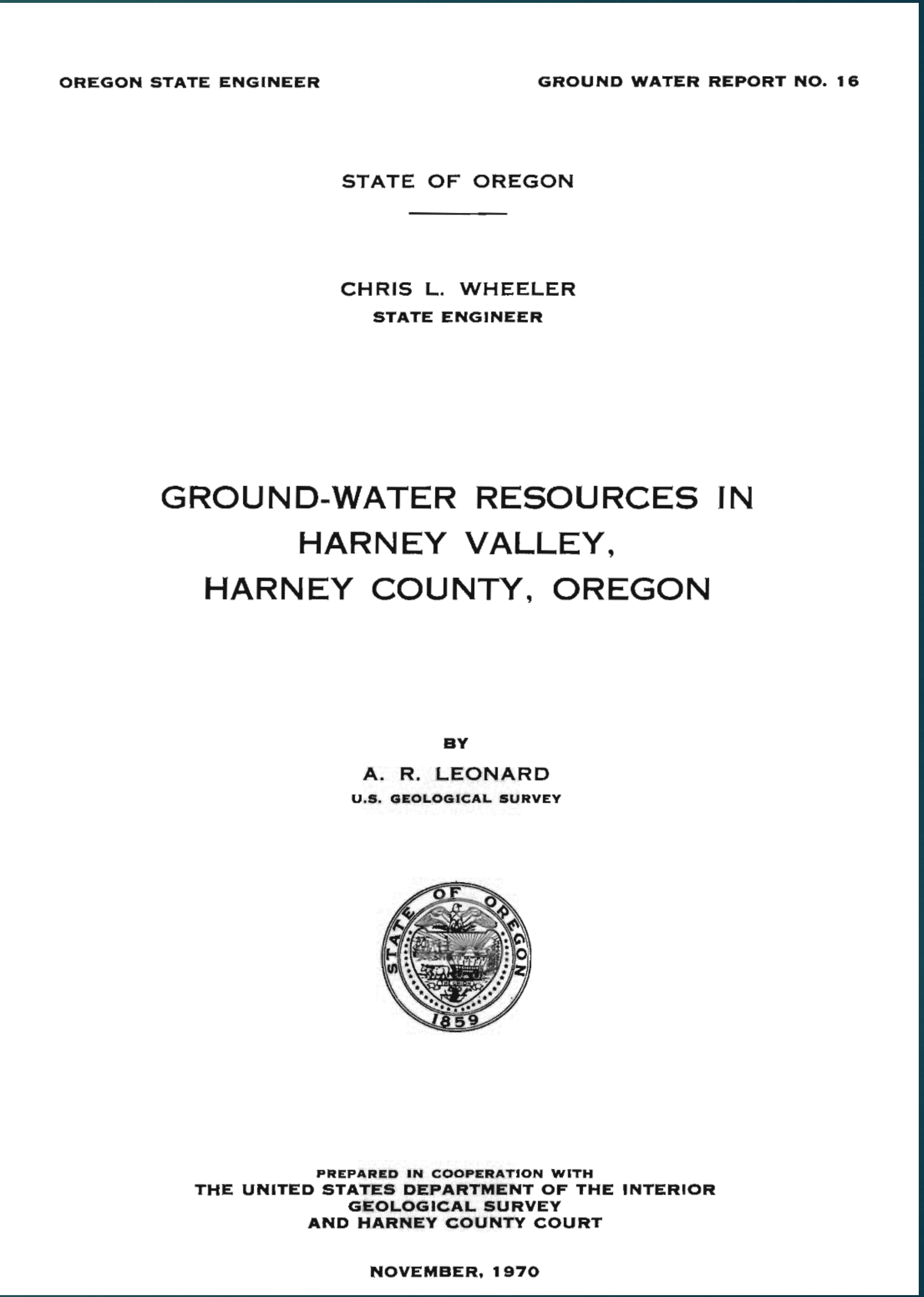
Objective of Presentation

- Present and synthesize existing hydrologic information from previous studies in the Harney Basin
- Hydrologic information includes:
  - Hydrogeologic framework
  - Surface water (rivers, creeks, and lakes)
  - Groundwater occurrence and flow
  - Water budgets
  - Water chemistry

Previous Studies

- A library of more than 40 relevant studies have been compiled
- The most comprehensive hydrologic studies include:
  - USGS **Water-Supply Paper 231**, “Geology and water resources of the Harney Basin Region, Oregon” by Waring (1909)
  - USGS **Water-Supply Paper 841**, “Geology and groundwater resources of the Harney Basin” by Piper and others (1939)
  - State of Oregon **Ground Water Report No. 16**, “Ground-water resources in Harney Valley, Harney County, Oregon” by Leonard (1970)



OREGON STATE ENGINEER GROUND WATER REPORT NO. 16

STATE OF OREGON

CHRIS L. WHEELER
STATE ENGINEER

GROUND-WATER RESOURCES IN
HARNEY VALLEY,
HARNEY COUNTY, OREGON

BY
A. R. LEONARD
U.S. GEOLOGICAL SURVEY

PREPARED IN COOPERATION WITH
THE UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
AND HARNEY COUNTY COURT

NOVEMBER, 1970

Climate – Harney Valley Floor

Reference	Years	Annual average temperature (°F)	Annual average precipitation (in)
Waring (1909)	1890-1907	45-50	10-15
Piper and others (1939)	1890s-1930s	43-45	<10
Leonard (1970)	1891-1921, 1938-1970	47	<10

- Tree-ring evaluation (Piper and others, 1939):
  - Precipitation from 1890s-1930s is similar to the 200-year mean (1730s-1930s)
  - Severe droughts might occur 70-90 years apart and persist for ~25 years

