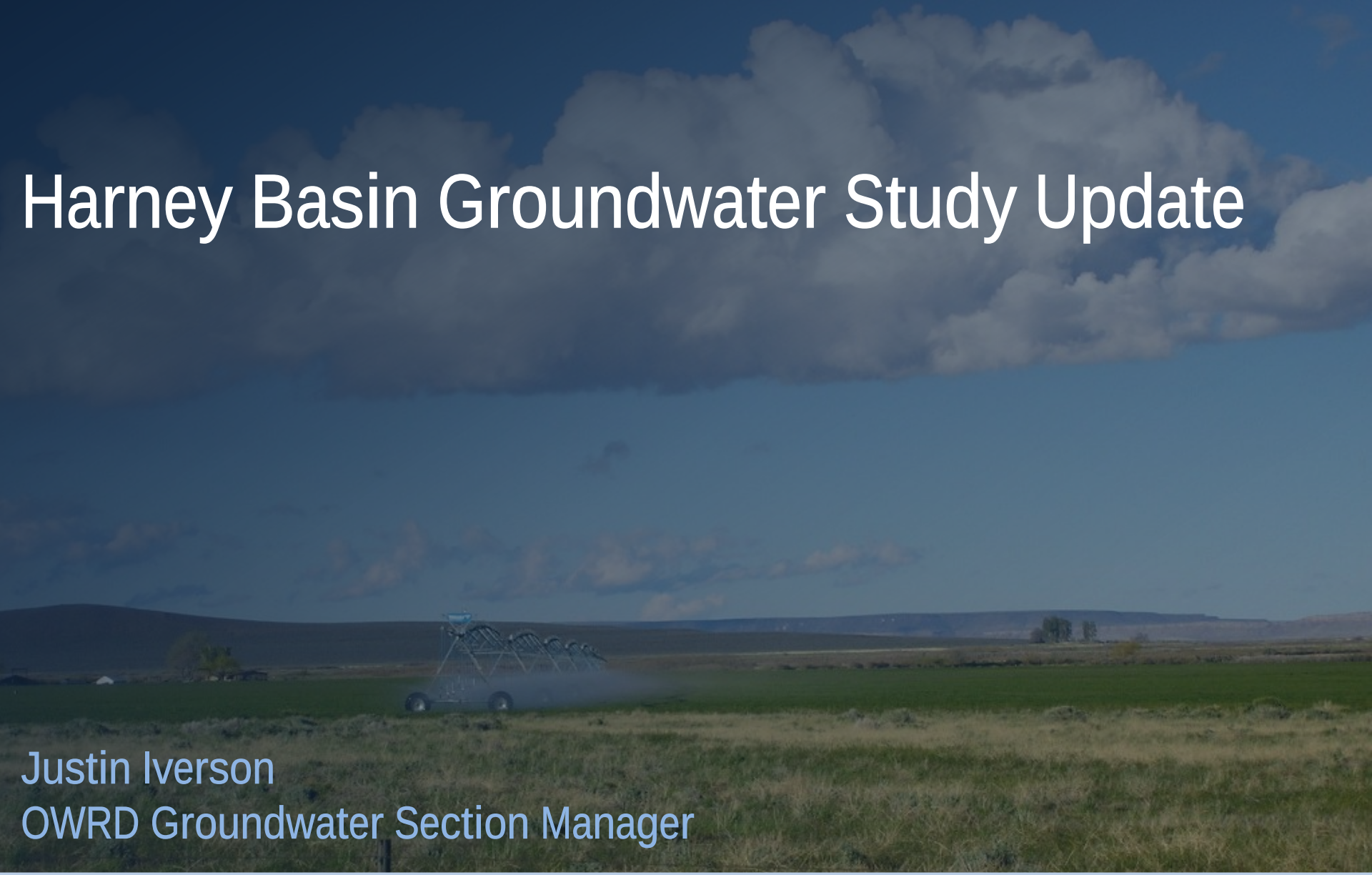
Harney Basin Groundwater Study Update



Justin Iverson
OWRD Groundwater Section Manager

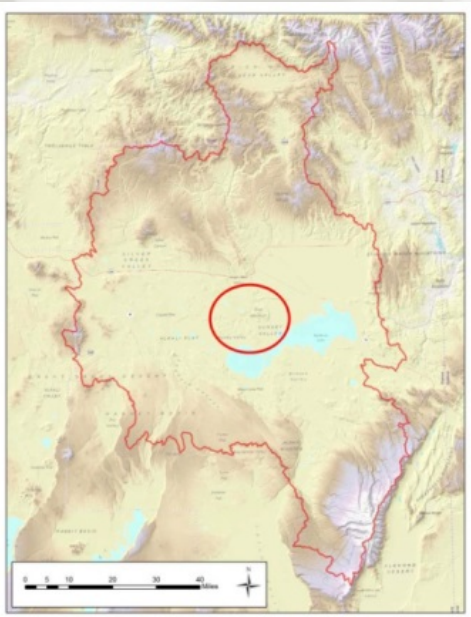
OREGON WATER RESOURCES DEPARTMENT

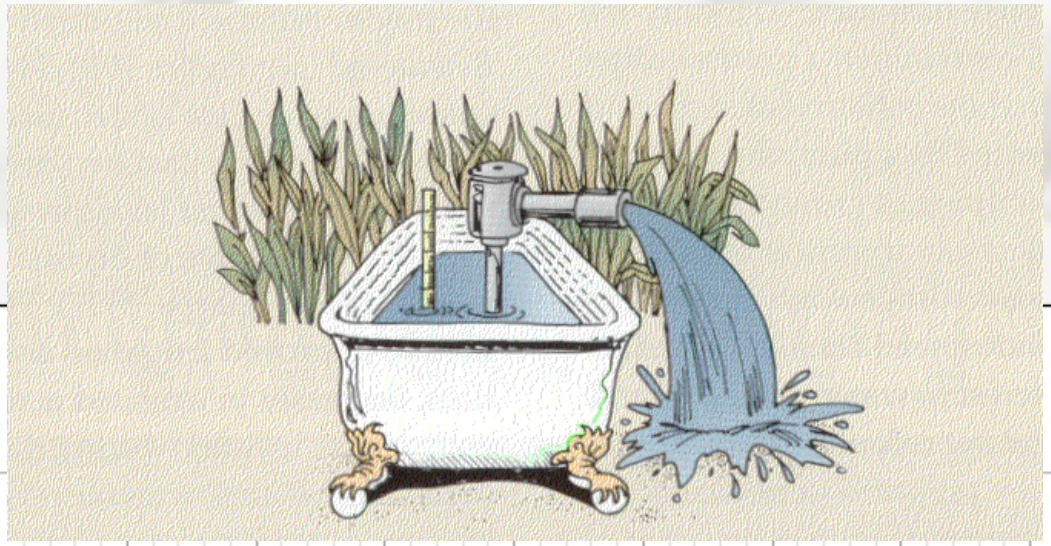
Water Resources Commission Meeting
February 21, 2019

Overview

- Background
- New groundwater permits issued within the GHVGAC
- Updates regarding groundwater level data
- **Updates regarding the groundwater study**
  - 5 “lightning talks” from OWRD and USGS study team members

Background – Water Level Trends





~1955 --- Time ---> Today

Background - Rulemaking

- Basin rules adopted in April 2016 to:
  - Protect existing groundwater users
  - Initiate a basin-wide groundwater study to develop a more detailed and commonly accepted understanding of the hydrologic system in the Harney Basin
  - Convene a local Groundwater Study Advisory Committee (unique)
  - Report annually to the Commission

Background - Division 512 Reporting Requirements

- **Annual report to the commission regarding:**
  - New groundwater permits issued within the GHVGAC
  - Updates regarding groundwater level data and the groundwater study
  - Staff recommendations, if any

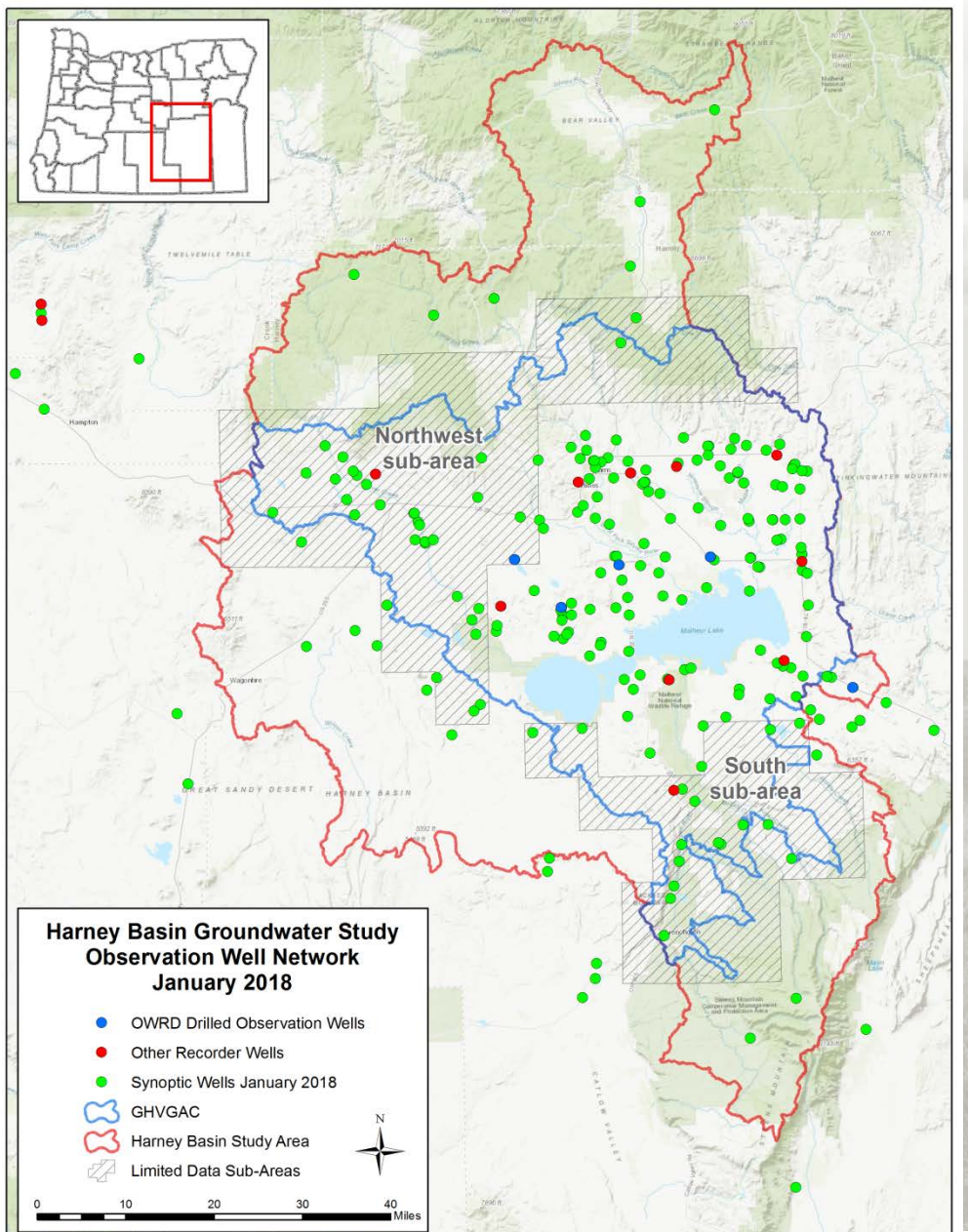
1 Permit Issued in the GHVGAC in 2018

- **<u>Application G-17575, priority date 8/22/2012</u>**
  - Permit processed and Final Order proposing to approve was issued before new rules were promulgated in April 2016
  - Permit was not issued with final order due to well construction issues
  - Applicant addressed construction issues in 2018 and the permit was issued 9/12/2018

Groundwater Level Data

Date	1/2019	1/2014
Total Wells Field-Located	634	51
Total Water-Level Synoptic Wells	231	-
Total Water-Level Quarterly Wells	111	23
Spring 2018 Water Level Synoptic Measurements	205	-
Fall 2017 Water Level Synoptic Measurements	221	-
Total Water Levels Measured 2015 (by OWRD staff)	400	-
Total Water Levels Measured 2016 (by OWRD staff)	672	-
Total Water Levels Measured 2017 (by OWRD staff)	688	-
Total Water Levels Measured 2018 (by OWRD staff)	555	-
Continuous Recorder Instruments Installed	24	2
New Observation Wells Constructed	12	-

Groundwater Level Data



Groundwater Basin Study - Timeline

2016 – USGS/OWRD Cooperative Study Initiated, GSAC Established

2016-2018 Intensive Data Collection Effort, GSAC Input

Late 2018 – Transition to Data Analysis

2019 - Intensive Data Analysis Effort, Continued GSAC Input

2020 – Study Reports Scientifically Peer-Reviewed and Published

2021 and beyond – Reassess Management Options, Develop GW Model for Planning Support

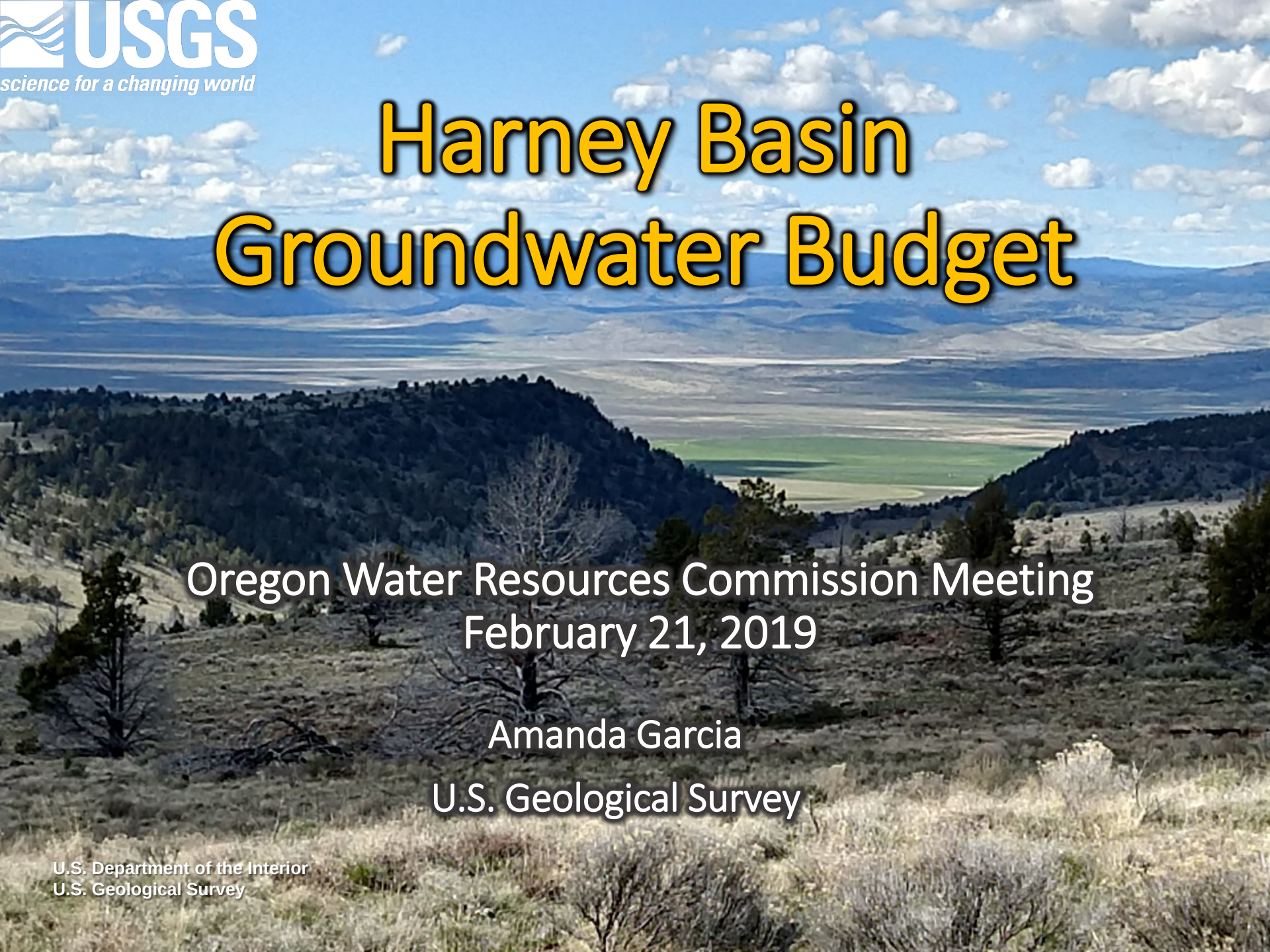
Groundwater Basin Study

- Study Cooperators:
  - Oregon Water Resources Department (OWRD)
  - United States Geological Survey (USGS)
  - Local involvement through the Groundwater Study Advisory Committee and Watershed Council
  - Other contracted studies (DOGAMI) and independent studies (Crane School/PSU, DEQ, OSU, UNR-DRI, TNC) will add to this work

Groundwater Basin Study

- <u>OWRD and USGS Study Team Members Not Presenting Today:</u>
  - Halley Barnett
  - Darrick Boschmann
  - Nick Corson-Dosch
  - Melony Hoskinson
  - Jonathon La Marche

All lightning talks from October 25, 2018 information sharing event in Burns are available at: https://apps.wrd.state.or.us/apps/misc/vault/vault.aspx?Type=WrdNotice&notice_item_id=8032


USGS
science for a changing world
Harney Basin
Groundwater Budget
Oregon Water Resources Commission Meeting
February 21, 2019
Amanda Garcia
U.S. Geological Survey
U.S. Department of the Interior
U.S. Geological Survey

Groundwater Budget

Image source: Microsoft PowerPoint Clip Art Gallery
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USGS

IN

OUT

Image sources: Microsoft PowerPoint Clip Art Gallery
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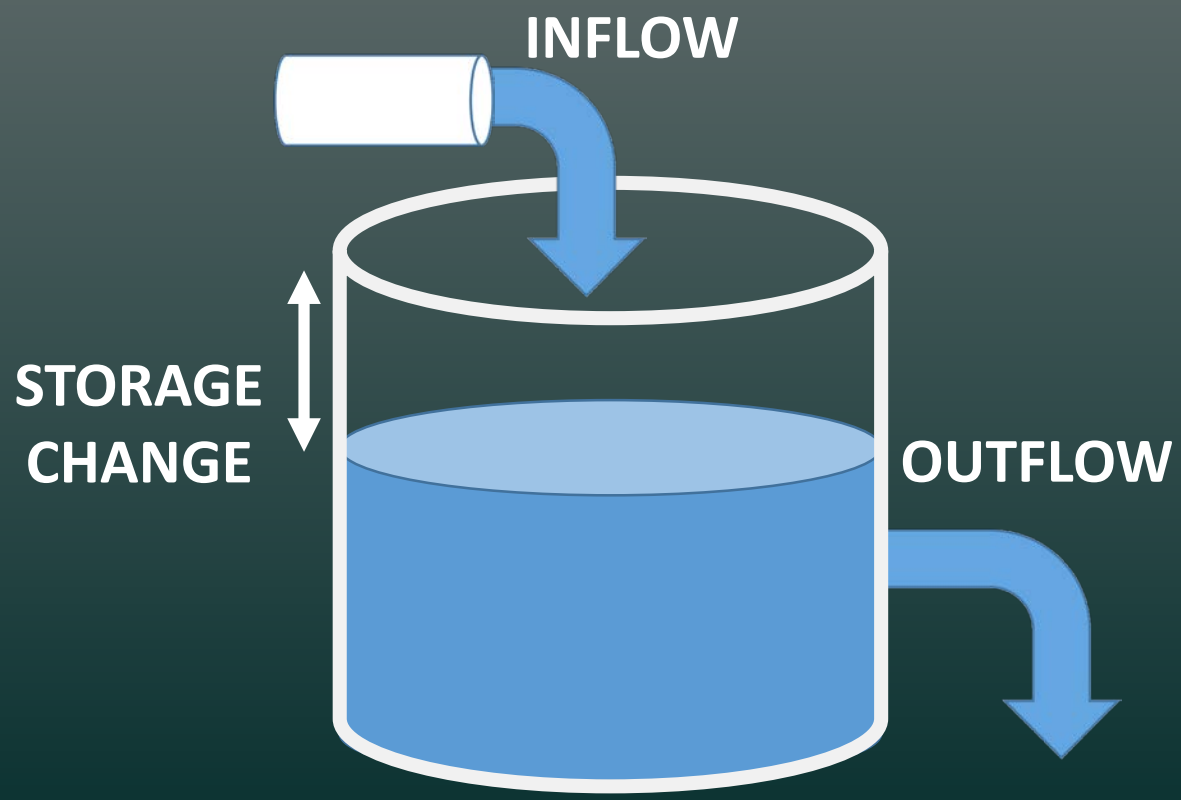
NET CHANGE IN ACCOUNT

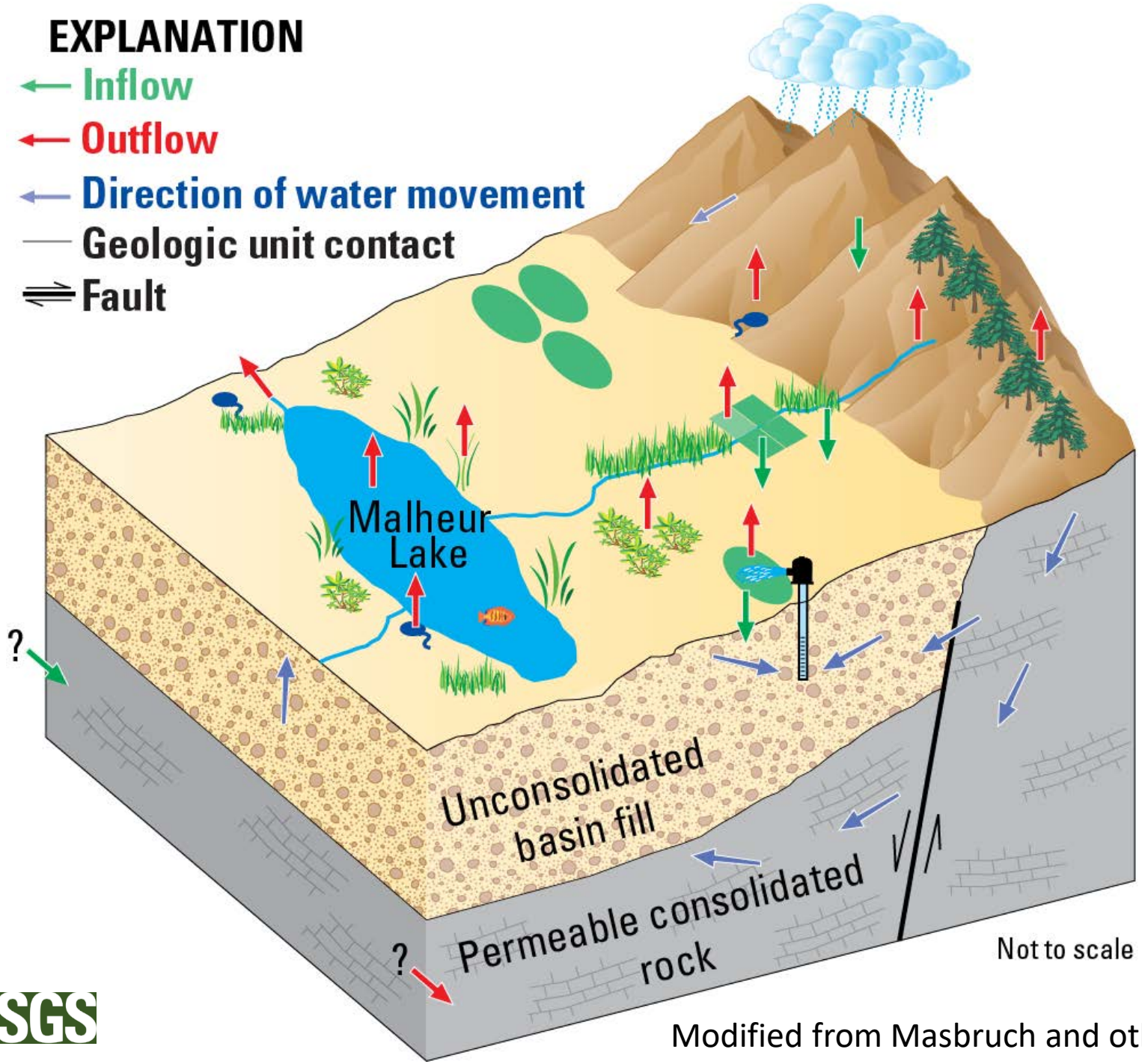
USGS

Basin Groundwater Budget

↓INFLOW = ↑OUTFLOW ± CHANGE IN STORAGE

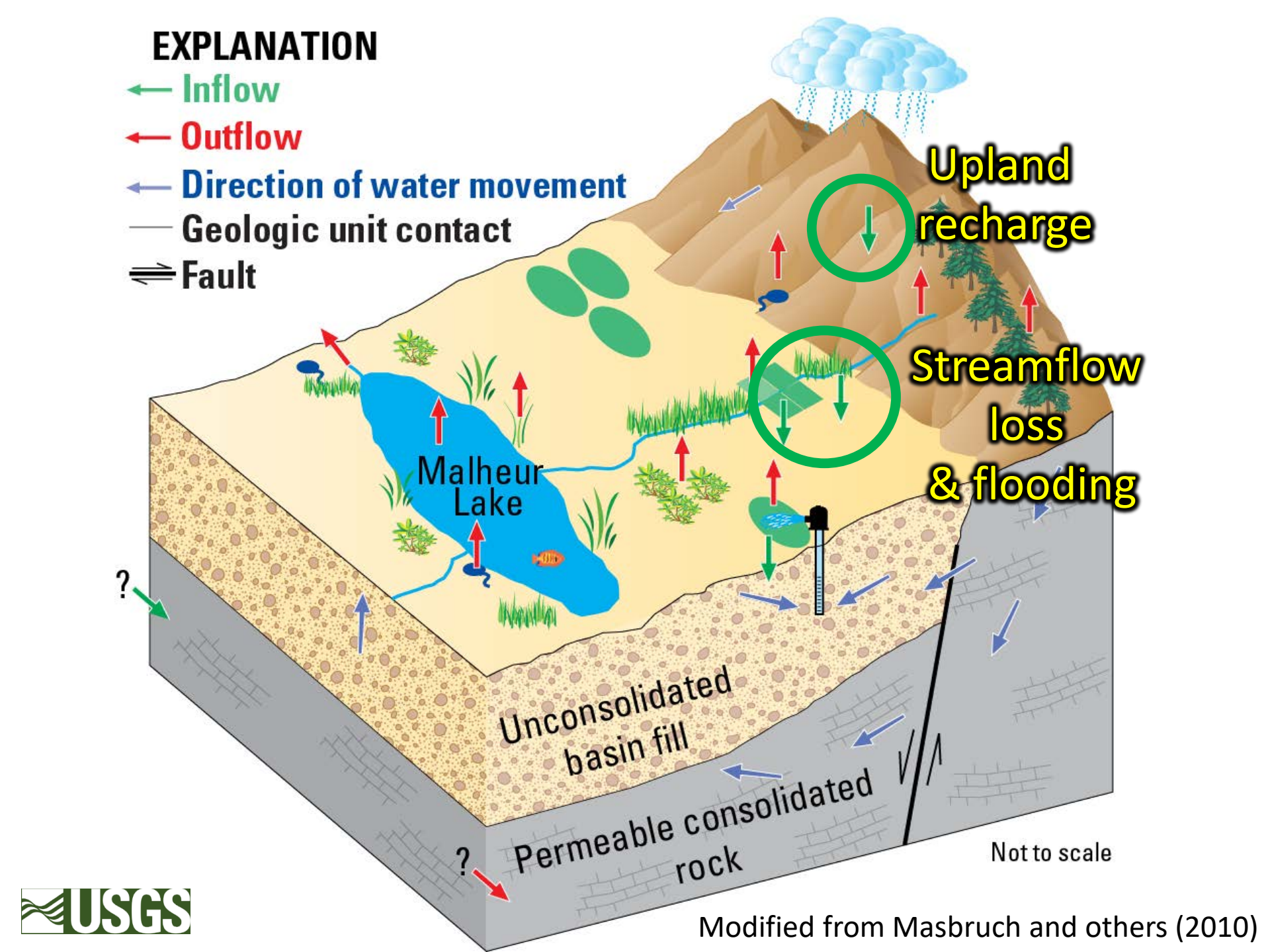


USGS



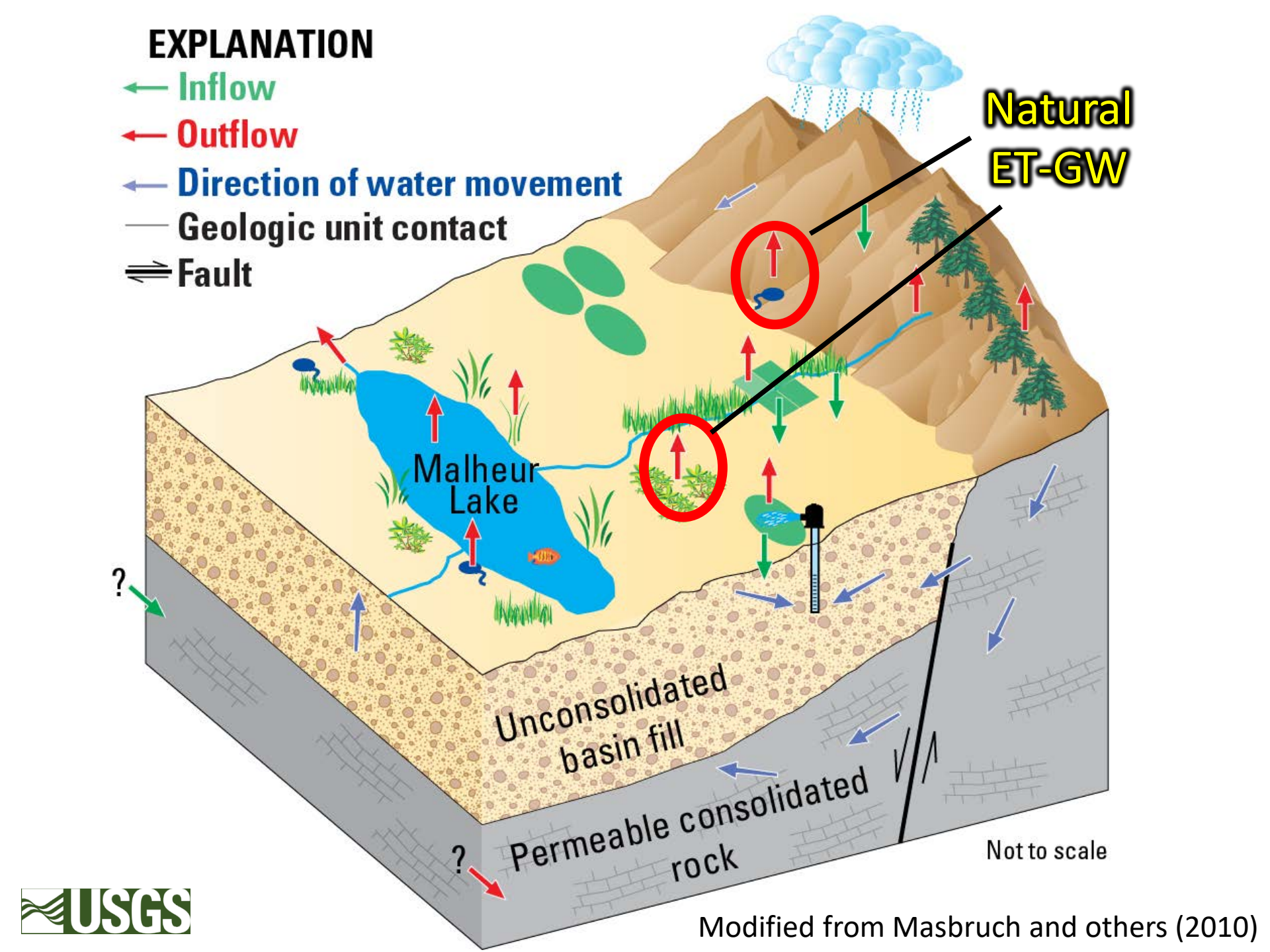
USGS

Modified from Masbruch and others (2010)



USGS

Modified from Masbruch and others (2010)

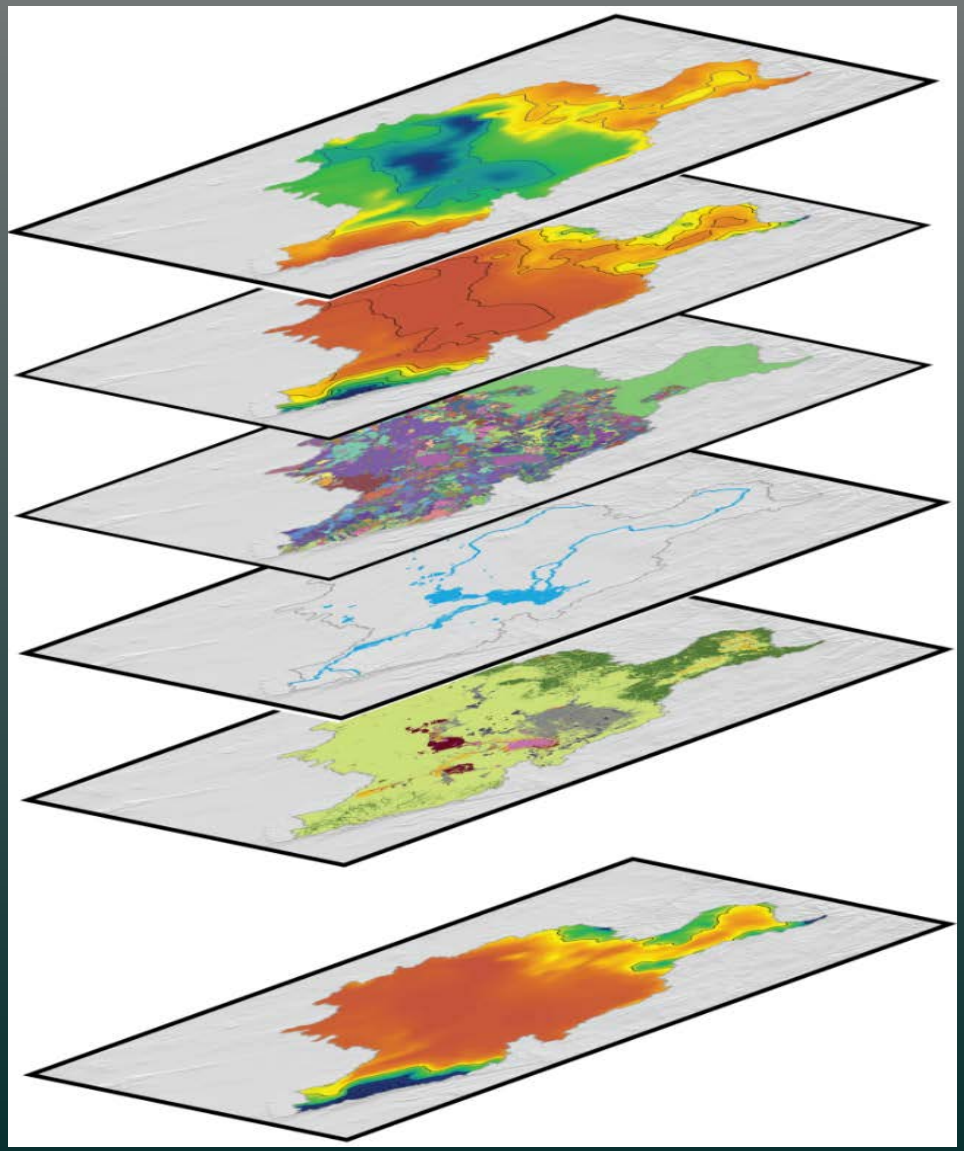


USGS

Modified from Masbruch and others (2010)

Recharge Estimation

- Precipitation
- Evapotranspiration (ET)
- Soils
- Runoff
- Land cover
- Flood maps

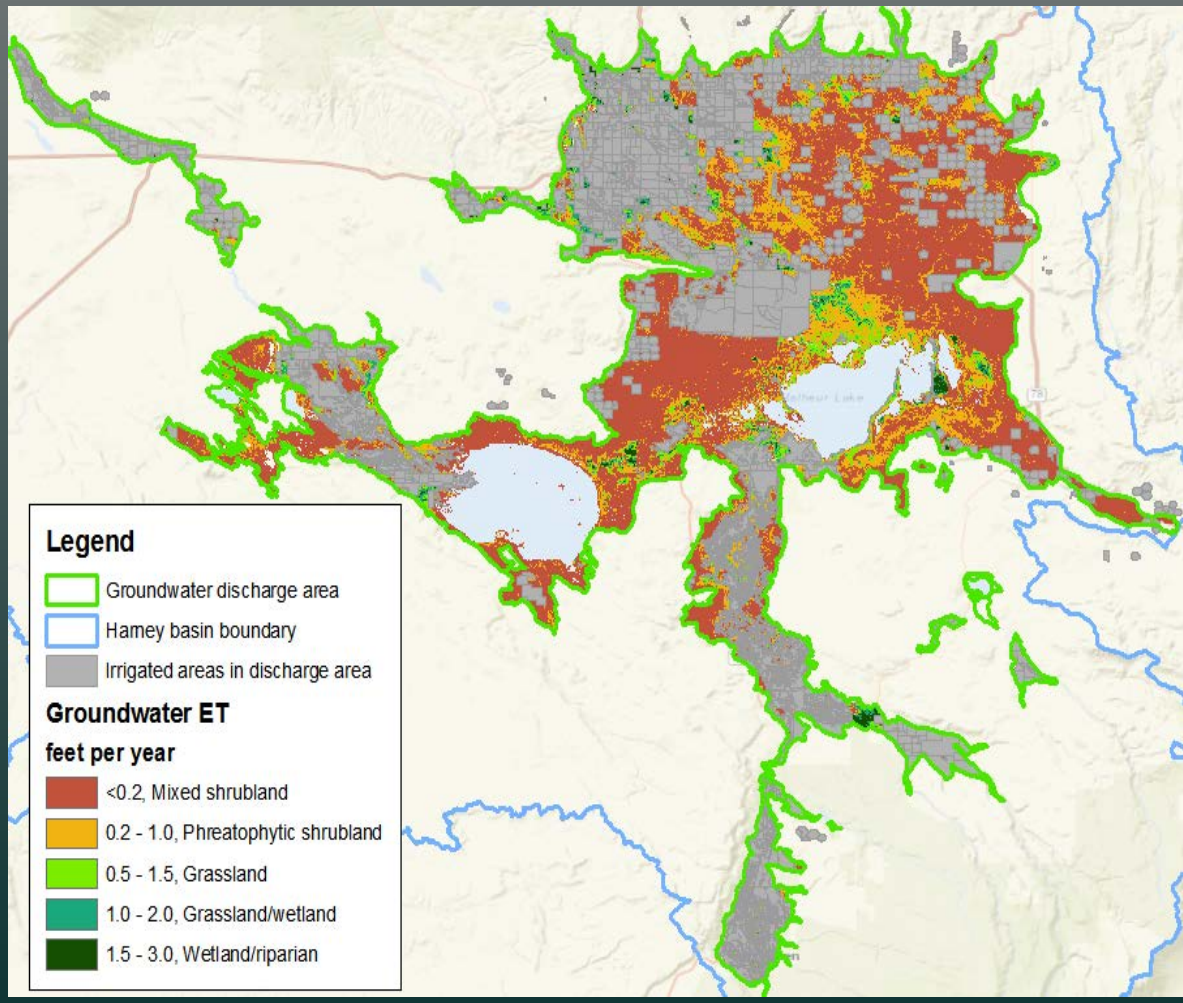


- Recharge

USGS

Discharge Estimation

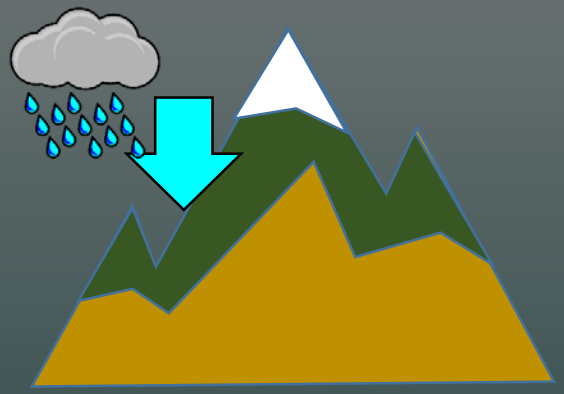
- Natural groundwater evapotranspiration (ET)
  - Vegetation maps
  - Weather data
  - ET data
  - Field verification



USGS

Total Recharge (Preliminary Estimate)

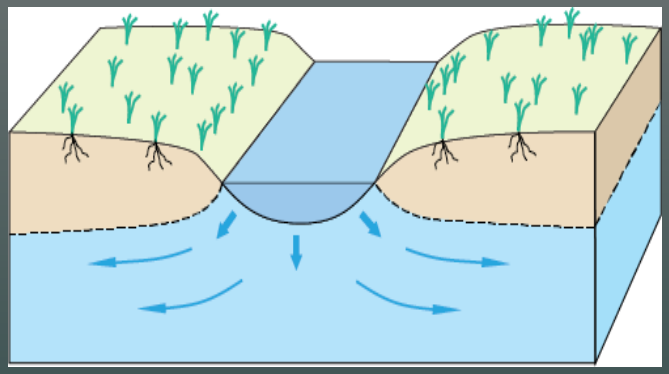
Upland recharge



~120,000 acre-ft/yr (AFY)

+

Streamflow loss

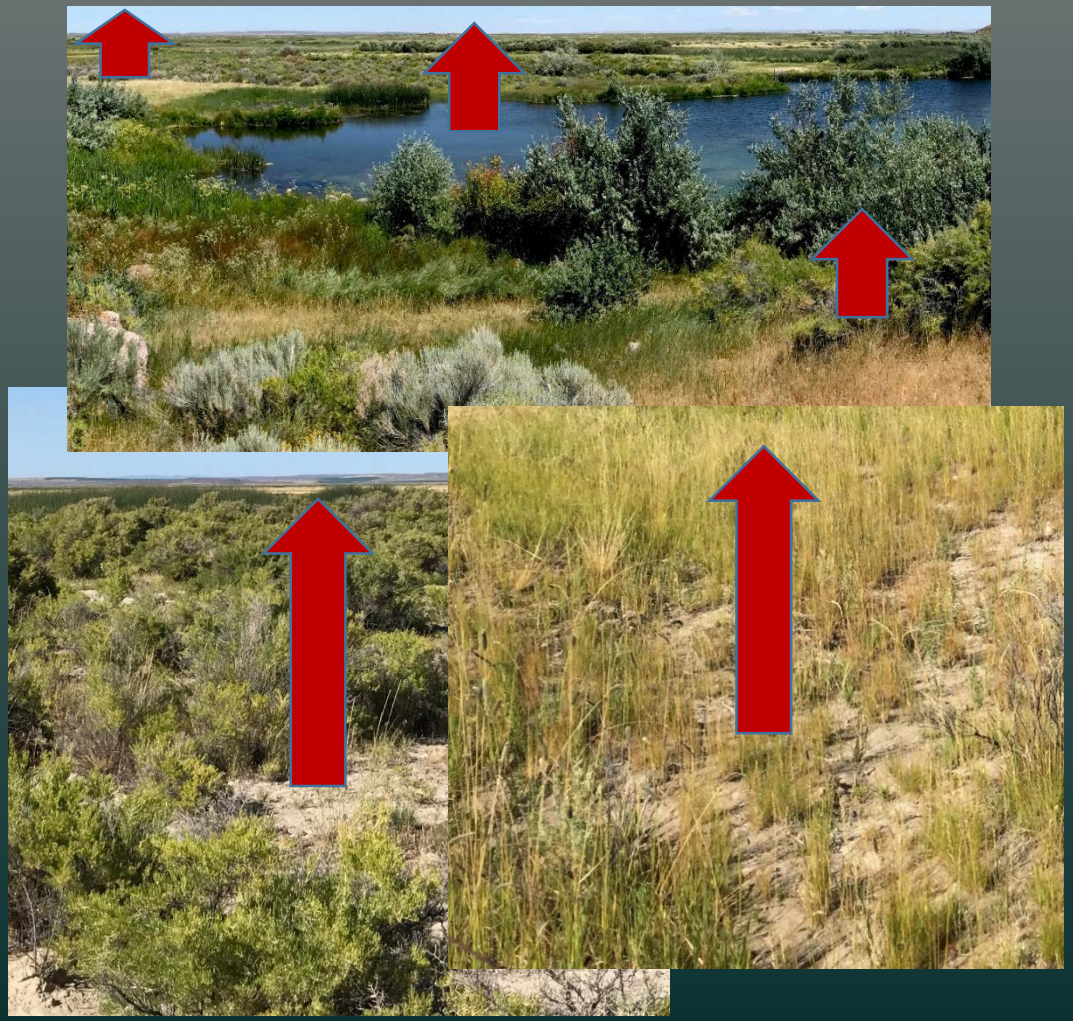


~40,000 –100,000 AFY

Total recharge ≈ 160,000 – 220,000 AFY

Similar to range in previous estimates (170,000 – 260,000 AFY)

Natural Groundwater Discharge by Evapotranspiration (Preliminary Estimate)



190,000 – 220,000 acre-ft/yr (AFY)

- **Similar to recharge est.**
- **Within previous est. range (170,000 – 260,000 AFY)**

USGS

Unpublished data, subject to revision. Do not cite.