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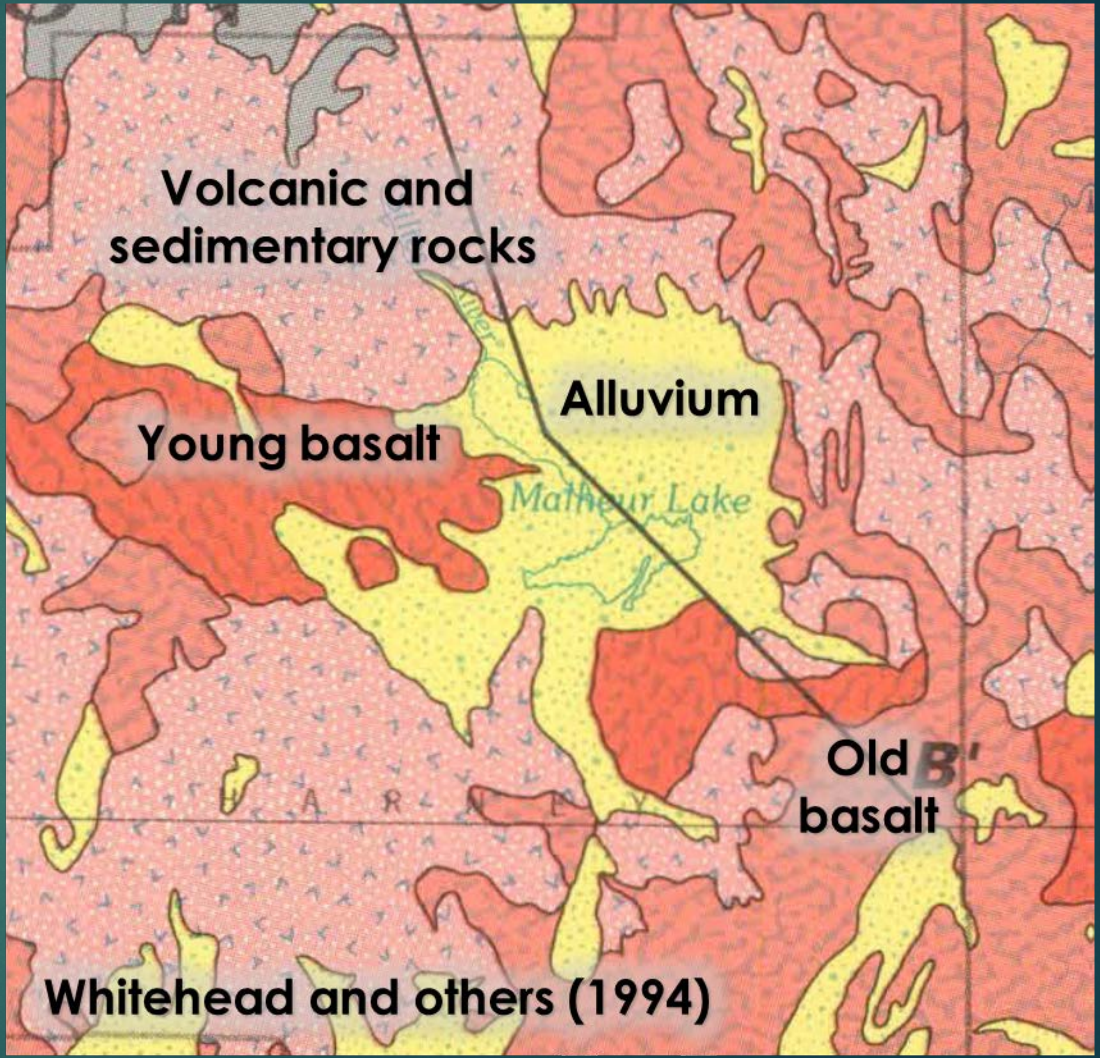
Hydrogeologic Framework

- Complex geology
- Major water-bearing units of interest:
  - Steens Basalt & Tertiary Volcanics
  - Danforth Fm - tuffs, rhyolite, breccia, sediments
  - Harney Fm – tuff, breccia, sandstone
  - Late Basalt – basalt from recent volcanism
  - Alluvium – sand, gravel, clay, volcanic sediment



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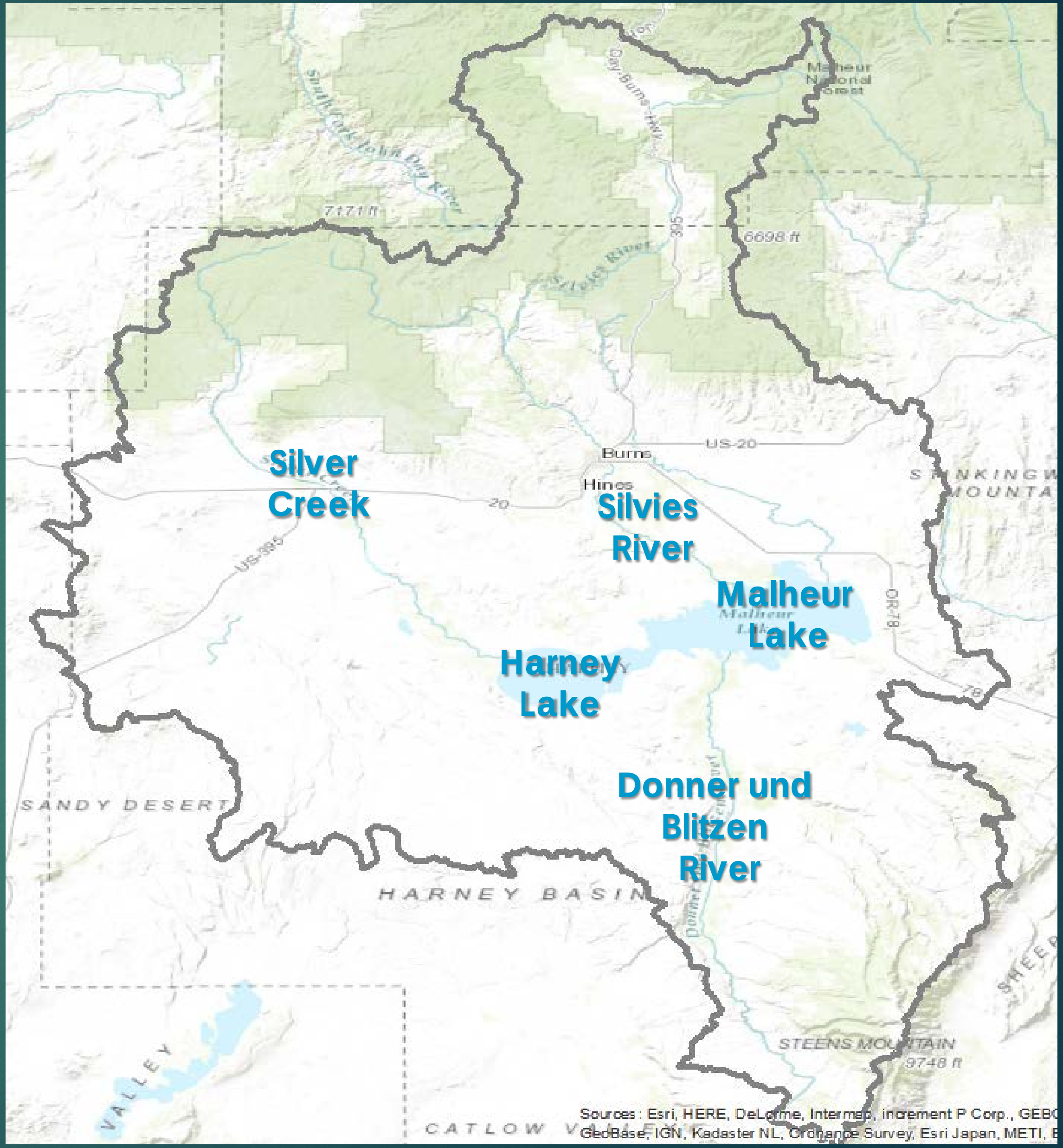
Surface Water

- Major features include:
  - Silvies River
  - Donner und Blitzen River
  - Silver Creek
  - Malheur Lake
  - Harney Lake
- Minor contributors
  - N. of Malheur Lake: Sagehen, Poison, and Rattlesnake Creeks and Malheur Slough
  - S. of Malheur Lake: Kiger, McCoy, Krumbo, Cucamonga, Bridge, and Mud Creeks
- Surface flow through Malheur and Crane Gaps blocked by recent volcanism
- Malheur and Harney Lakes are remnants of an ancient lake (>12,000 years)