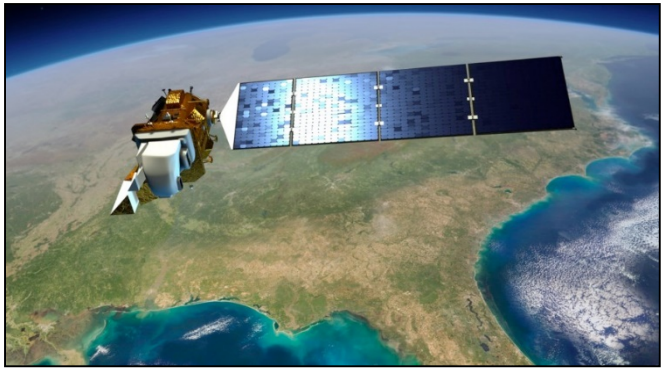
Next Steps

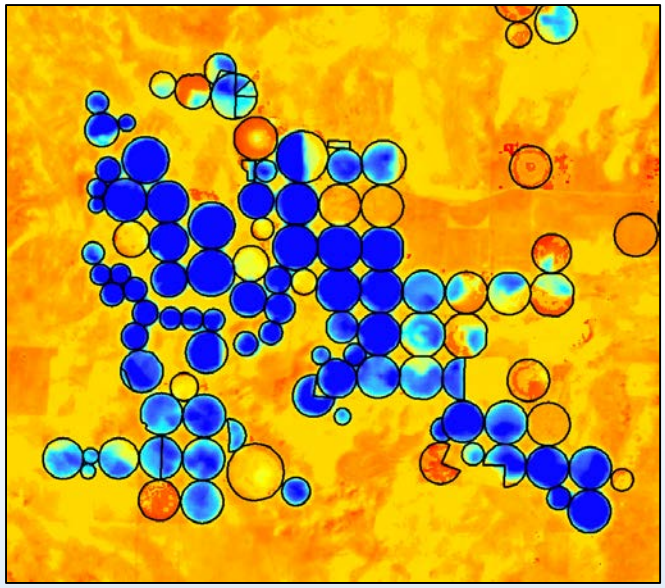
- Refine estimates using satellite and measured data
- Evaluate distributions of recharge and discharge across the basin

USGS

Irrigation Water Use in the Harney

OREGON
WATER RESOURCES
DEPARTMENT





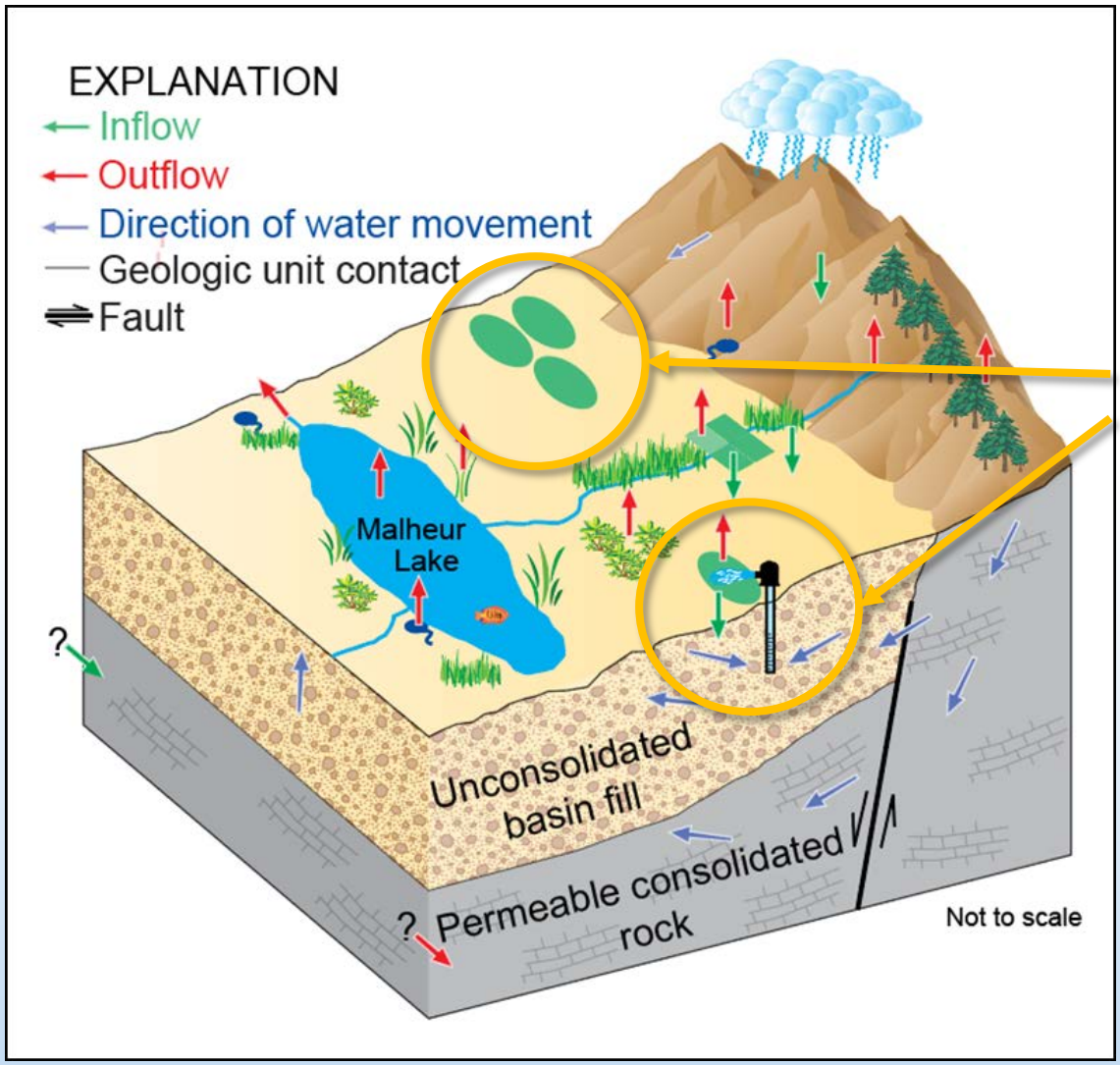
Jordan Beamer, Hydrologist

Water Resources Commission Meeting

Salem, OR February 21, 2019

OREGON WATER RESOURCES DEPARTMENT

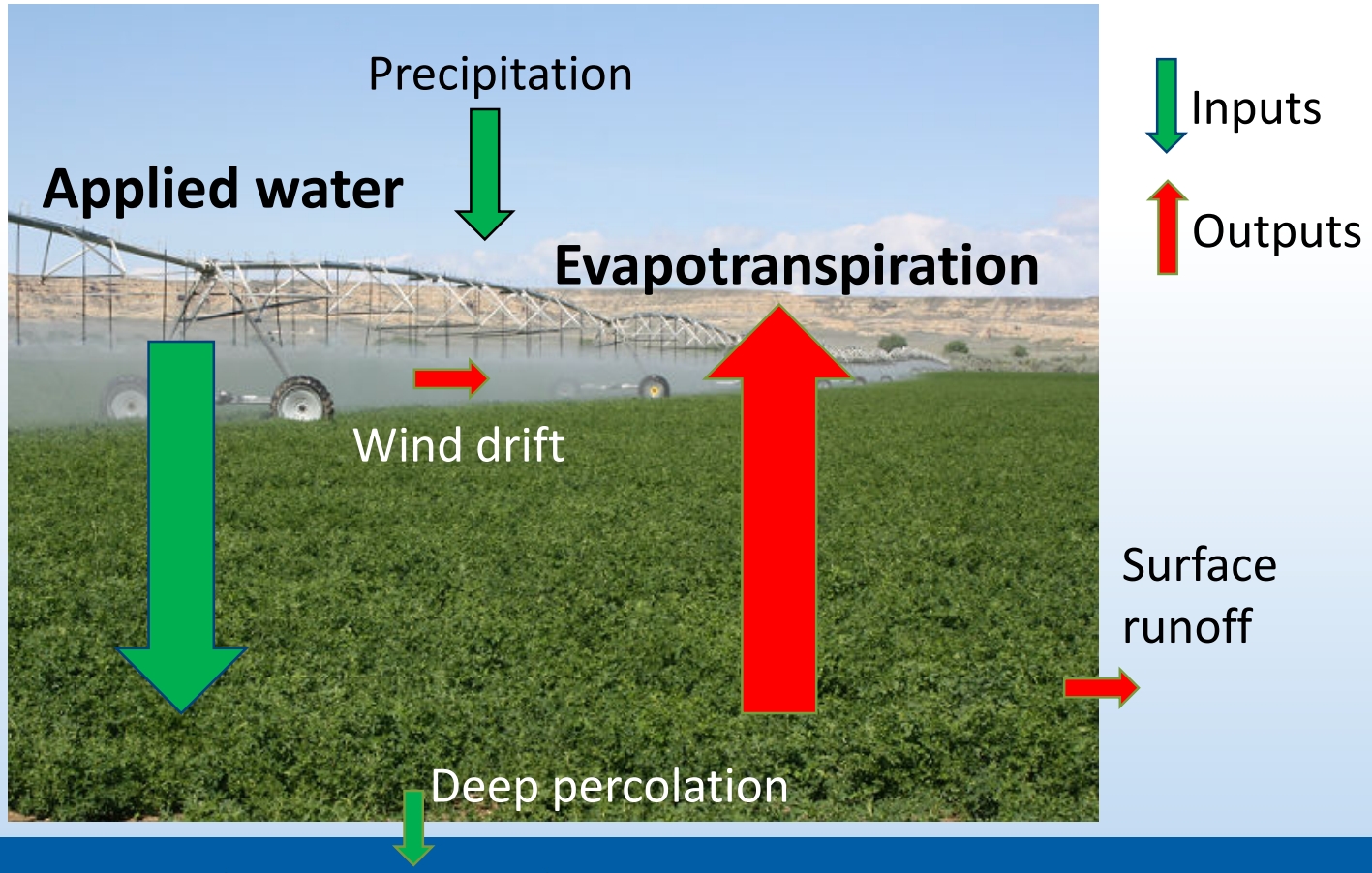
Basin Water Budget



Groundwater Pumping for Irrigating Crops

Irrigation Water Use

Key Concept: We use Evapotranspiration (ET = evaporation + plant transpiration) to estimate irrigation water use

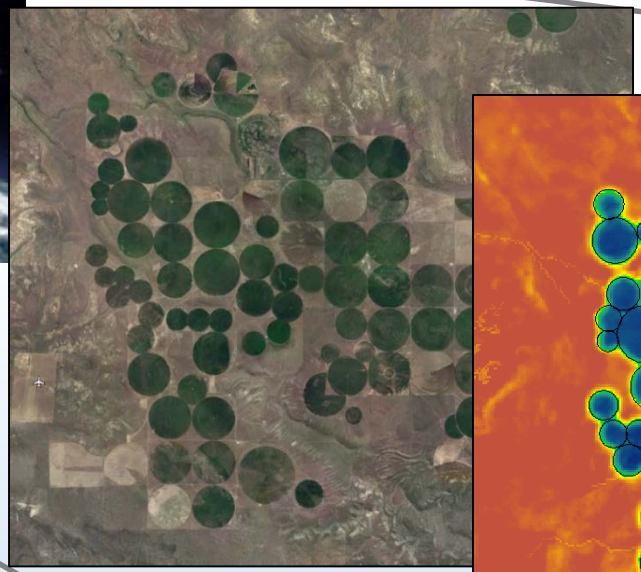


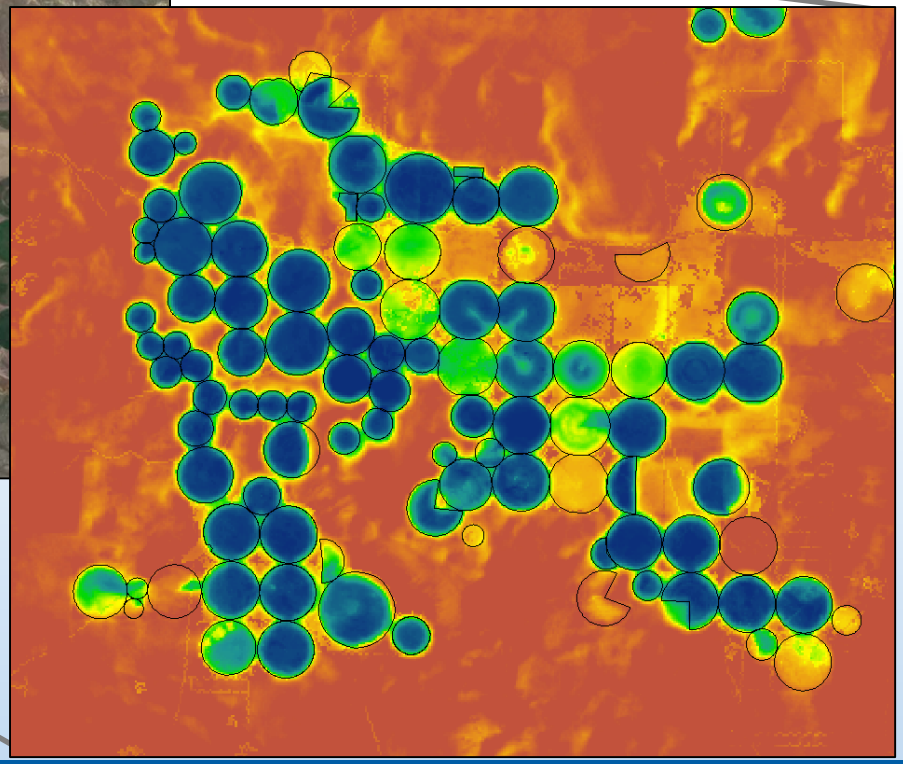
Source: http://www.teachingfromthetractor.com/alfalfa-seed-established-fields/

OREGON WATER RESOURCES DEPARTMENT

Images of Water Use

We use satellite imagery to map irrigated areas and model actual crop ET (METRIC) over study area and period (1991-2016)





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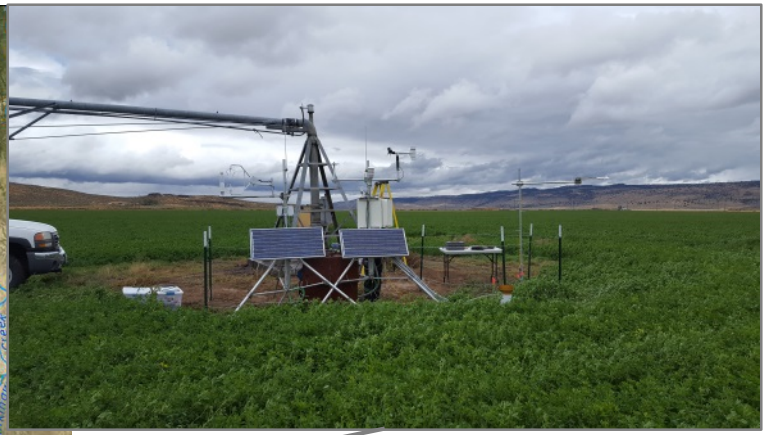
Measurement Stations



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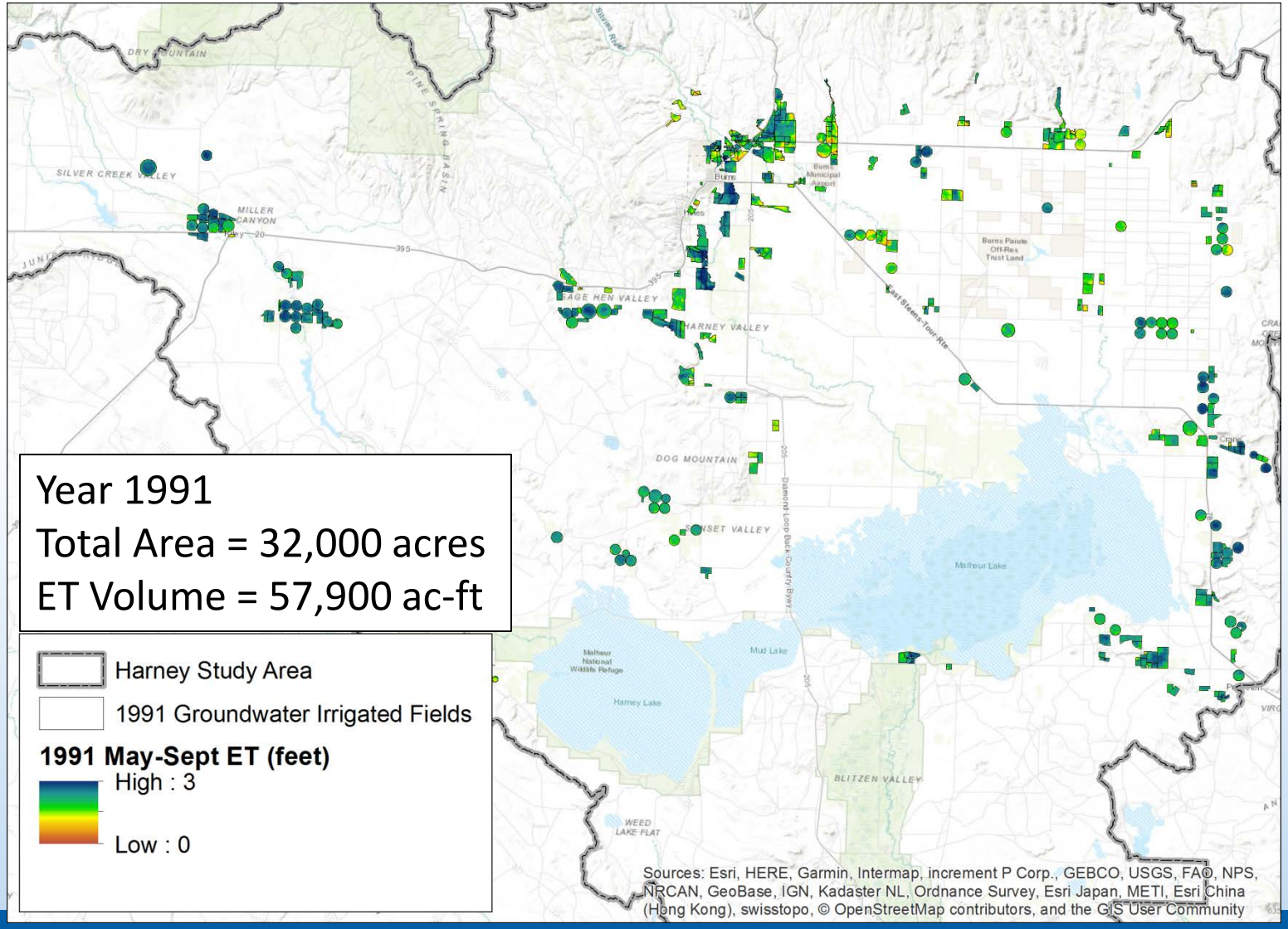
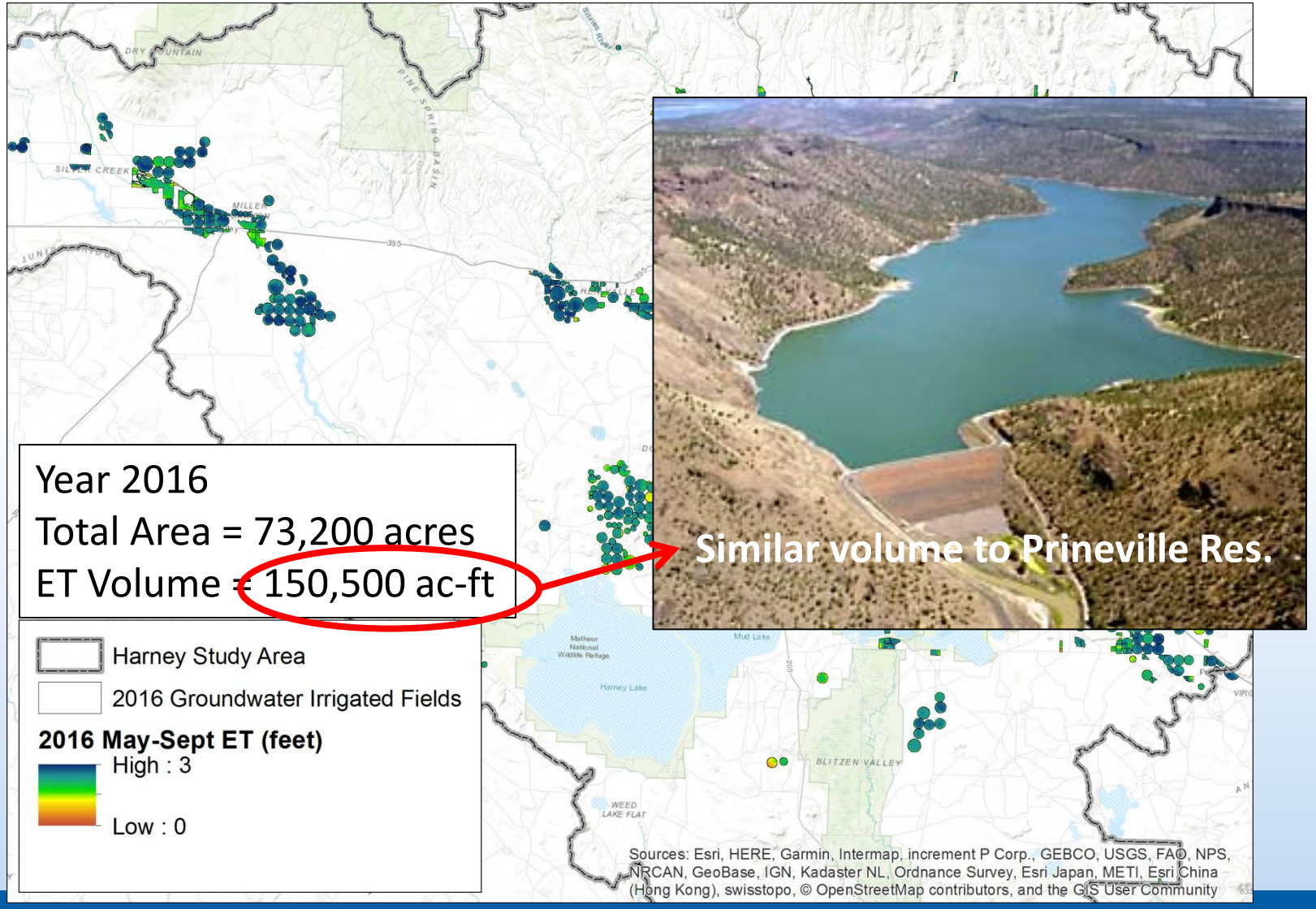
Preliminary Results



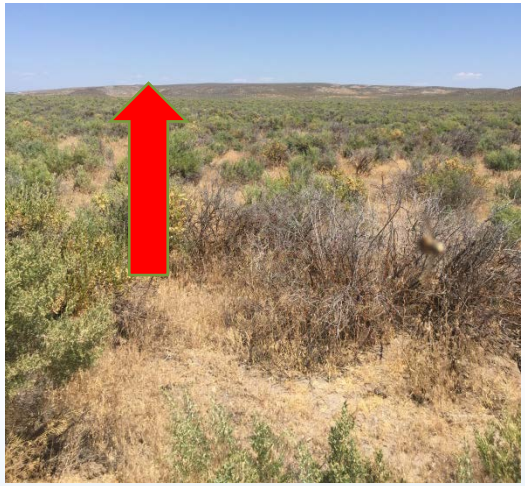
OREGON WATER RESOURCES DEPARTMENT

Preliminary Results



GW Discharge Estimate

Natural ET-GW



190,000 – 220,000 AF

+

Crop ET-GW

110,000 – 150,000 AF

Total discharge ≈ 300,000 – 370,000 AF

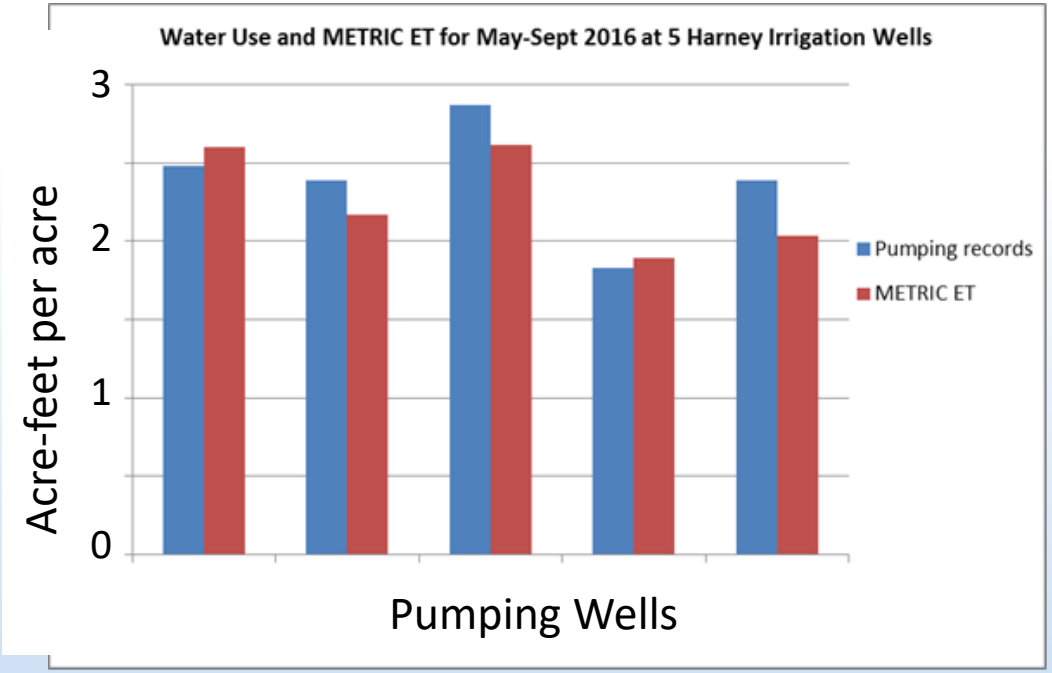
Outside est. recharge range (160,000-220,000 AF)