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Surface Water

- Dominated by snowmelt
- Silvies River
  - Gains from spring-fed creeks in upper reaches
  - Generally loses to GW south of Burns
  - Large part diverted for irrigation
  - Discharges into Malheur Lake all year during wet years
- Donner und Blitzen River
  - Gains from spring-fed creeks in upper reaches
  - Loses to GW
  - Small part diverted for irrigation
  - Large part rerouted through the refuge
  - Discharges into Malheur Lake all year
- Silver Creek
  - Gains from spring-fed creeks in upper reaches
  - Large part diverted for irrigation
  - Discharges into Harney Lake during wet years

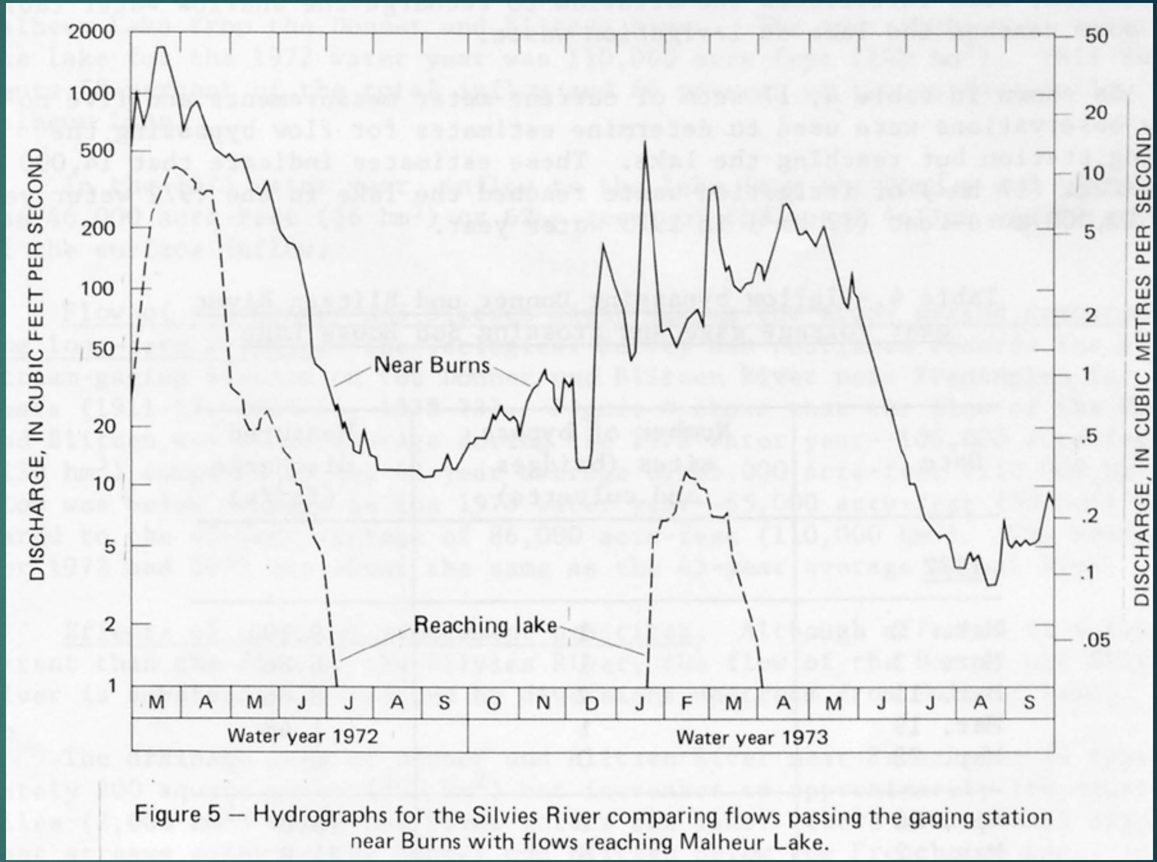

Figure 5 – Hydrographs for the Silvies River comparing flows passing the gaging station near Burns with flows reaching Malheur Lake.

Piper and others (1939)

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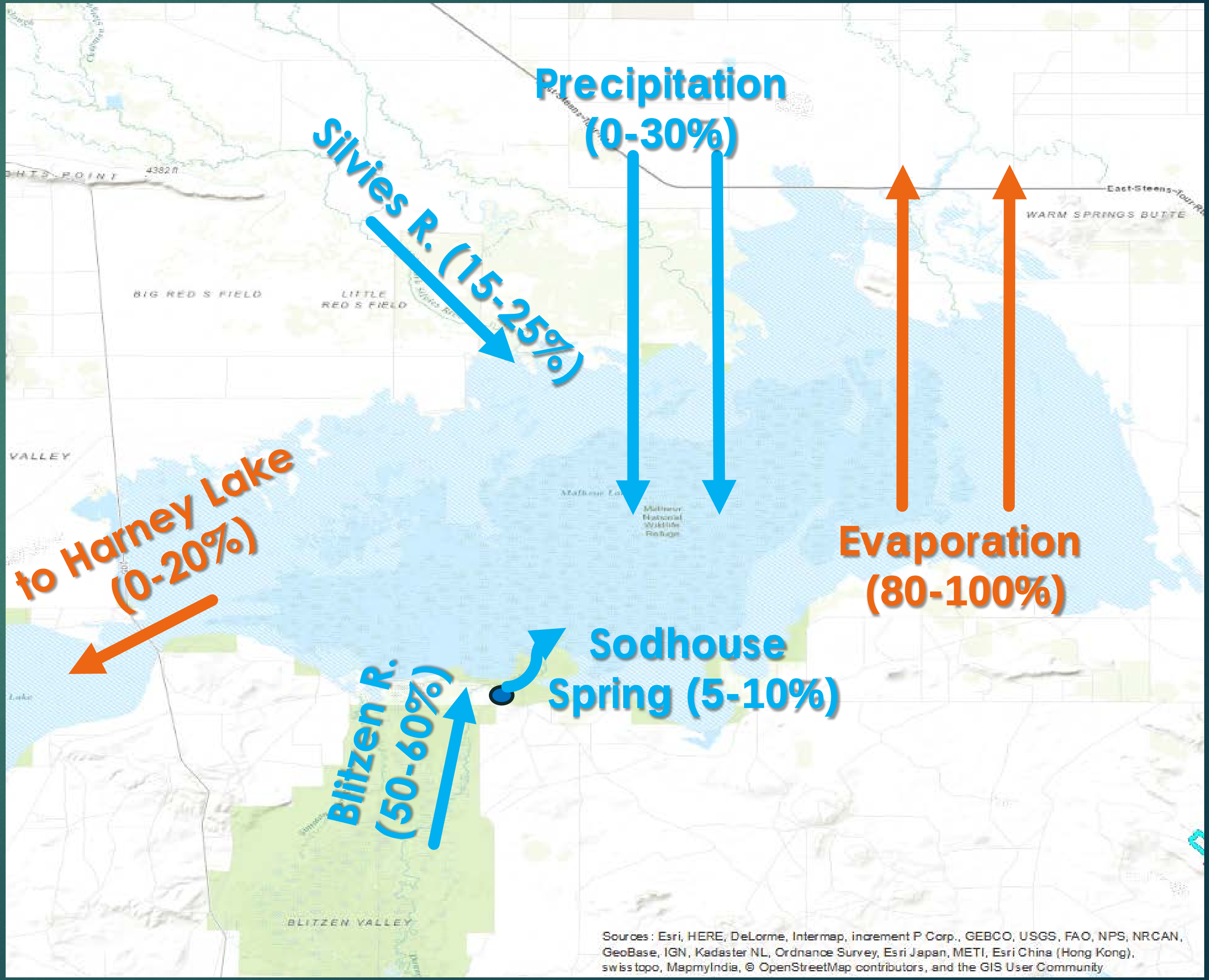
Surface Water – Malheur Lake