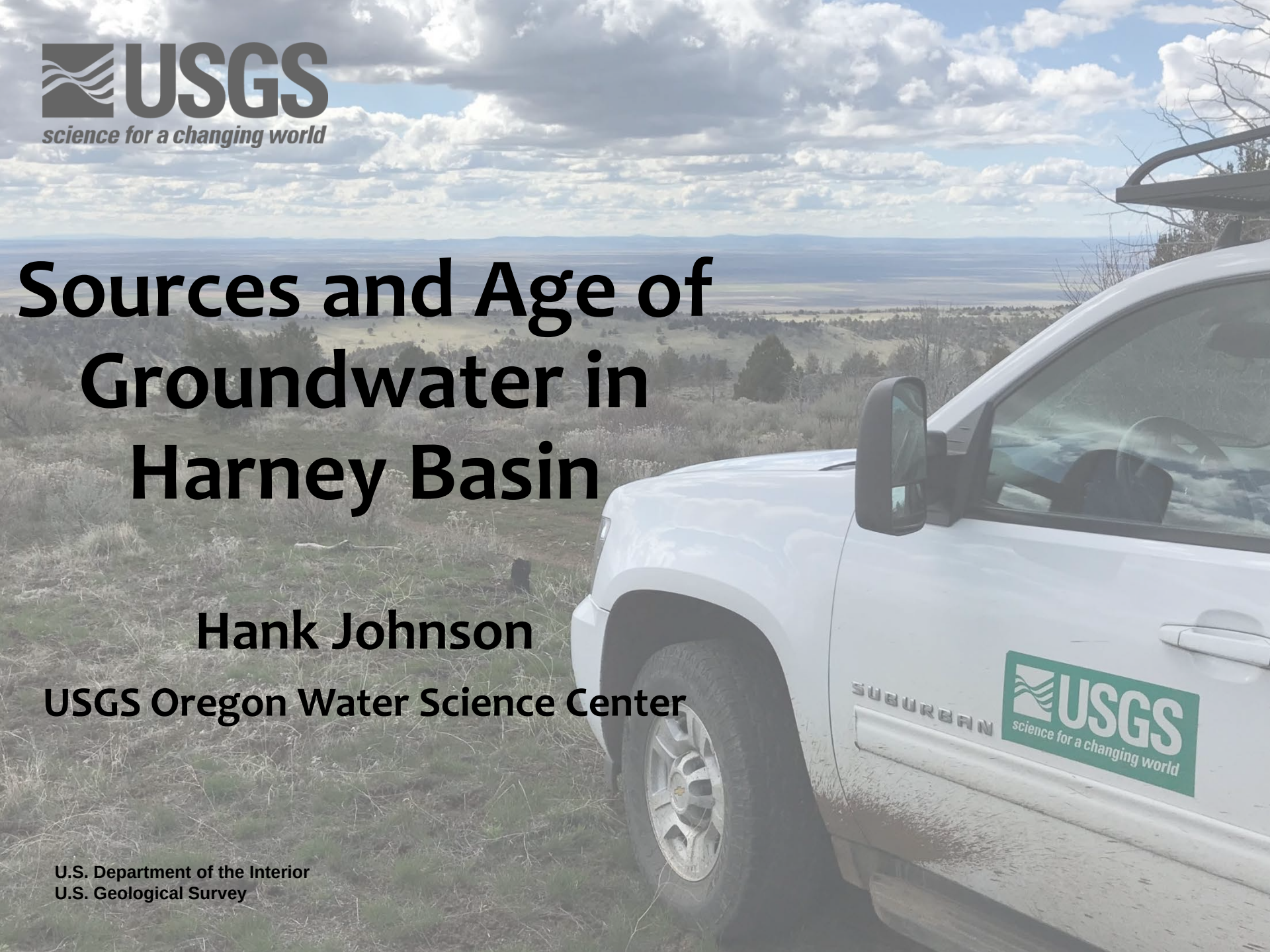
OREGON WATER RESOURCES DEPARTMENT

Next Steps

Validate Satellite-based ET with ground-based measurements

Compare Reported Pumping Volumes vs Satellite-based ET





Sources and Age of Groundwater in Harney Basin

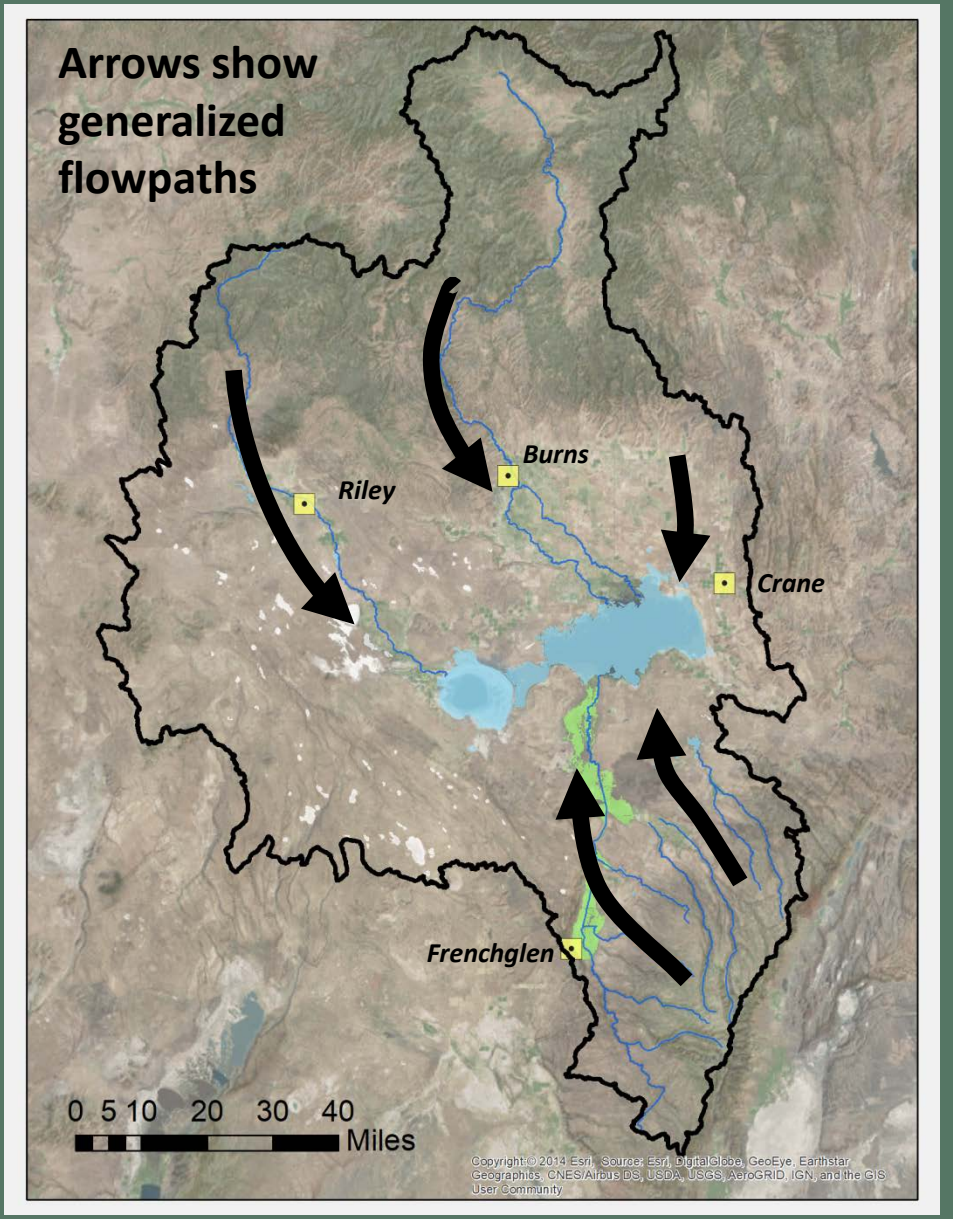
Hank Johnson

USGS Oregon Water Science Center

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

Use natural chemistry of the groundwater to:

- Clarify flowpaths
  → **WHERE and HOW?**
- Estimate travel times
  → **HOW LONG?**
- Identify mixing
  → **SOURCES?**
- Calibrate numerical models



Why does this matter?

- Precipitation in uplands → Demand in basin bottom
- Two regions of high precipitation
- Three main streams
- Vertically and horizontally heterogeneous basin fill deposits

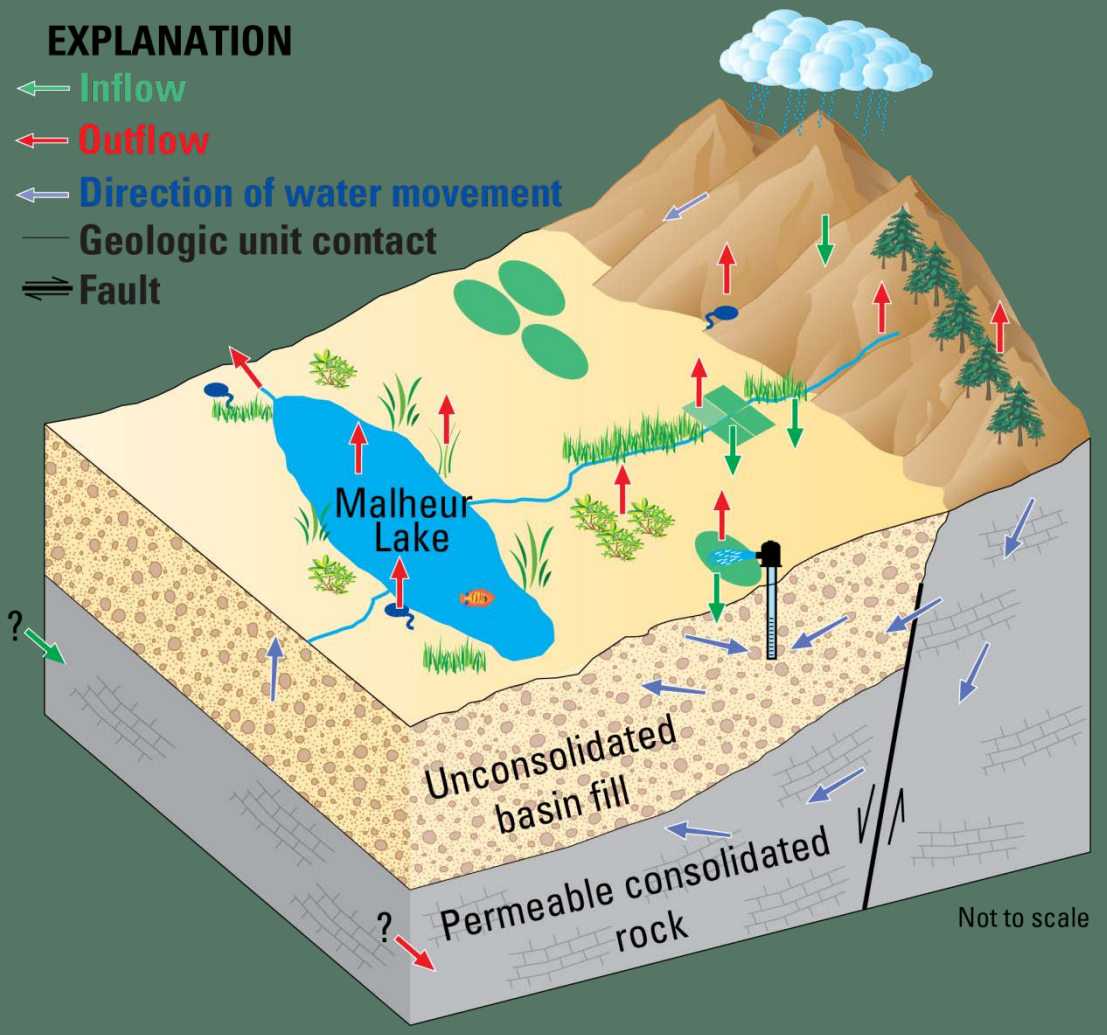


Diagram modified from Masbruch and others (2010)

Collect and measure chemistry in samples from:

- Springs
- Wells
- Streams during low flow

USGS

Sources and Age of Groundwater in Harney Basin

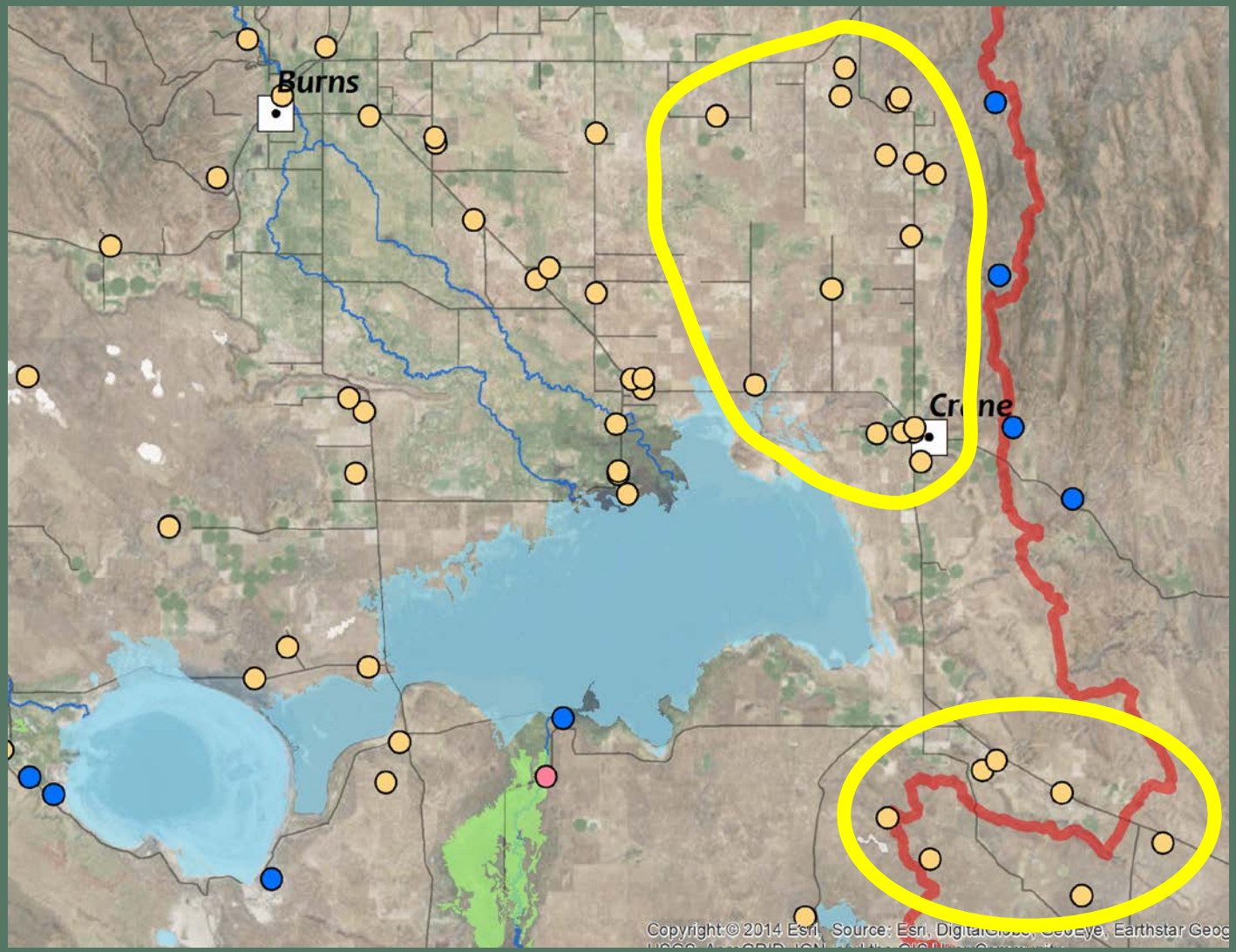
Recharging precipitation carries trace amounts of chemicals that can be used to determine the age of groundwater

Common ions such as calcium, sodium, and chloride

Stable isotopes of water

$^{1}H - ^{18}O - ^{1}H$

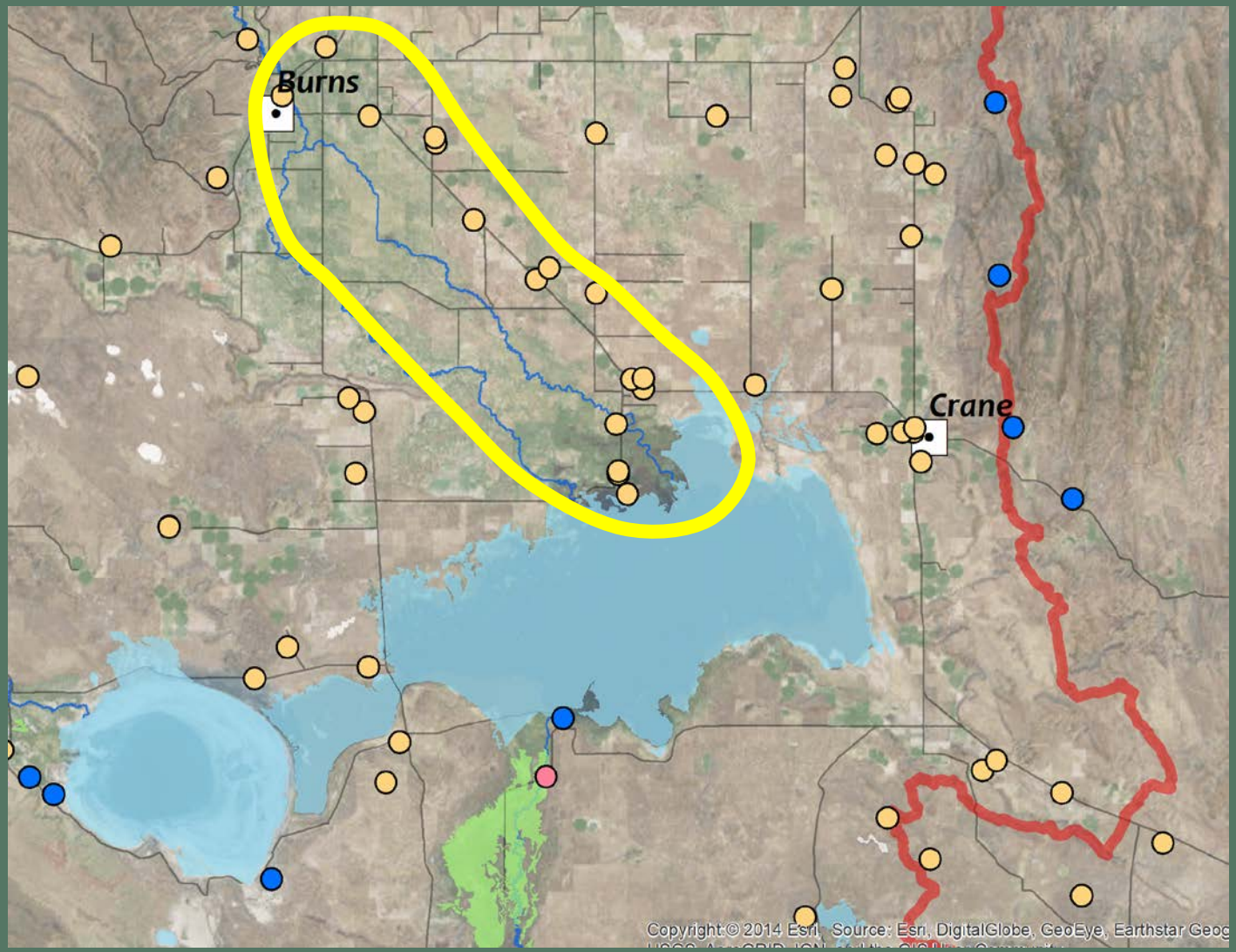
Clipart obtained from openclipart.org



INDICATIONS OF PRE-MODERN WATER

USGS

Sources and Age of Groundwater in Harney Basin

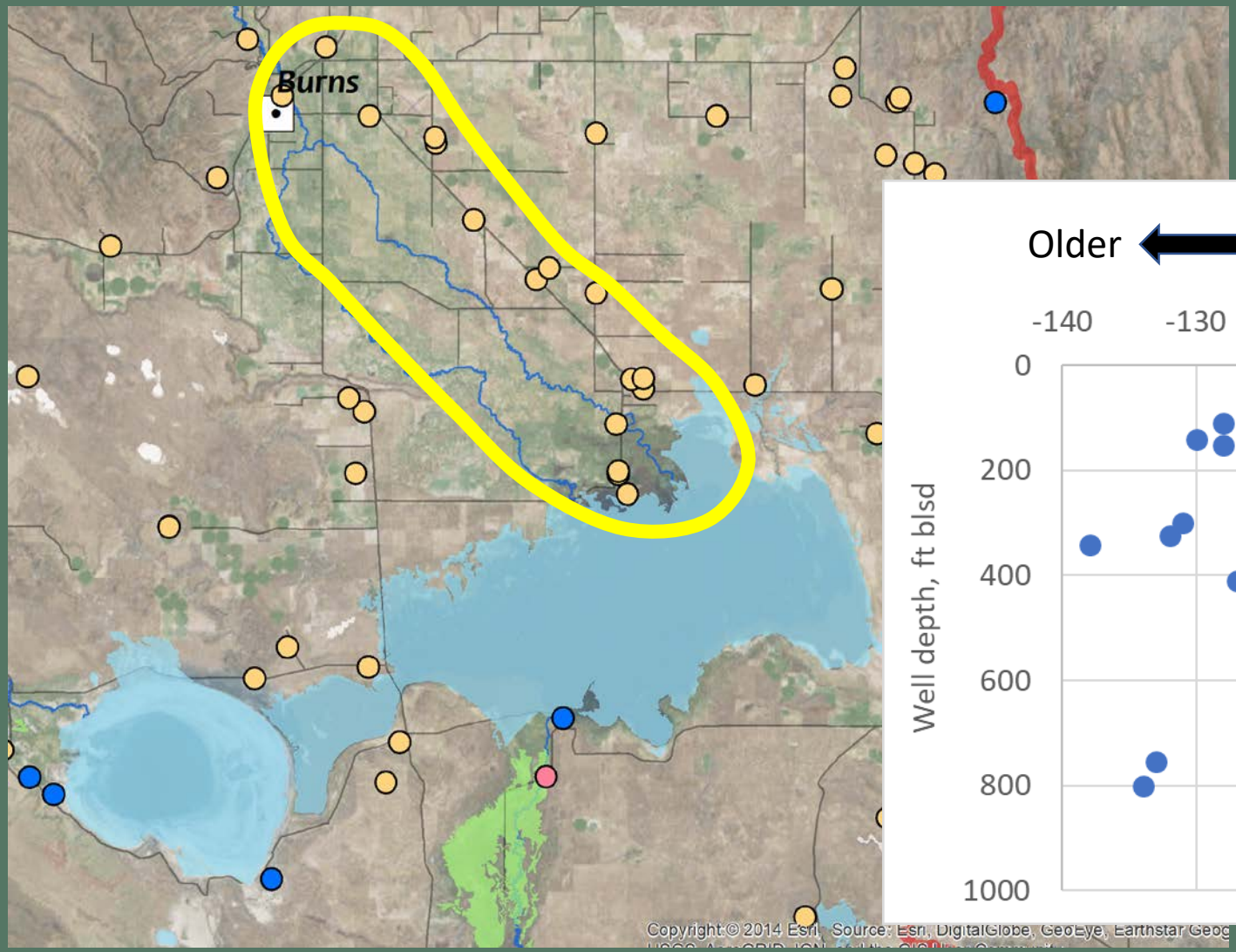


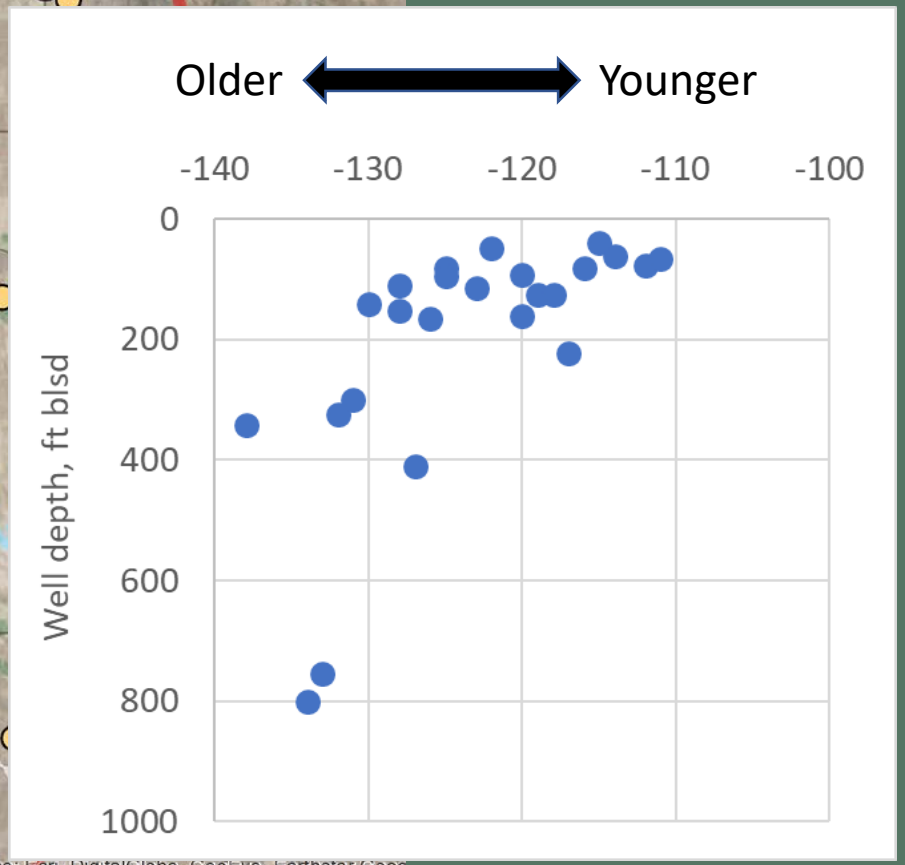
SILVIES RIVER RECHARGE ZONE

INDICATIONS OF MODERN WATER SITTING ATOP OLDER WATER

USGS

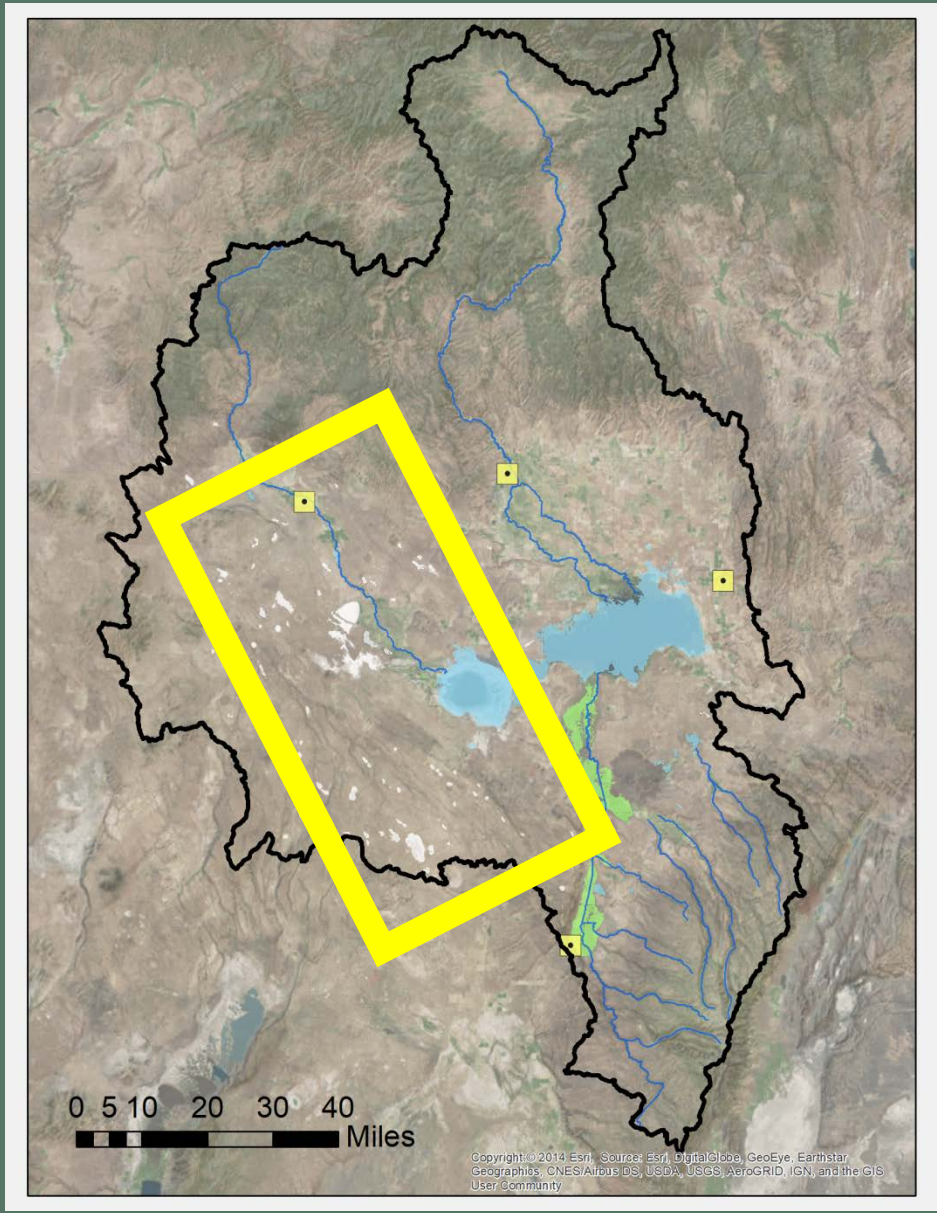
Sources and Age of Groundwater in Harney Basin





USGS

Sources and Age of Groundwater in Harney Basin



WORK IN PROGRESS

USGS

Sources and Age of Groundwater in Harney Basin

Harney Basin Groundwater Study

Oregon Water Resources Commission Meeting
Salem, Oregon
21 February 2019

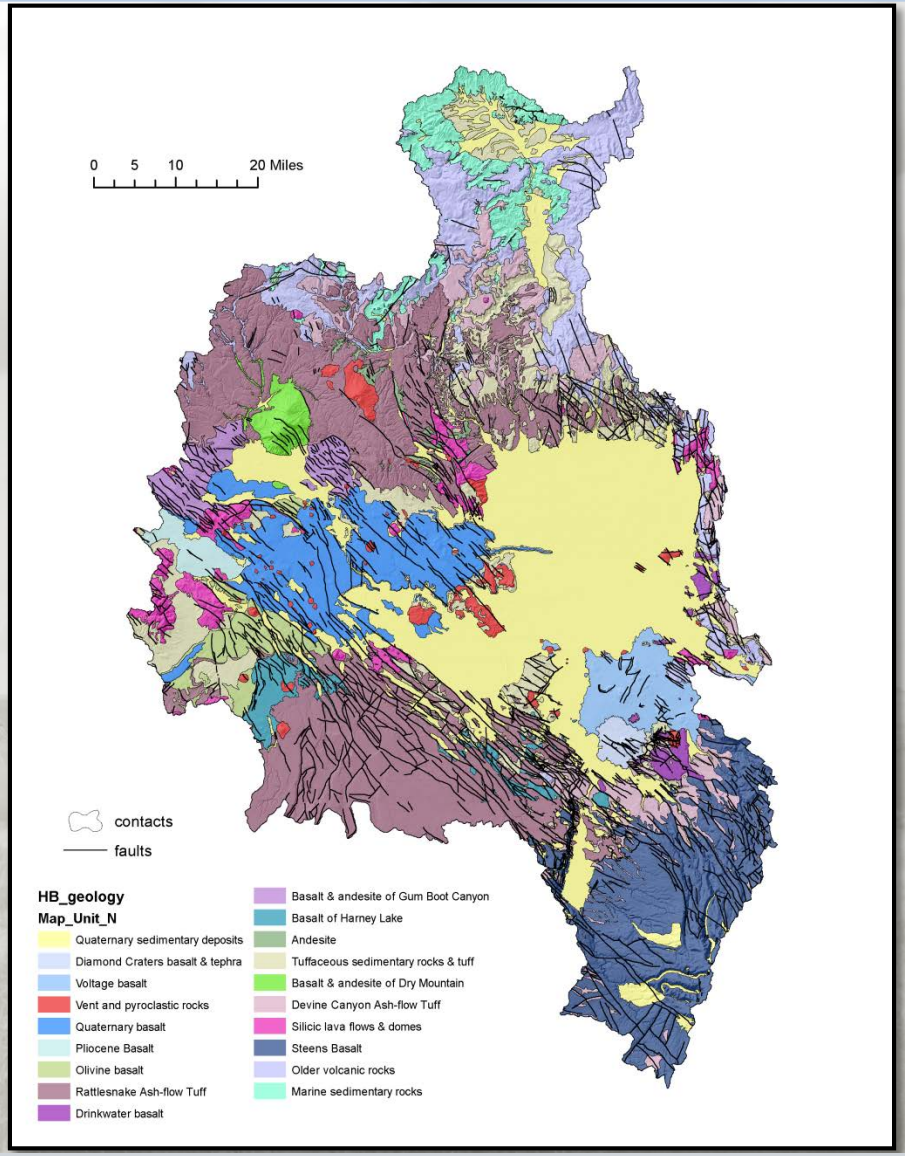
OREGON WATER RESOURCES DEPARTMENT

Jerry Grondin
OWRD Hydrogeologist

Harney Basin GW Study: Boschmann Tasks

Geologic Framework

- Surface Geology
- Subsurface Geology
- Geologic Structure

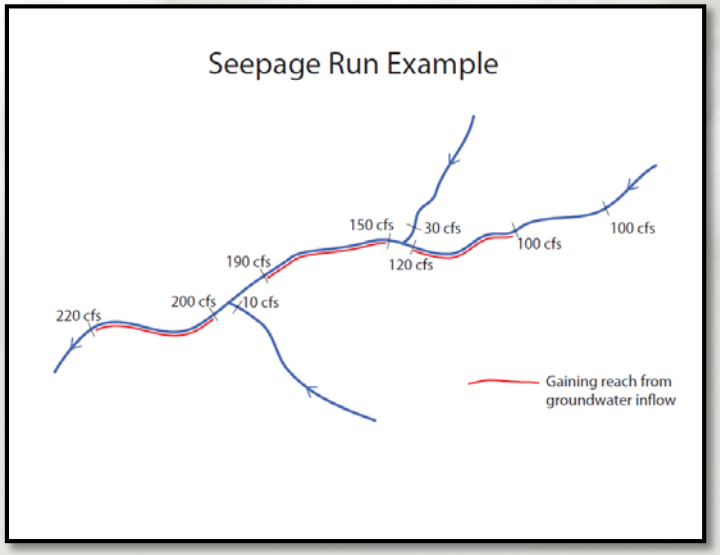


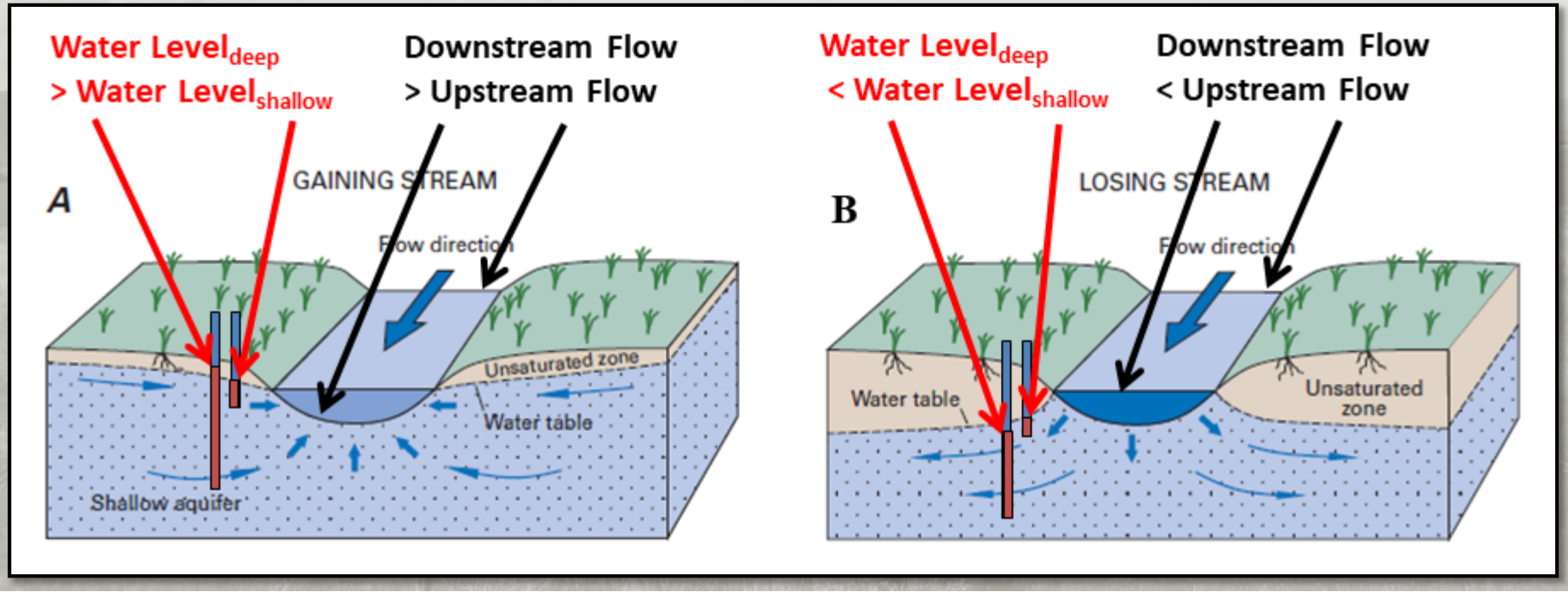
Preliminary…Subject to Change…Do Not Quote or Cite