- Shallow – surface area fluctuates seasonally
- Sodhouse Spring
  - Likely only groundwater source
  - Minimally flowing at present compared to 5-10% historically
- Loss to peat deposits during wet years
- Not significantly connected with regional groundwater system (Hubbard, 1975)



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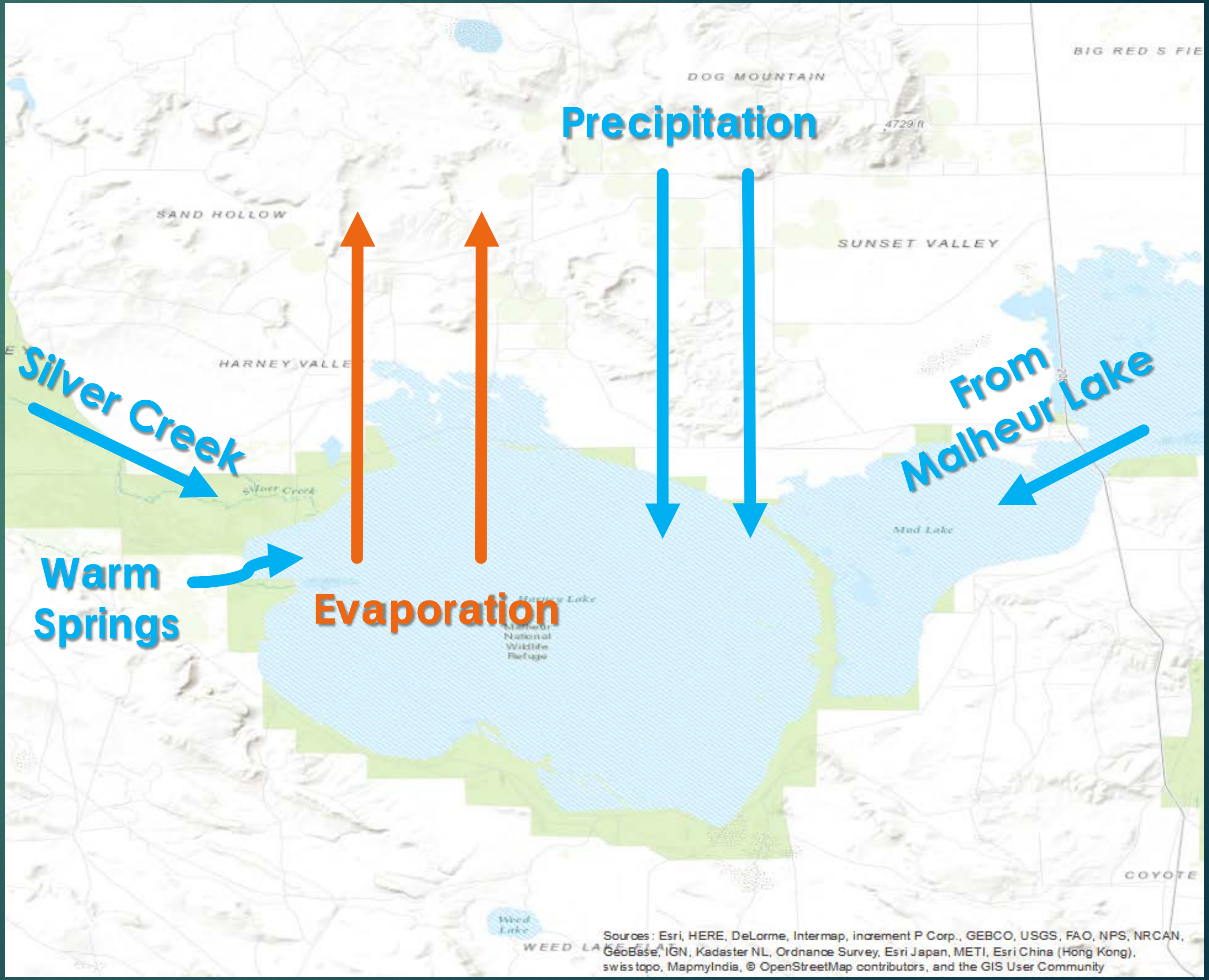
Surface Water – Harney Lake

- Deeper than Malheur – surface area less variable
- Has been dry historically – not directly connected to regional groundwater system