Harney Basin GW Study: LaMarche Tasks

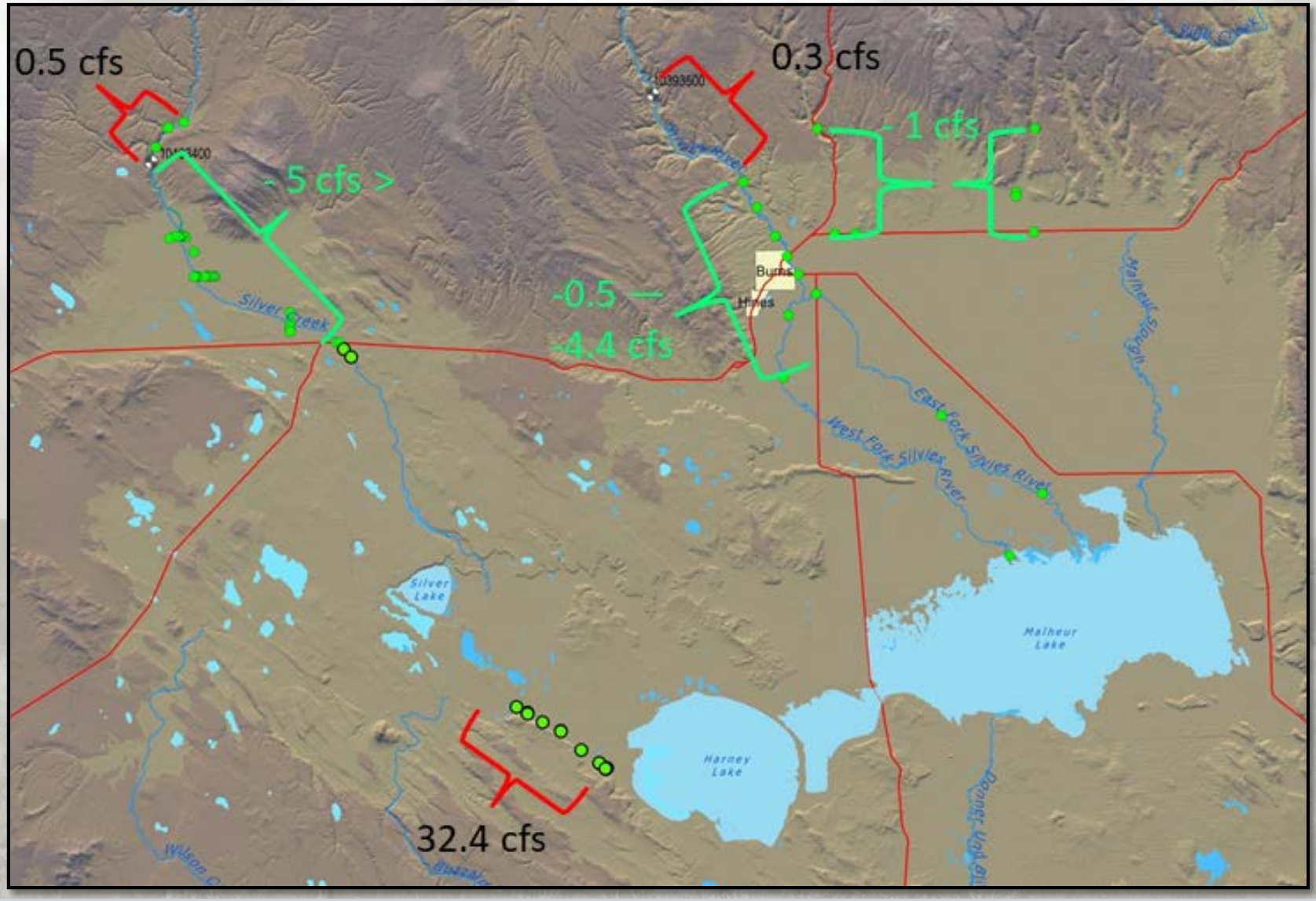
Surface Water Hydrology

- Surface Water Flow
- Stream Gains & Losses





Harney Basin GW Study: LaMarche Tasks

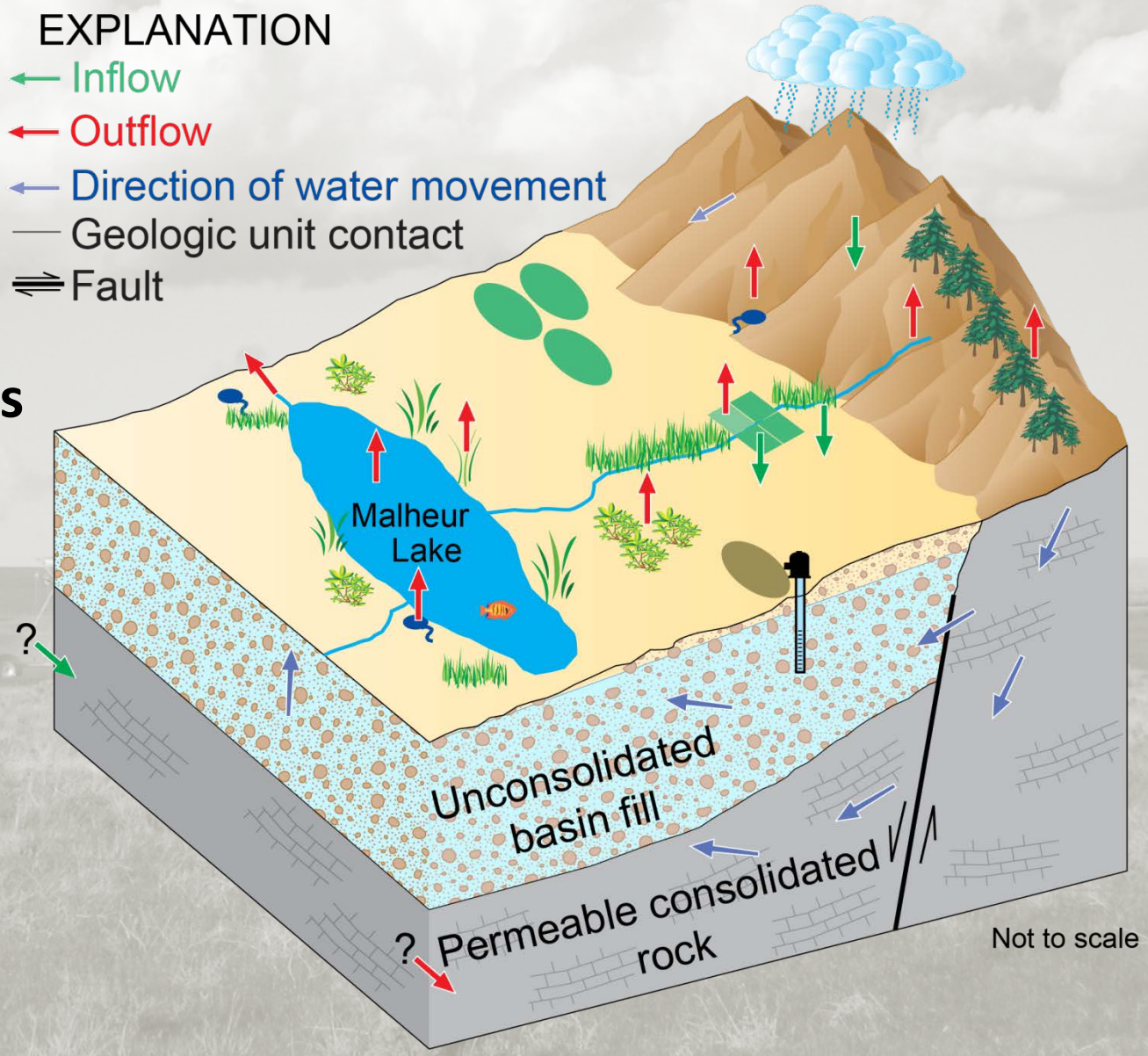


Preliminary…Subject to Change…Do Not Quote or Cite

Harney Basin GW Study: Grondin Tasks

Hydraulic Properties

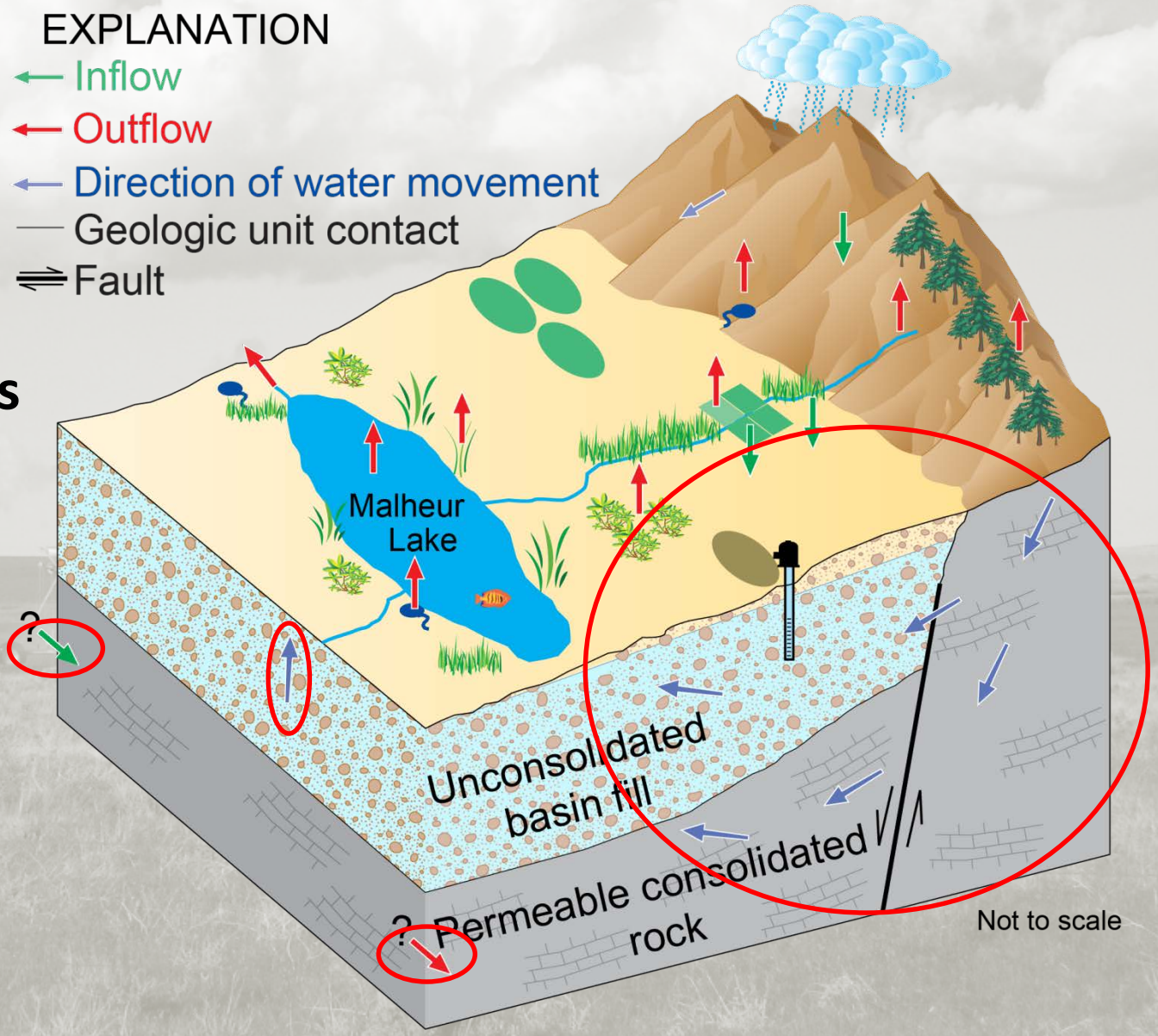
- Permeability
- Storage



Harney Basin GW Study: Grondin Tasks

Groundwater Levels

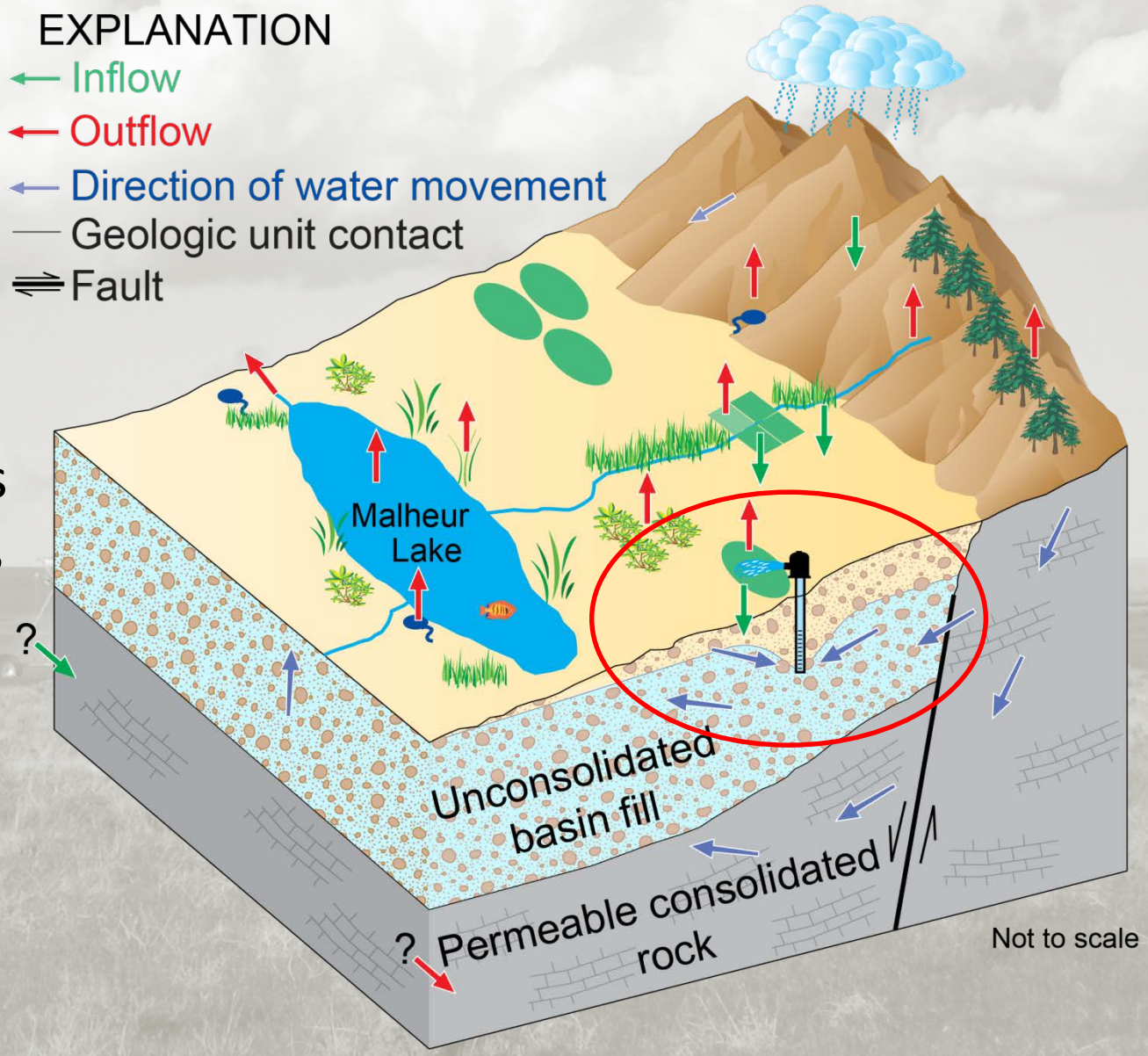
- Diagnostic Tool
- GW Connections
- GW Flow Paths
- GW Trends



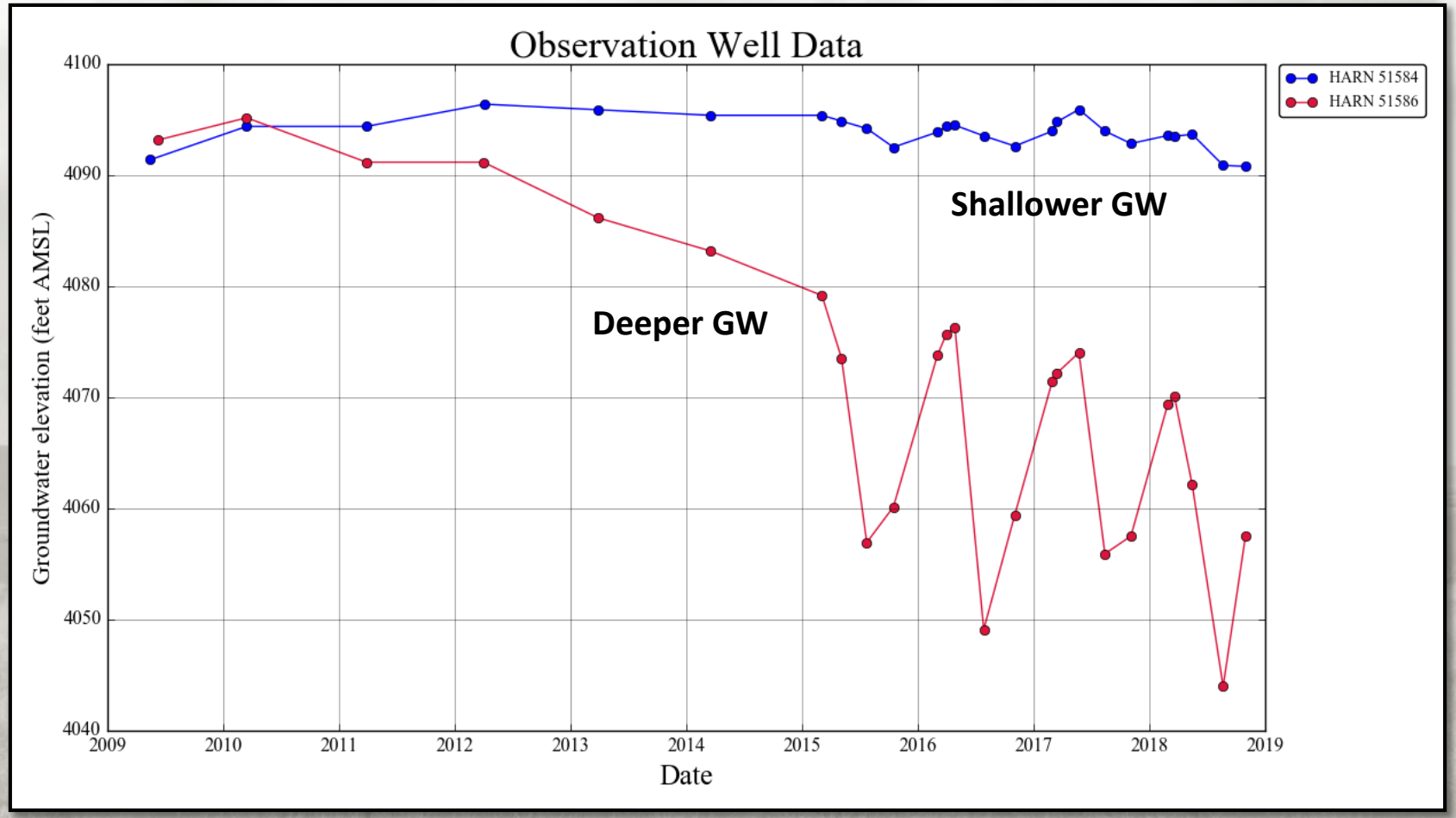
Harney Basin GW Study: Grondin Tasks

GW Response

- Natural Influences
- Human Influences
- Seasonal
- Long-Term



Harney Basin GW Study: Grondin Tasks



Preliminary…Subject to Change…Do Not Quote or Cite

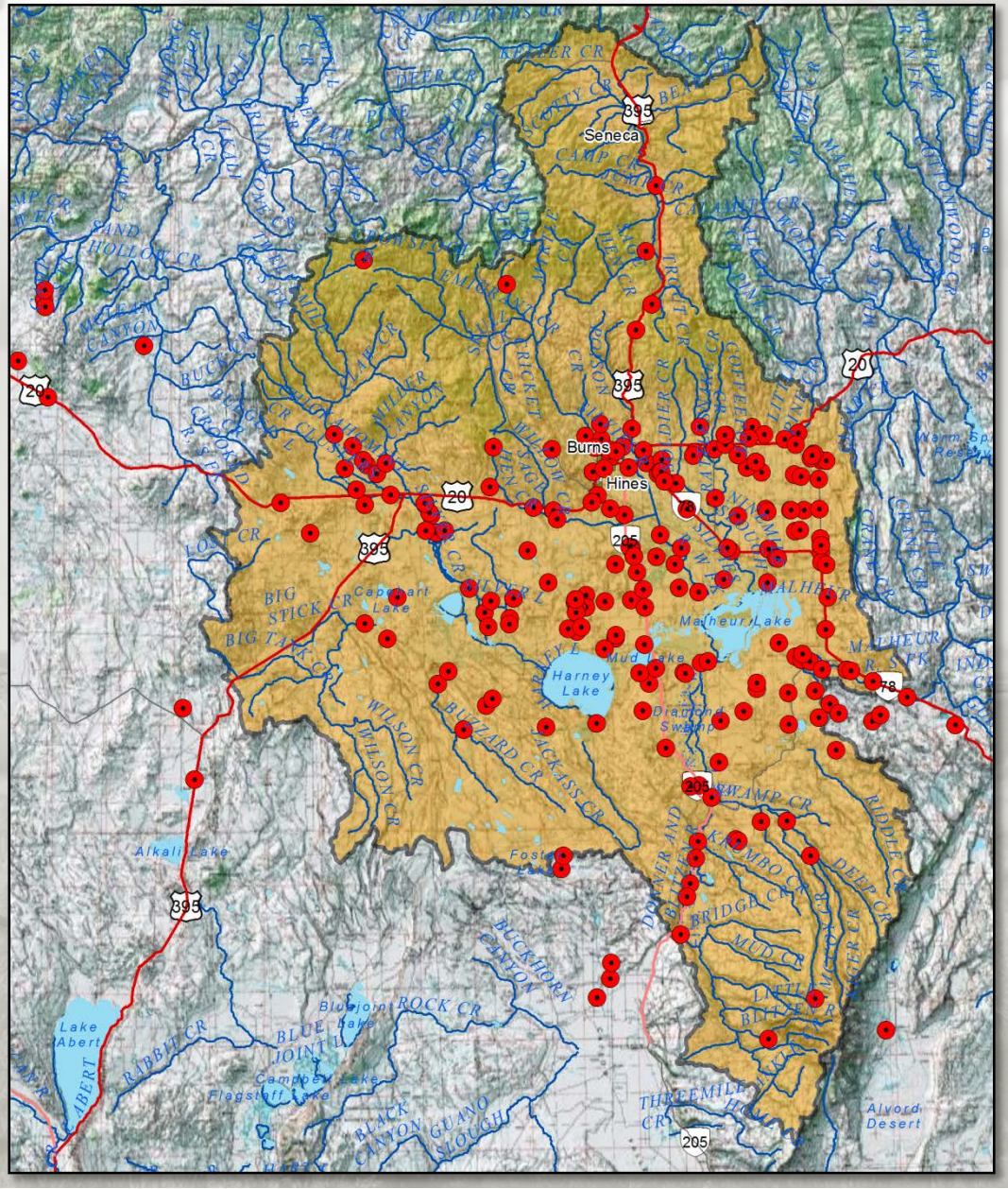
Harney Basin Study Wells for GW Flow Maps

OWRD Synoptic Wells = 231

Harney Watershed Council Wells = 102 (not shown)

OWRD Permit Condition Wells = 194 (2018, not shown)

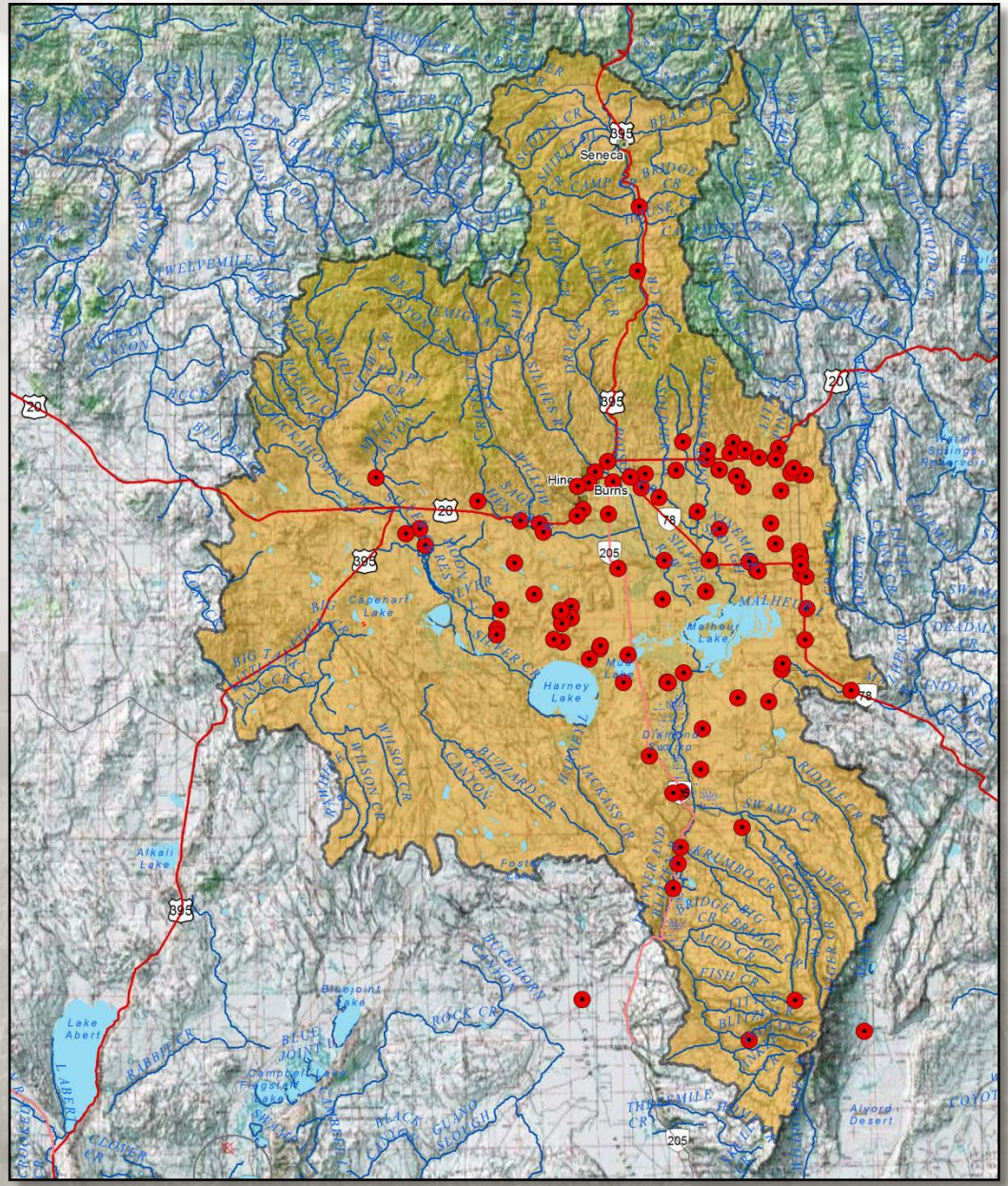
NHD Identified Springs = 2552 (not shown)



Harney Basin Study Wells for GW Trends

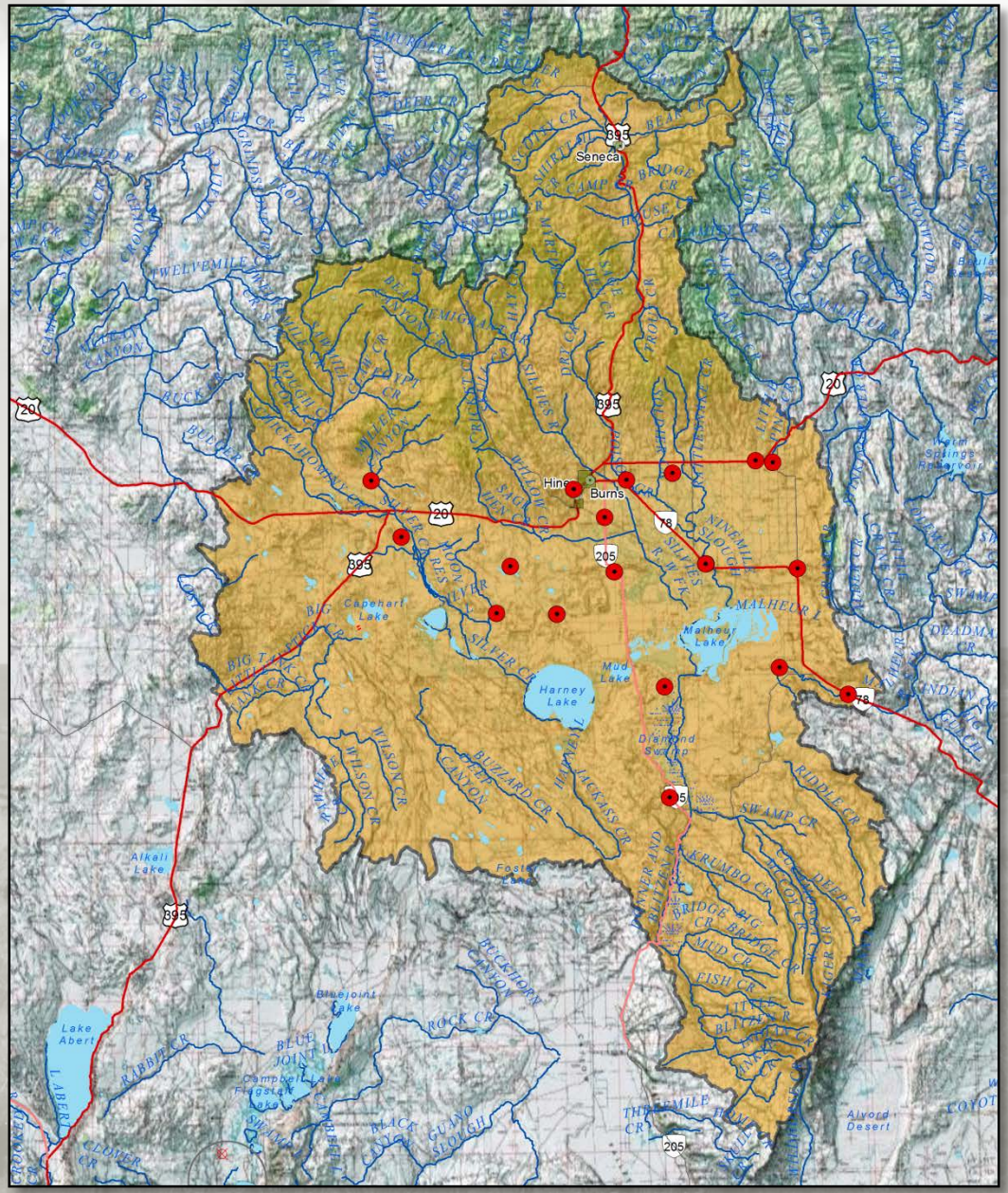
OWRD Quarterly Wells = 112 through 2018

Harney Watershed Council Wells = 102 (not shown)