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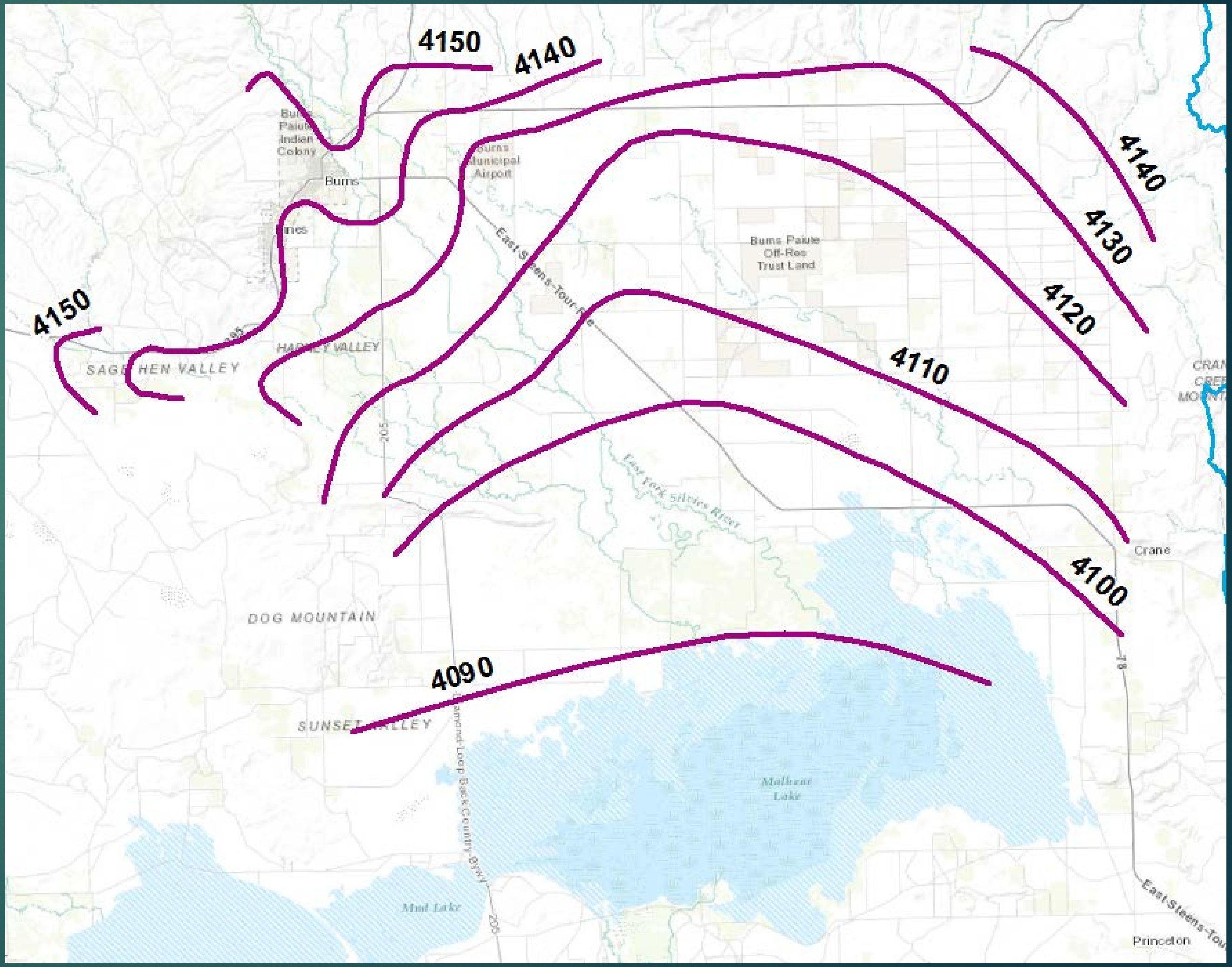
Groundwater

- Recharged in the highlands and along rivers during snowmelt
- Generally flows toward the basin center
- Naturally discharged by ET and springs
- 1930s maps show shallow water-level elevation after multiple dry years
- 1970s maps show average water level of shallow and deep wells
  - Water levels in deeper wells are 10-15 ft higher than in shallow wells near the lake

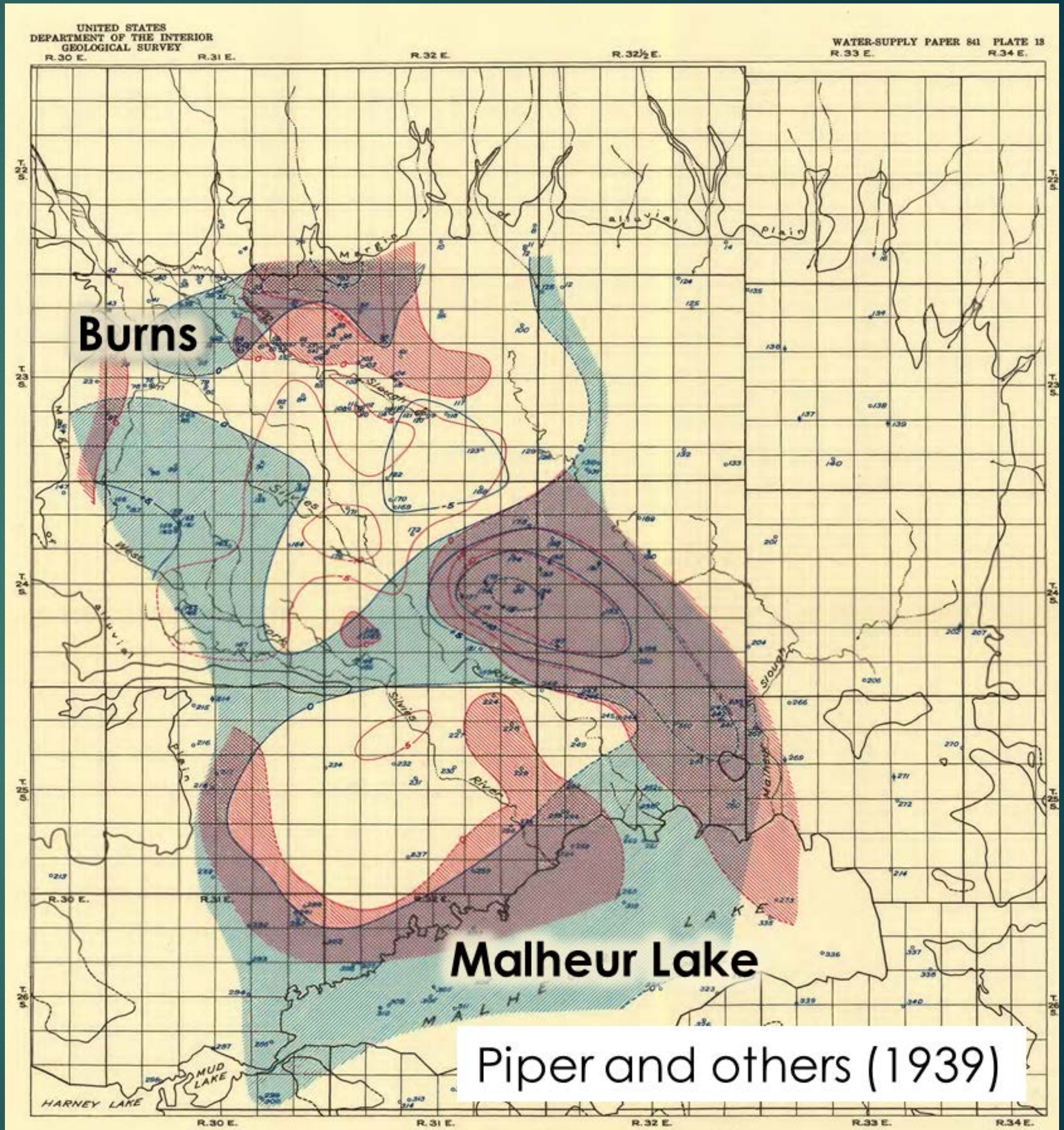


Piper and others (1939)
Leonard (1970)

USGS

Groundwater

- Shallow (unconfined) and deep (confined) alluvial units
  - Downward flow from shallow to deep alluvium along rivers
  - Artesian wells where water level in deep unit is higher than shallow unit
    - Varies seasonally and annually
    - Most pronounced during fall and dry years
  - Alluvium up to 300-ft thick
  - Deeper unit generally more permeable



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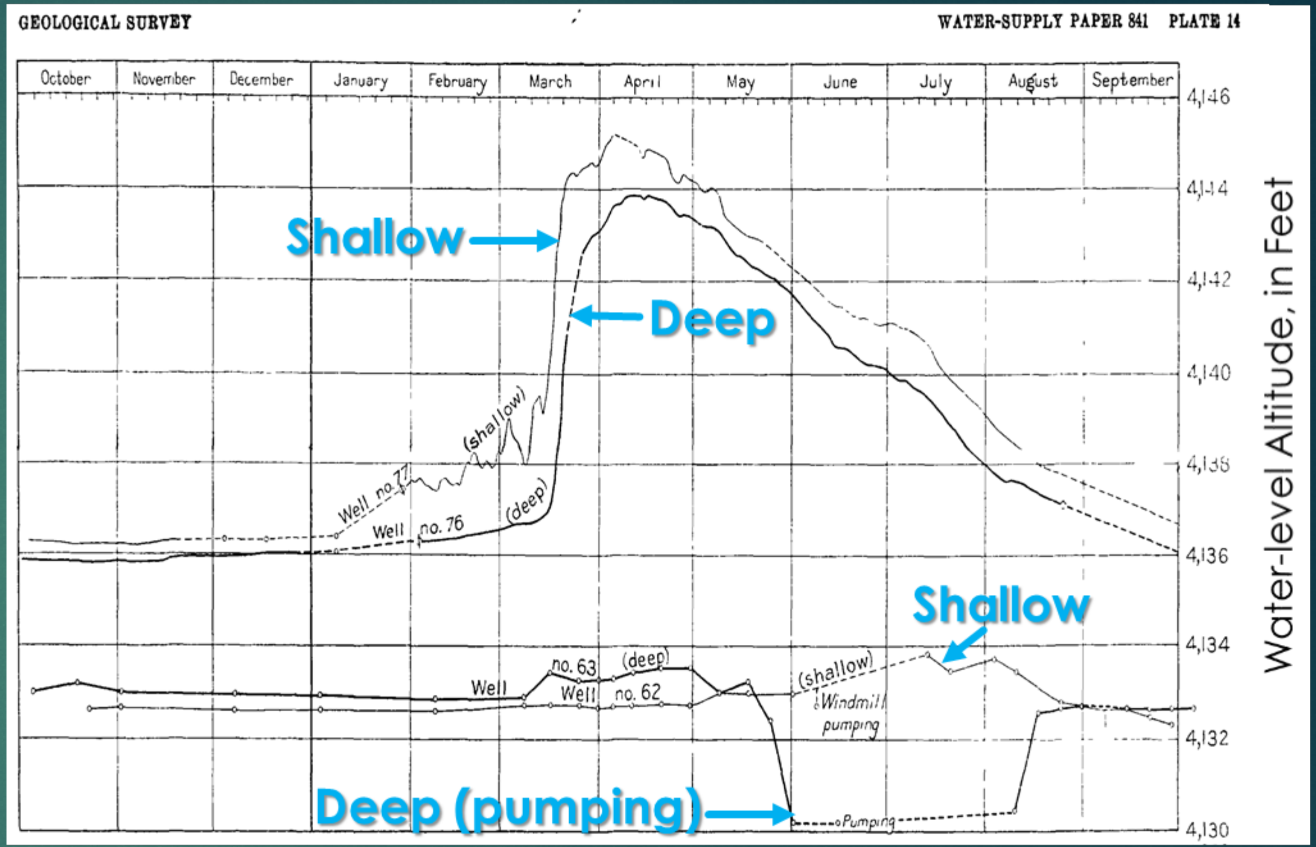
Groundwater

- Limited connection between shallow and deep alluvium
  - Thick clay unit between shallow and deep zones (20-100 ft) limits vertical flow
  - Hydrographs
    - Deeper zone responds to loading of shallow zone
    - Shallow zone does not respond to pumping in deep zone
  - Water chemistry
    - TDS of shallow zone toward lakes
    - TDS of deep zone is low and relatively constant



Piper and others (1939)

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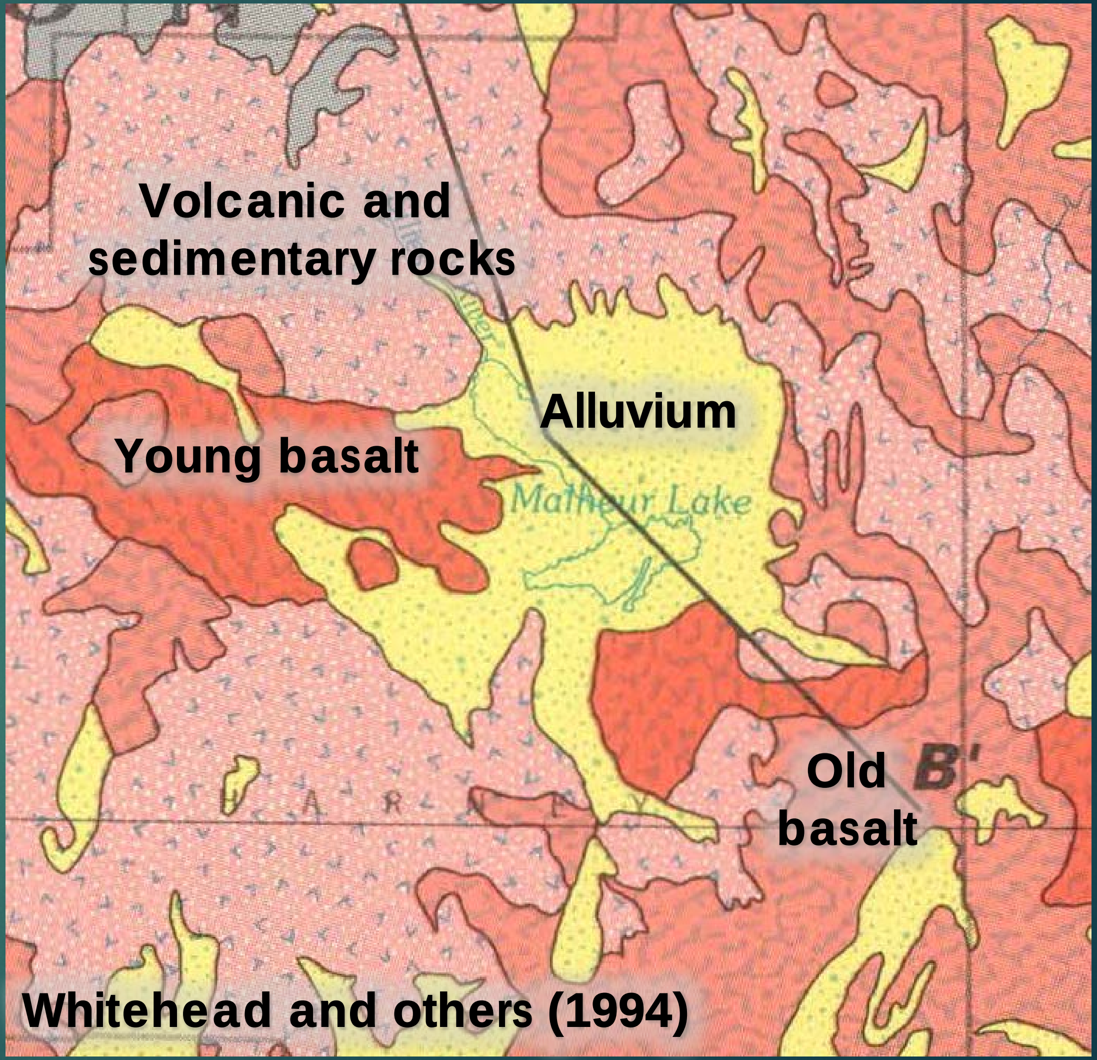
Groundwater