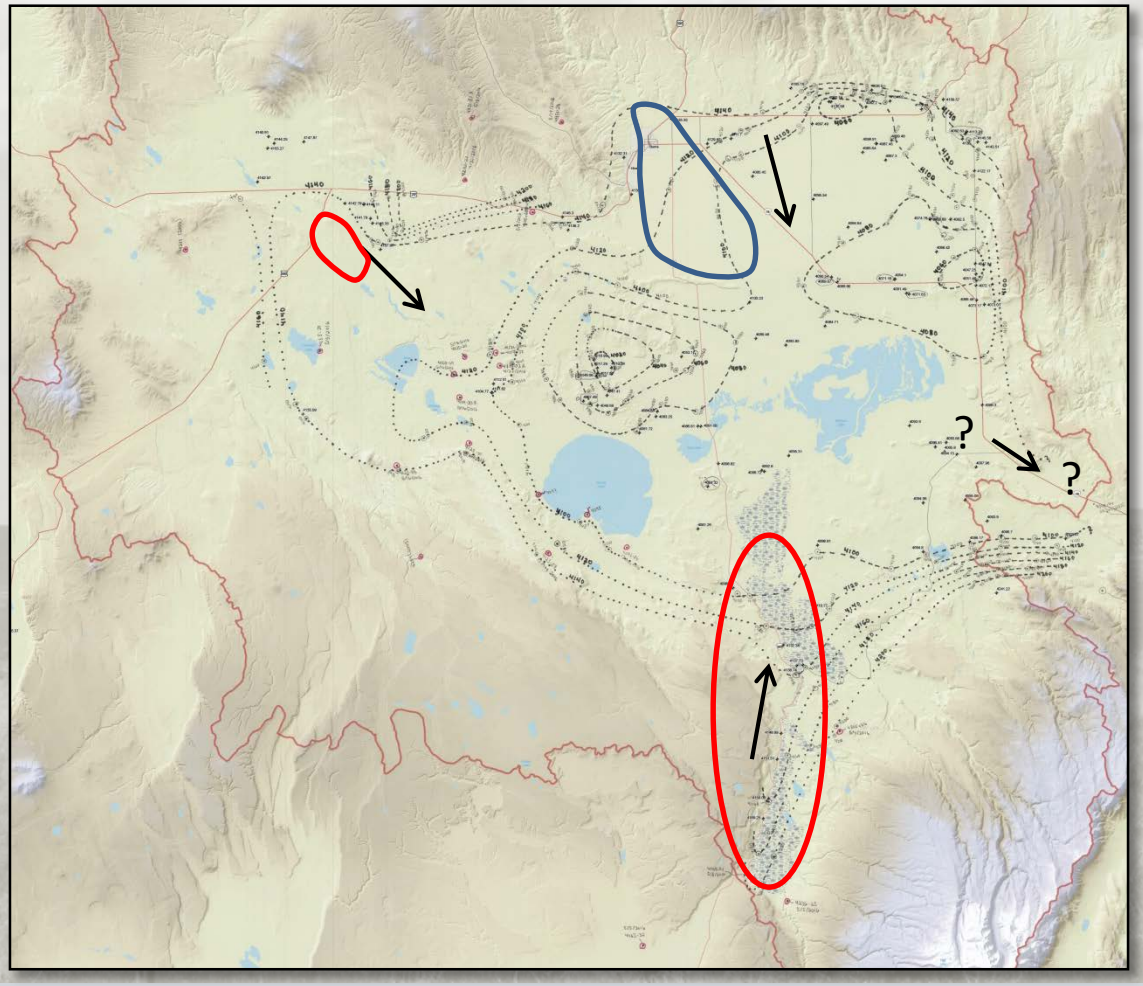
Harney Basin Study Wells for GW Trends

OWRD Recorder Wells = 24



Very Preliminary Groundwater Levels

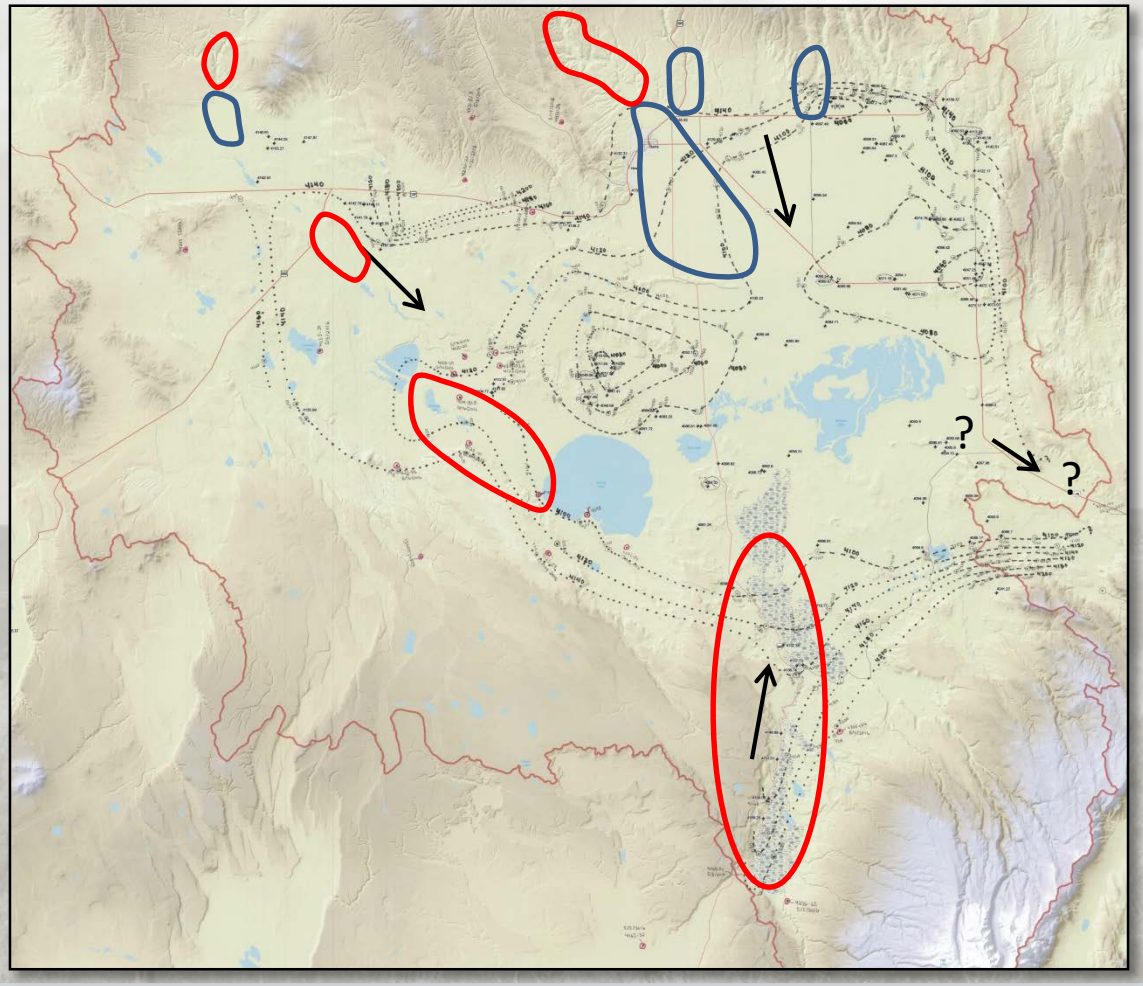
First Impressions: GW Recharge, Discharge, & Flow



Preliminary…Subject to Change…Do Not Quote or Cite

Very Preliminary Groundwater Levels

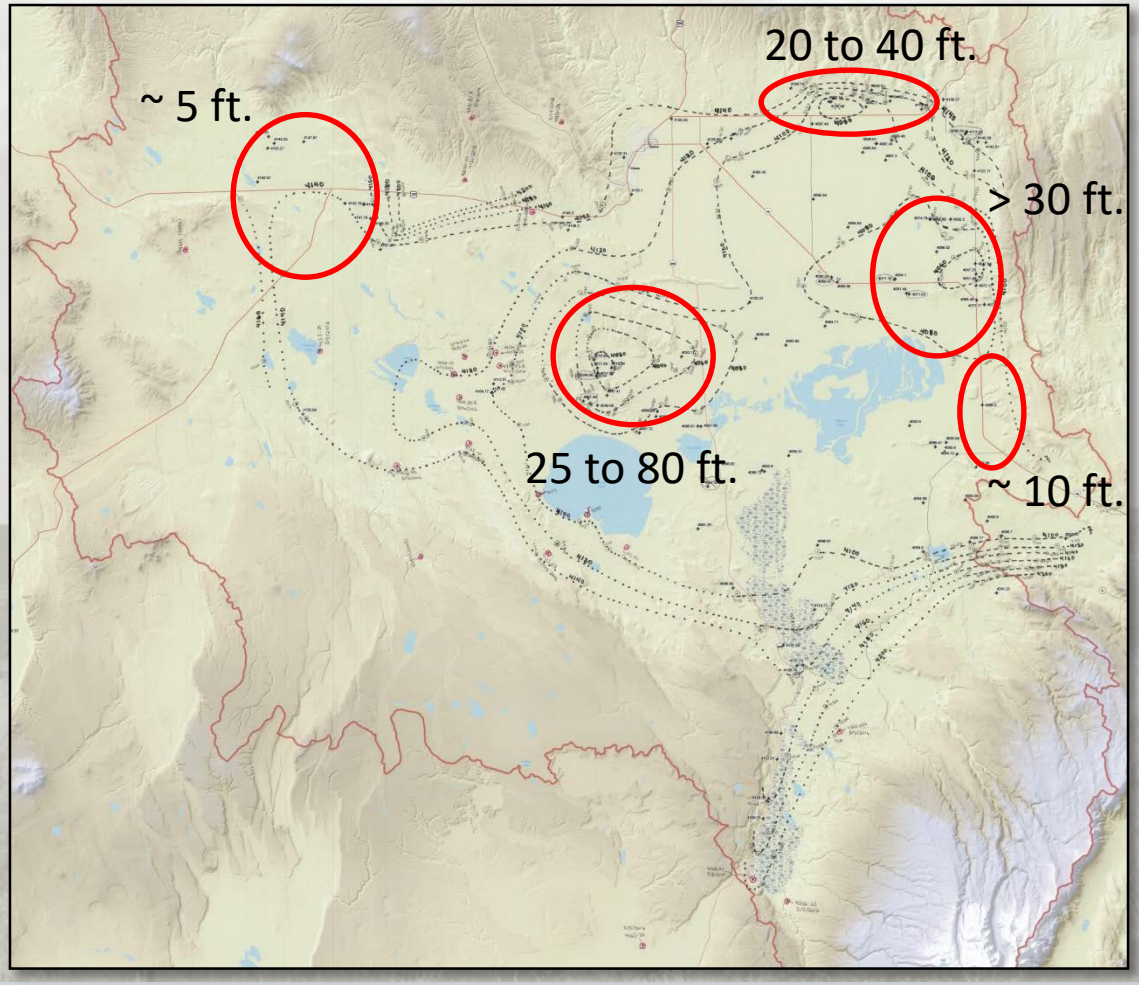
First Impressions: GW Recharge, Discharge, & Flow



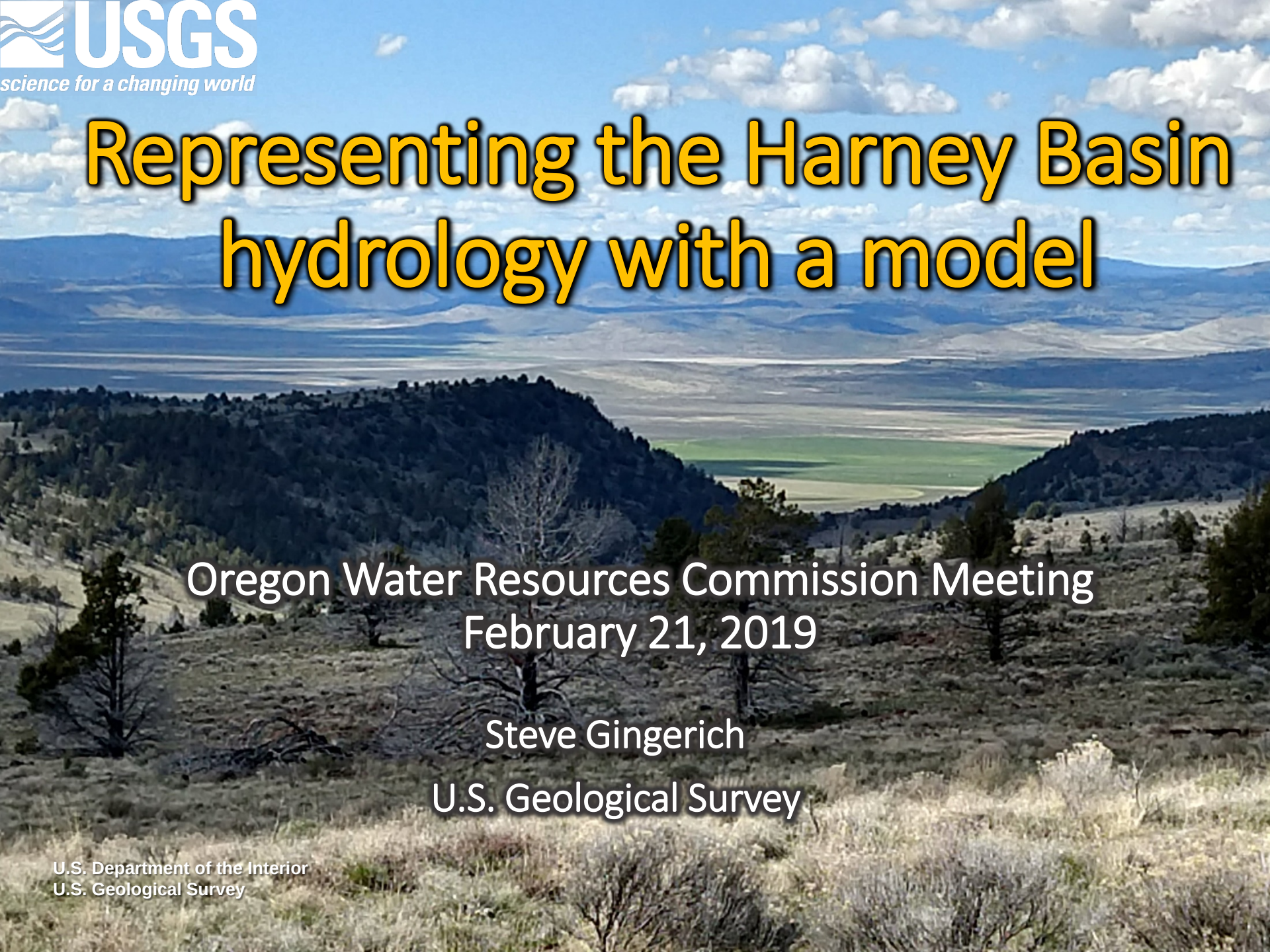
Preliminary…Subject to Change…Do Not Quote or Cite

Very Preliminary Groundwater Levels

First Impressions: Areas of GW Level Decline Since 1969



Preliminary…Subject to Change…Do Not Quote or Cite



Representing the Harney Basin hydrology with a model

Oregon Water Resources Commission Meeting
February 21, 2019

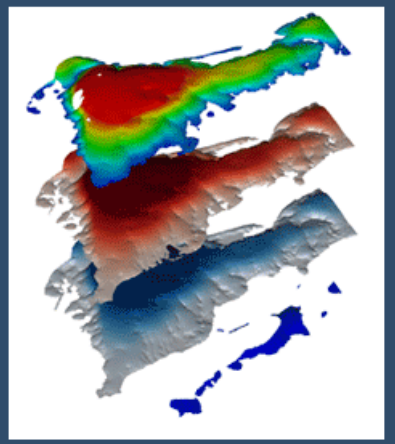
Steve Gingerich

U.S. Geological Survey

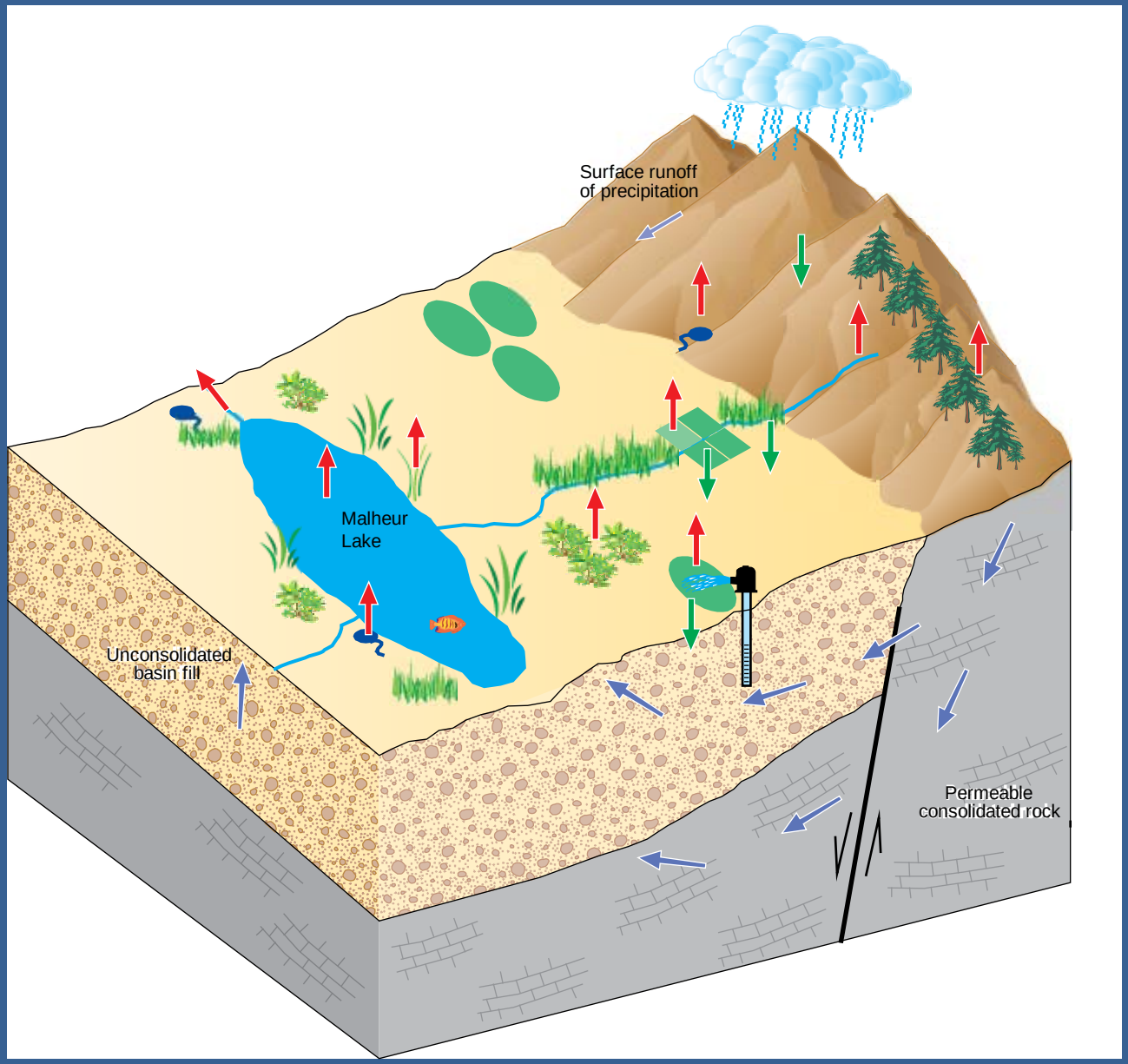
Phase 2 of Harney Basin study

- Need to synthesize the groundwater-flow system into a numerical, physically based model
- Common method to understand complex physical processes using equations that describe the physics of the process
- Numerical modeling used in many applications: aerodynamics of planes, weather forecasting, smoke-plume drift, mining, heating, etc.
- Used to test systems that can't be built in a laboratory

MODFLOW is the USGS's modular hydrologic model. MODFLOW is considered an international standard for simulating and predicting groundwater conditions and groundwater/surface-water interactions.