- Bedrock aquifers
  - Young basalt, Volcanic and sedimentary rocks
    - Water levels are above overlying deep alluvium
    - Bedrock water locally flows upward (deep alluvium warmer)
    - Permeable layers not continuous
  - Old basalt
  - Voltage lava flows (young basalt S. of Malheur Lk)



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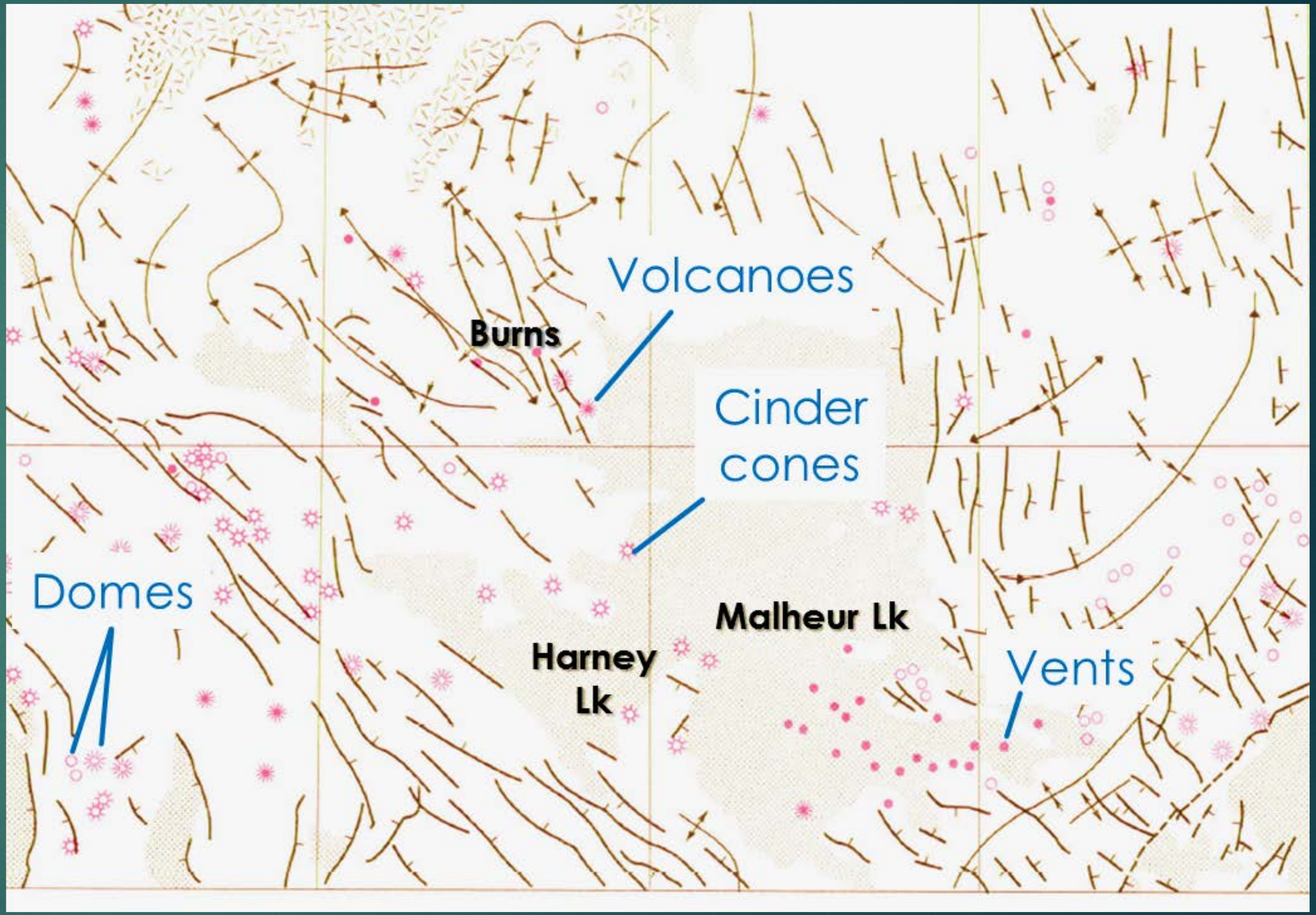
Groundwater

- Bedrock aquifers
  - Recharged in the highlands and heated by
    - Deep circulation
    - Nearby recent volcanism
  - Generally flows toward the basin center
  - Naturally discharged to springs or upward flow to alluvium (or out Malheur Gap?)



Greene and others (1972)

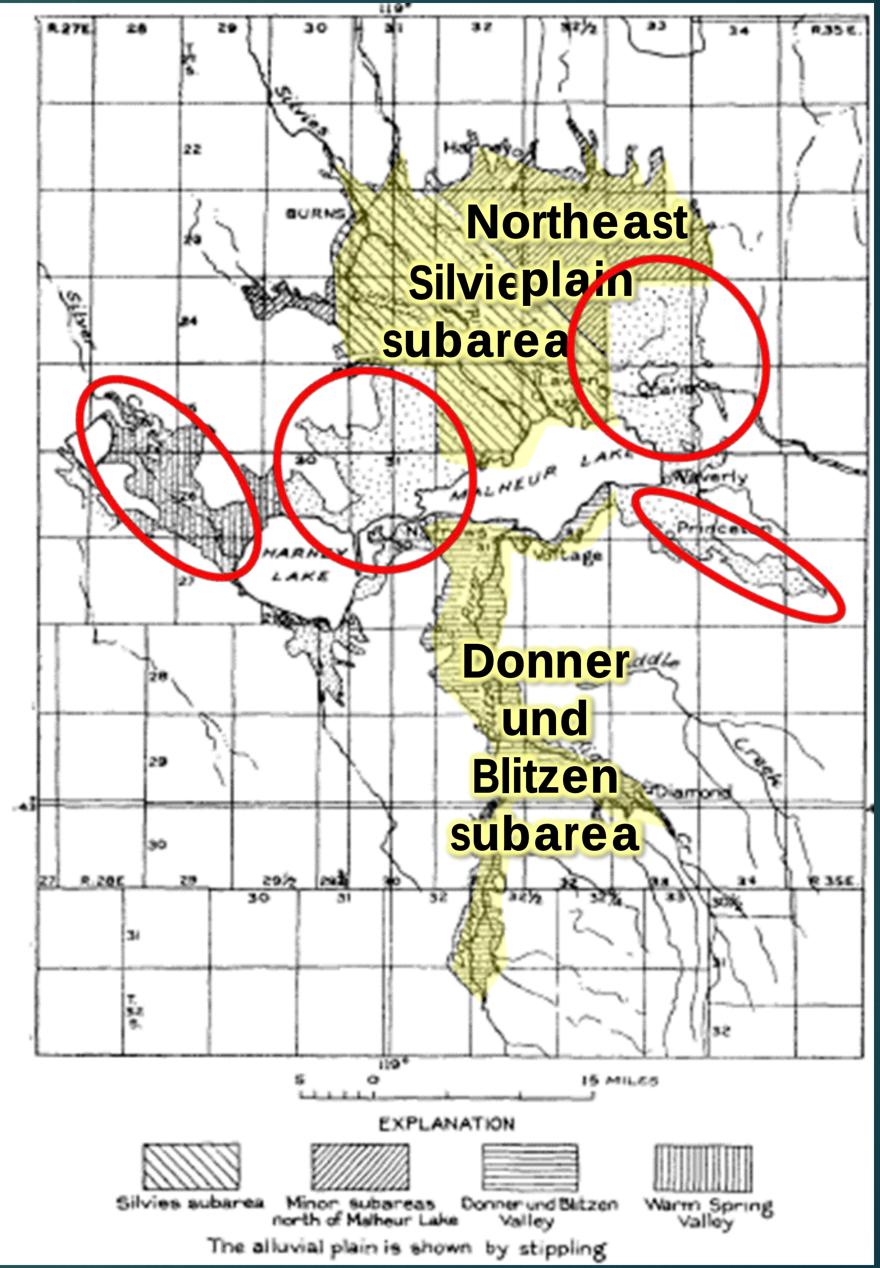
Groundwater - Springs

- Most discharge from bedrock
- Silvies plain
  - Examples are springs near Hines, Burns, and Crane
  - Predominantly from volcanic and sedimentary rocks
- Warm Springs Valley
  - OO Cold Spring recharged from Silver Creek highlands
  - Springs occur along a NW trending fault
  - Warmer springs likely discharge from old basalt
- Upper Blitzen Valley
  - Examples are Knox and Page Springs
  - Discharges from old basalt
- Sodhouse Spring
  - Likely discharges from Voltage lava flows (young basalt)
  - Precipitation infiltration near Voltage and Diamond
  - Seasonal variability indicative of a shallow flow path

Barnyard Spring

Water Budgets

- Average annual GW recharge/discharge
  - Silvies subarea ~40,000 acre-ft/yr
  - Northeast central plain ~20,000 acre-ft/yr
  - Donner und Blitzen subarea ~73,000 acre-ft/yr
- Budget components for remaining areas not estimated in previous studies
  - Eastern plain
  - Warm Springs Valley
    - 20,000-30,000 acre-ft/yr from springs (previous studies)
    - Groundwater ET below Moon Reservoir not estimated
  - Sunset Valley
  - Virginia Valley



Piper and others (1939)

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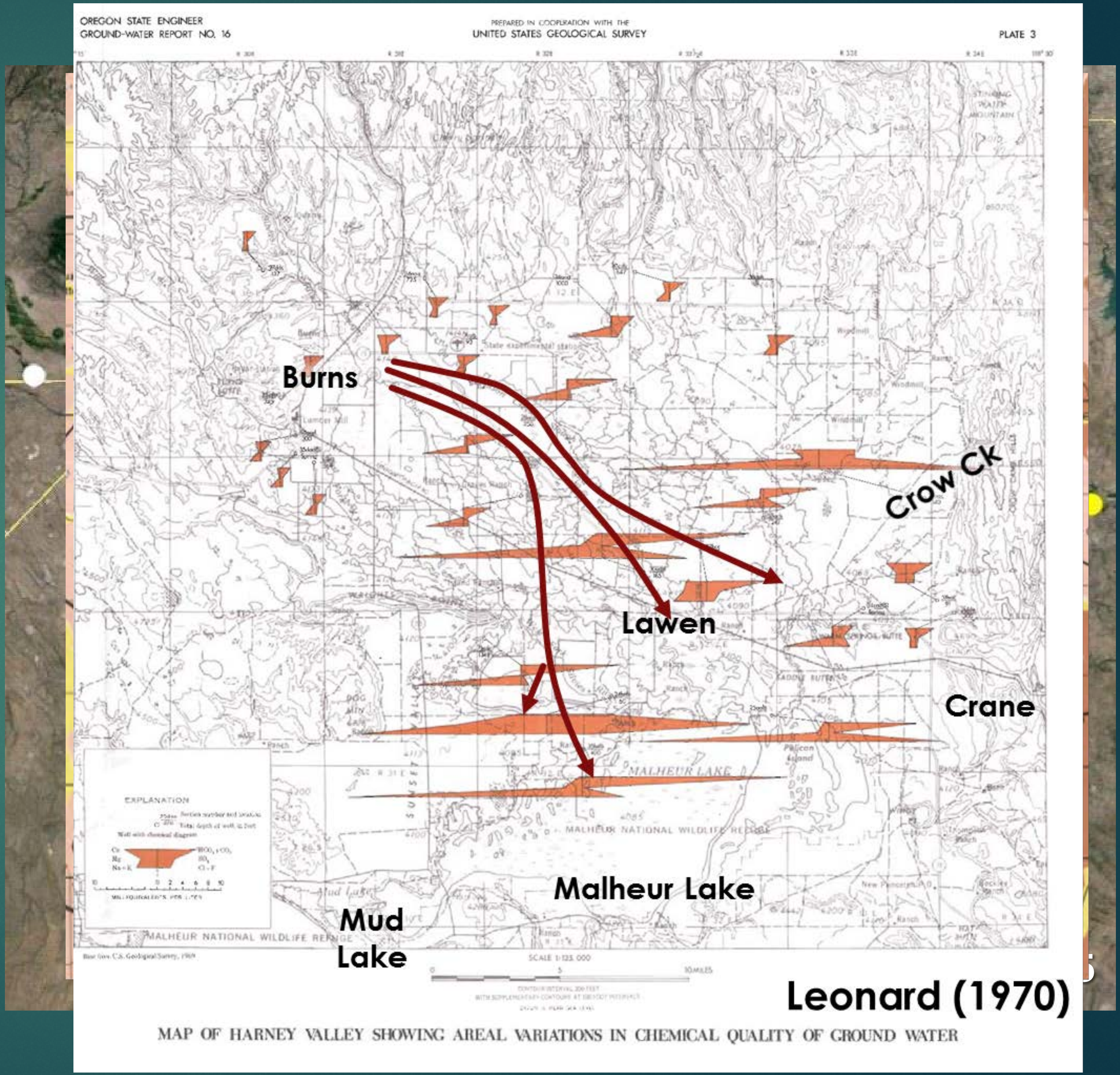
Chemistry

- Chemistry indicates GW flow paths
- Total dissolved solids (TDS)
  - Increases toward the valley center
  - Secondary drinking water standard is 500 ppm
  - Exceeds 1,000 ppm in alluvium only
- Arsenic
  - Exceeds Drinking Water Standard (10 ppb) in many areas across the basin
  - Detected in alluvium and bedrock



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Conclusion

- Previous studies
  - Provide a basis for understanding Harney Basin hydrology
  - Highlight areas where more information is needed

- The current Harney Basin groundwater study builds from these and other previous studies

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