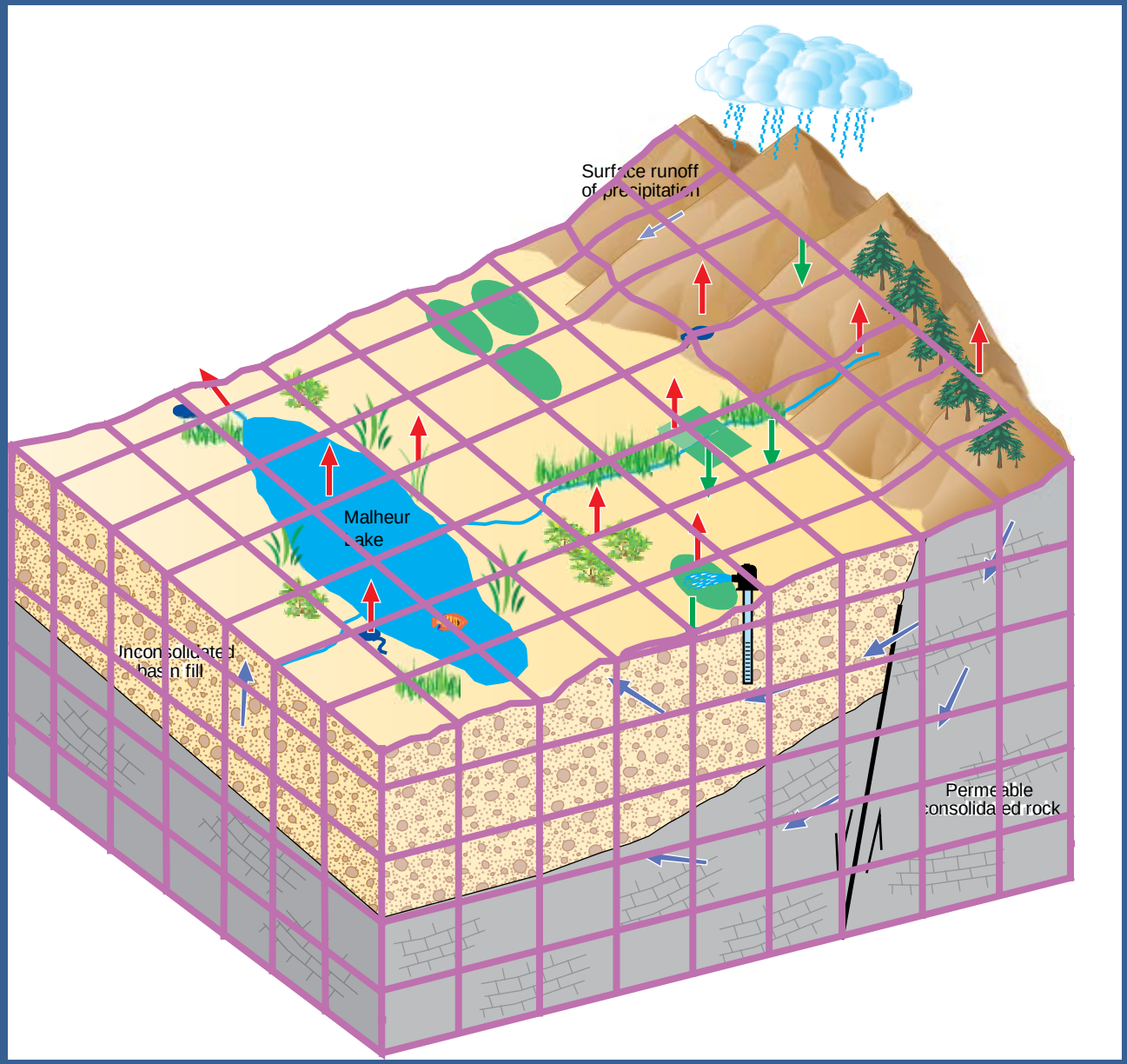


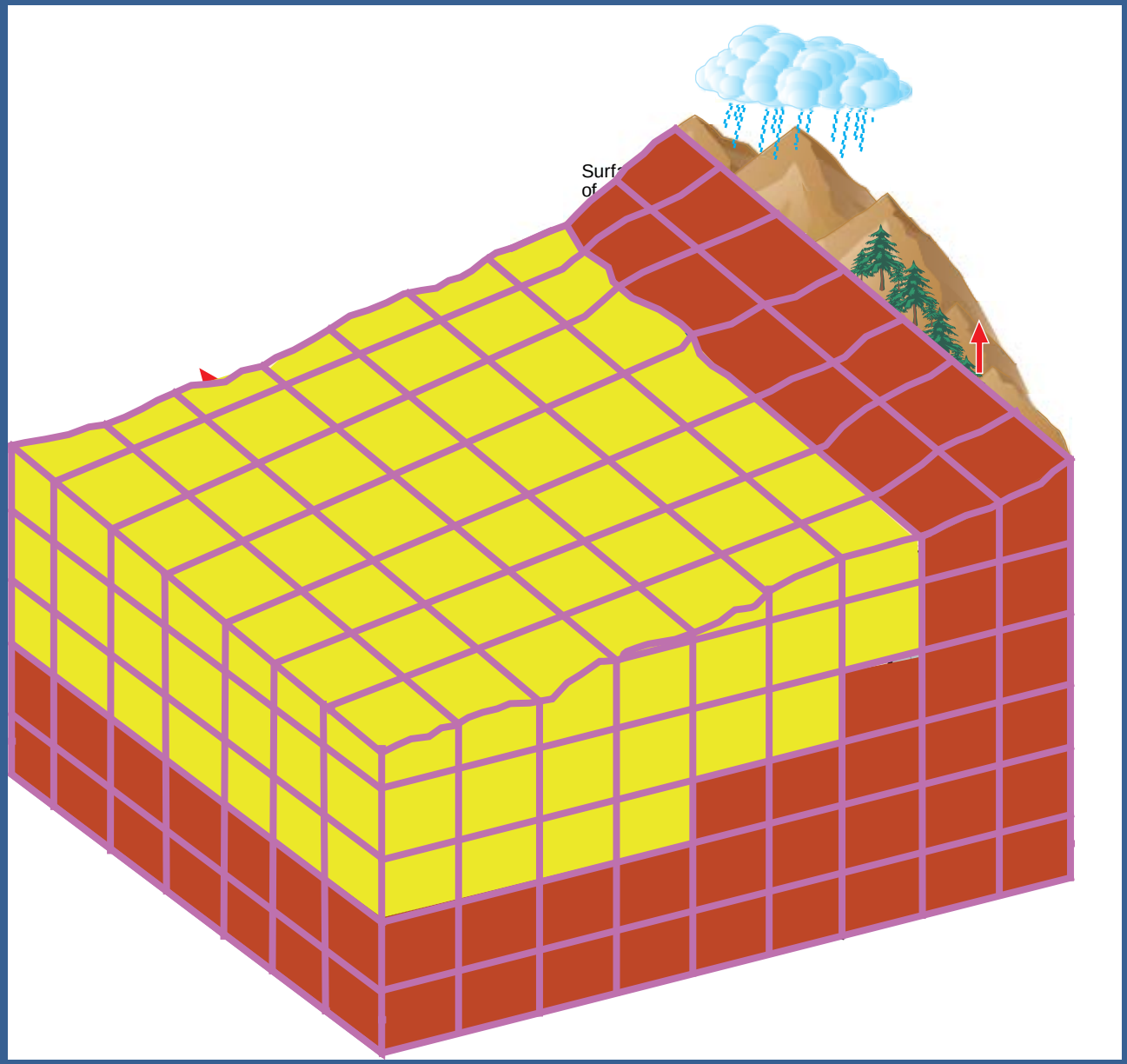
USGS



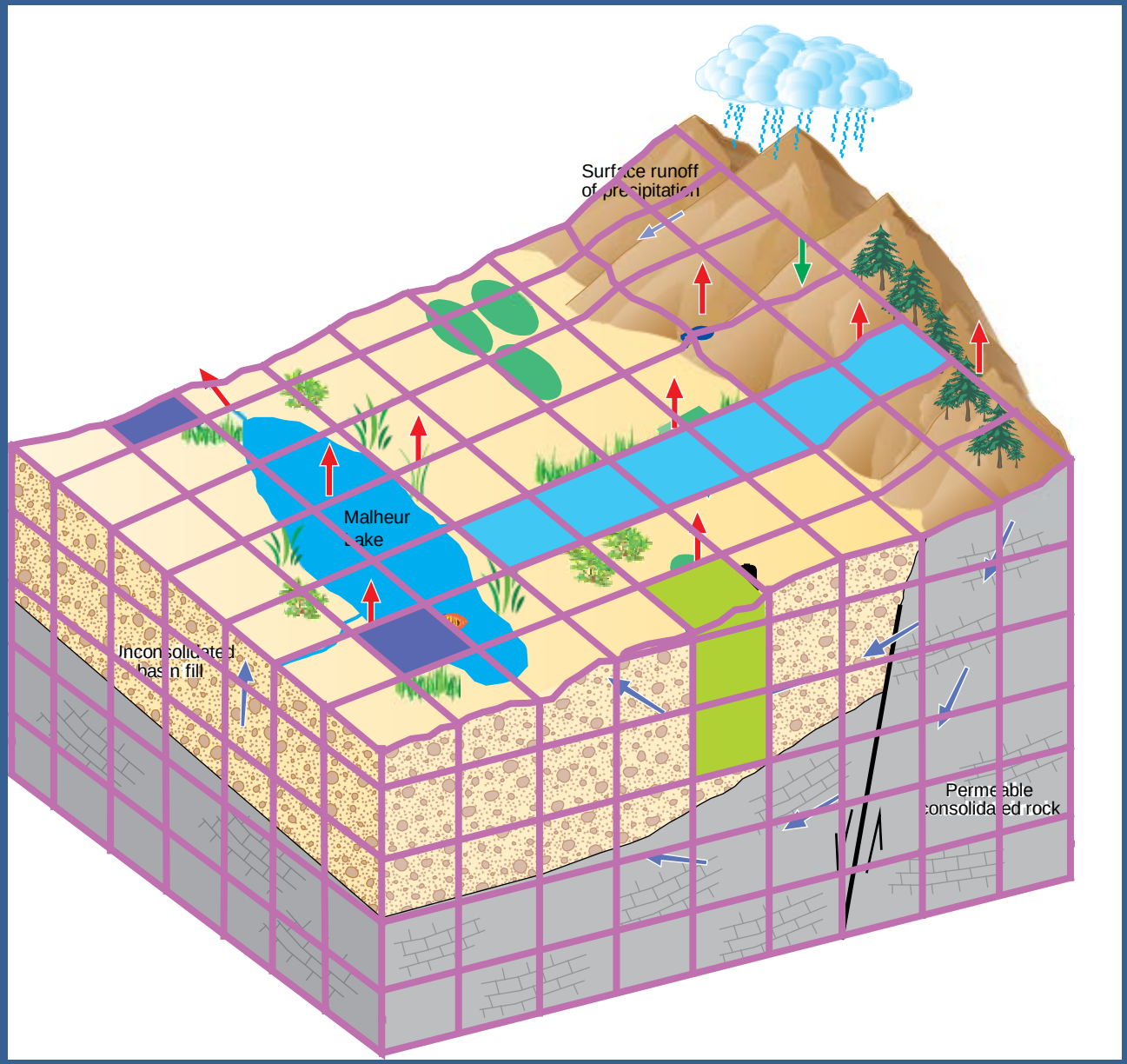
USGS

Modified from Masbruch and others (2010)


Surface runoff
of precipitation
Malheur
Lake
Unconsolidated
basin fill
Permeable
consolidated rock



USGS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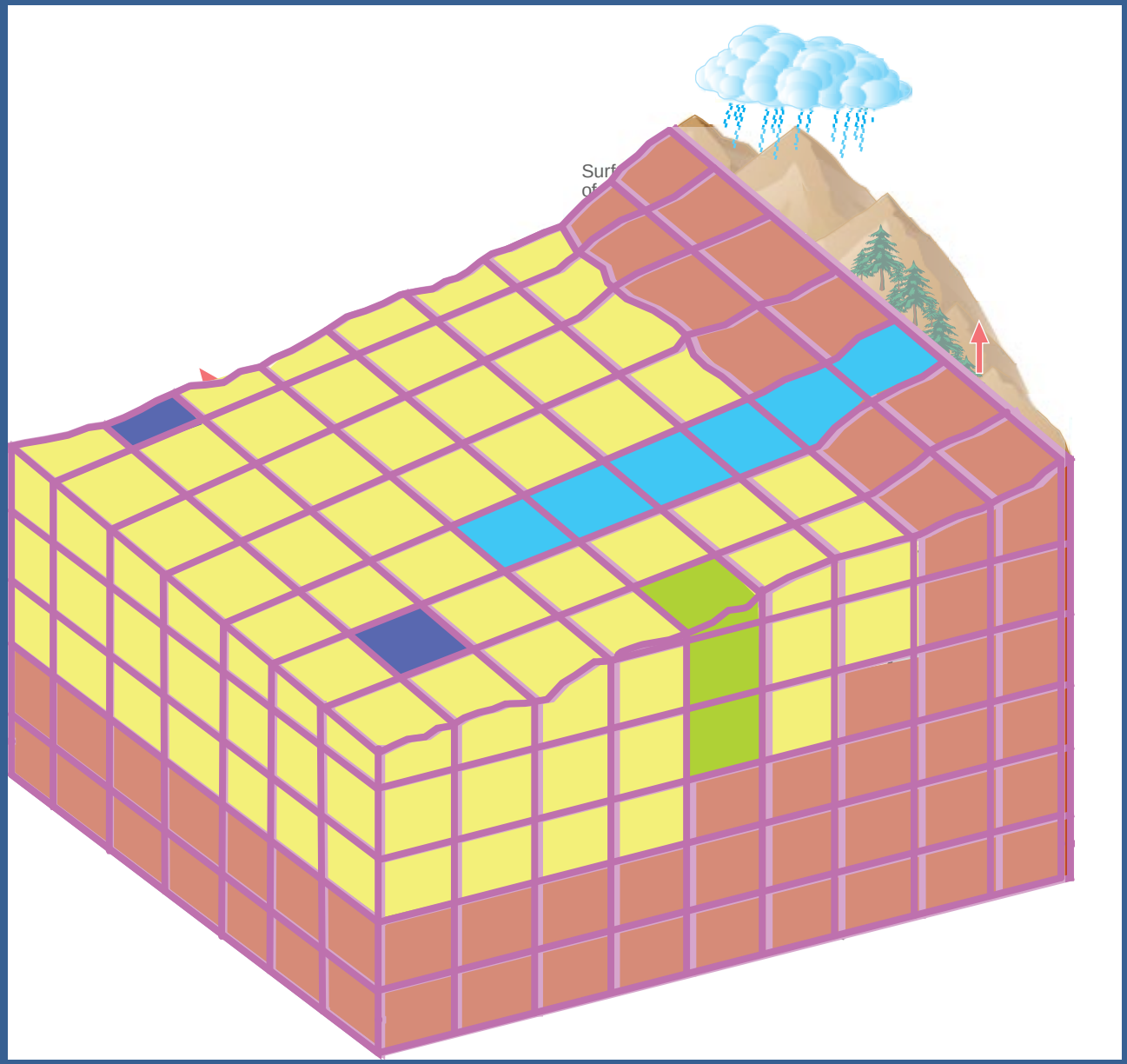
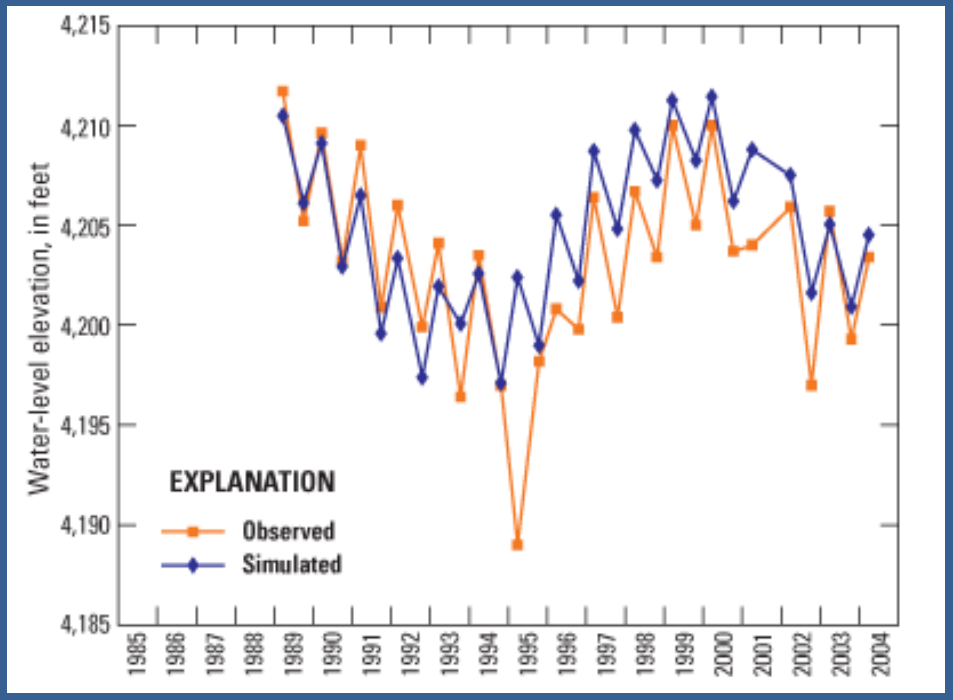
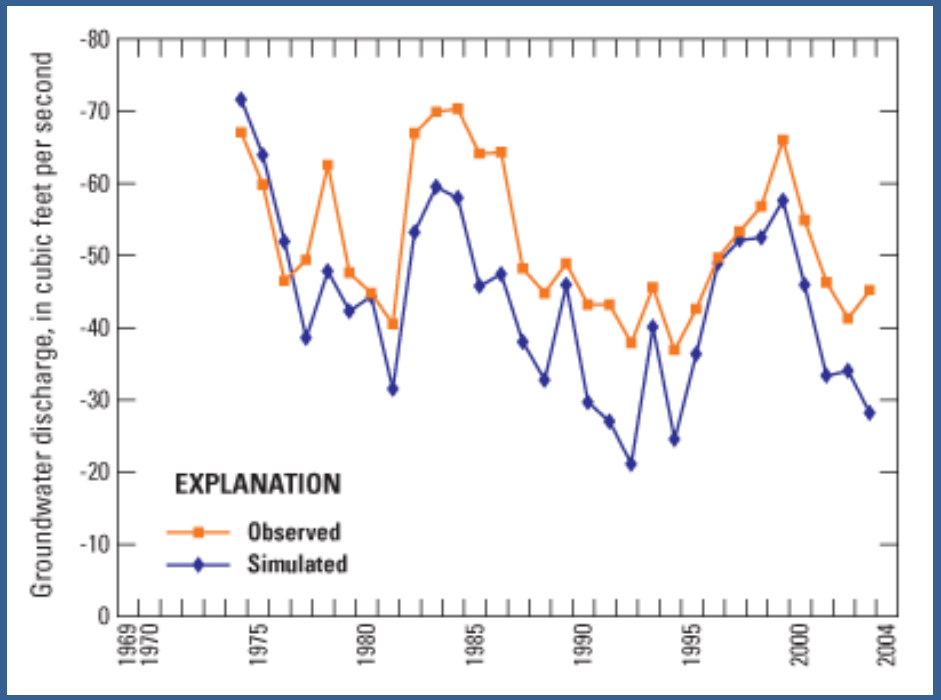


USGS

Match model to measured hydrologic data "Calibration"



Water levels



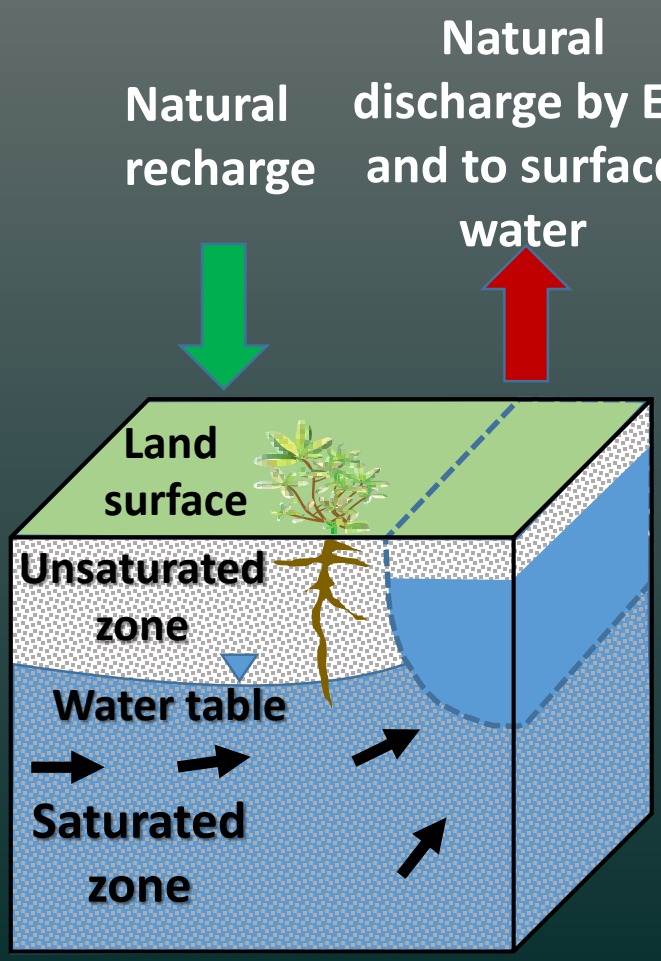
Stream and river discharge

USGS

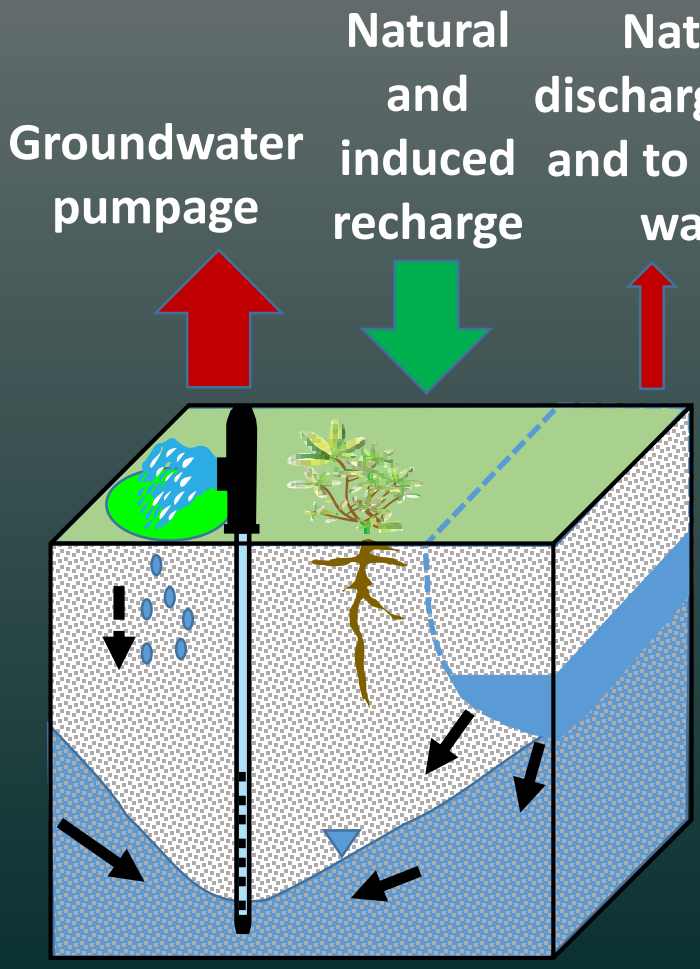
Gannett and others, 2012

Groundwater Storage Depletion

Predevelopment conditions



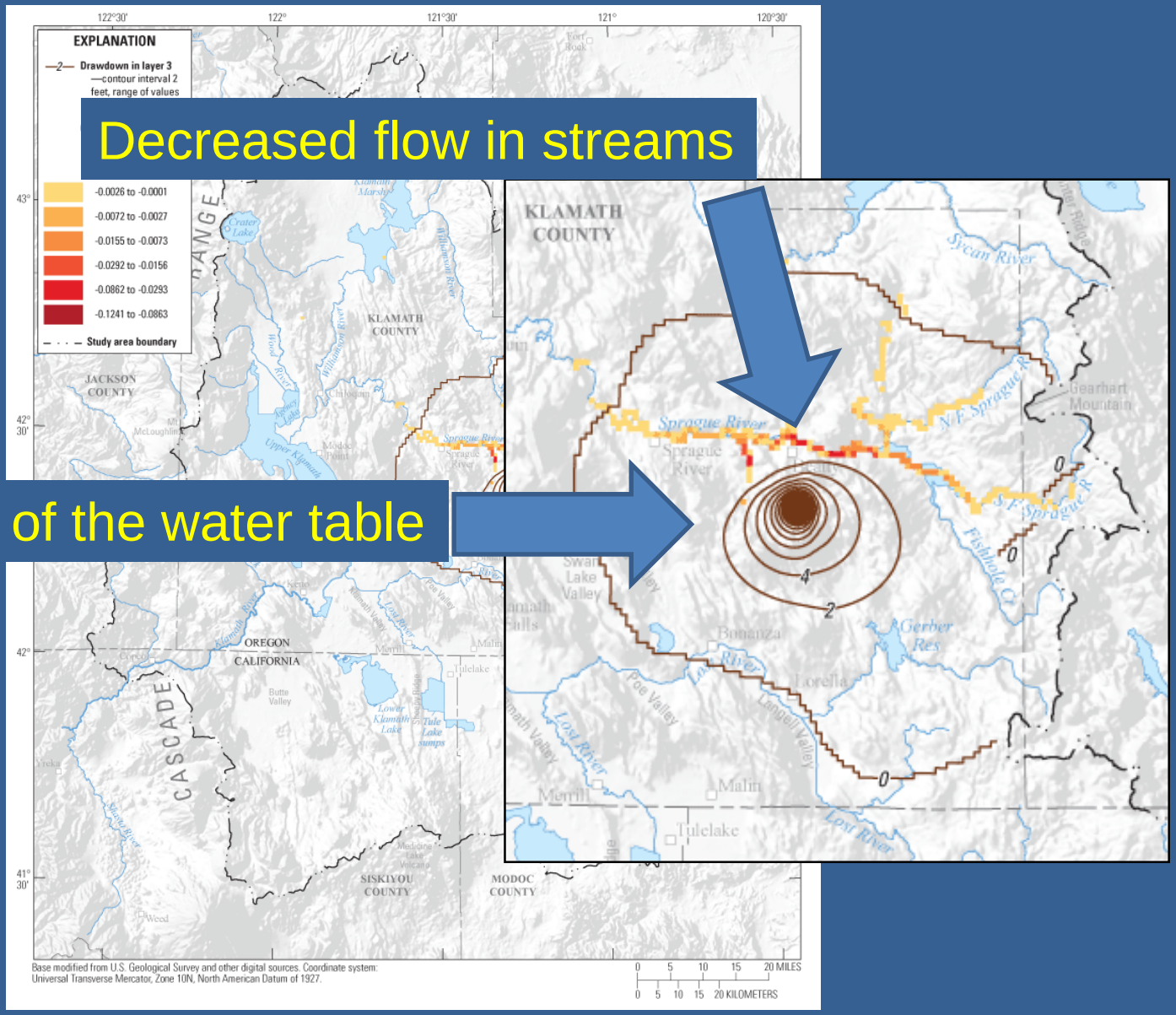
Development conditions



USGS

Test pumping scenarios with model

Example from Klamath Basin



Gannett and others, 2012

Next steps??

- Just beginning to lay out the framework of basin-scale model
- Preliminary model can be used now to guide where we might need to collect more data

USGS

Credit: D. Boschmann