



Hydrologic Characterization and a Coupled Watershed and Groundwater-Flow Model of the Russian River Watershed, California

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

Cooperators

- Sonoma County Water Agency
- CA State Water-Resources Control Board
- City of Ukiah
- County of Mendocino
- Mendocino County Russian River Flood Control and Water Conservation Improvement District
- Upper Russian River Water Agency

Russian River Problem

- Highly variable hydrology presents significant challenges for water-supply and environmental water managers.
- 2 Sustainable Groundwater Management Act (SGMA) medium-priority basins. More on the way?
- Current and future challenges to managing Russian River Watershed (RRW) water resources:
 - reliable flows for fisheries
 - extreme events due to climate change
 - greater hydrologic variability
 - streamflow and groundwater-storage depletion

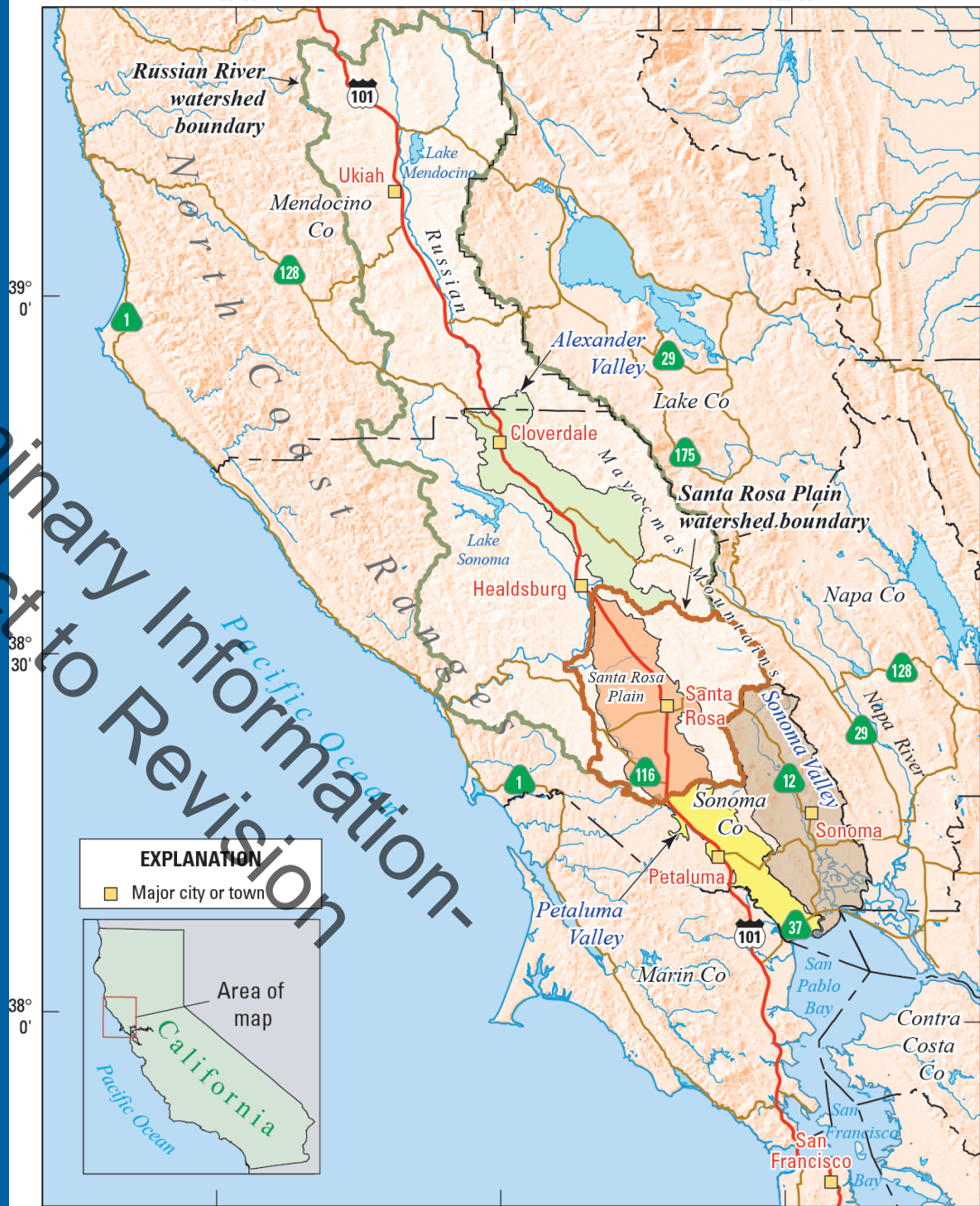
Project Objectives

- Refine the understanding of the RRW hydrologic system based on an analysis of new and available field data.
- Develop a coupled watershed/groundwater-flow model for the RRW that will facilitate improved management of the region's water resources.

Study Area



Preliminary Information-
Subject to Revision



Base from U.S. Geological Survey digital data, 1:1,000,000, downloaded 2003 State Plane Projection, Fipzone 402.
Shaded relief base from 1:250,000 scale Digital Elevation Model: sun illumination from northwest at 30 degrees above horizon



Selected Previous Work in RRW

- **USGS**

- **RRW: Cardwell (1965)**
- **Alexander Valley: Metzger et al. (2006)**
- **Santa Rosa Plain: Nishikawa (2013) and Woolfenden and Nishikawa (2014)**

- **CADWR**

- **Santa Rosa Plain: Bulletin 118-4, vol 4 (1982)**
- **Alexander Valley: Bulletin 118-4, vol 5 (1985)**
- **General overview: Bulletin 118 (2003)**



Prepared in cooperation with the Sonoma County Water Agency

Hydrologic and Geochemical Characterization of the Santa Rosa Plain Watershed, Sonoma County, California



Scientific Investigations Report 2013–5118

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

Approach: 4 Tasks

- Stakeholder outreach
- Data collection and analysis
 - Data compilation and GIS database
 - Data collection
 - Data interpretation and geohydrologic characterization
- Develop GSFLOW model
- Couple GSFLOW w/ MODSIM

Outreach

- Talk to local agencies, communities, water managers, and agricultural entities
- Fact sheet
- Website



Prepared in cooperation with the California State Water Resources Control Board, Sonoma County Water Agency, City of Ukiah, County of Mendocino, Mendocino County Russian River Flood Control and Water Conservation Improvement District, Upper Russian River Water Agency, and Redwood County Water District.

The New USGS Study of the Russian River Watershed

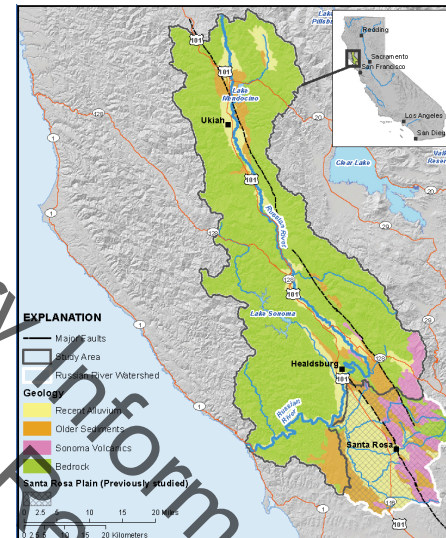


Figure 1. This map shows the Russian River Watershed and its location within the state of California.

- The Russian River Watershed (RRW) is about 1,500 square miles of urban, agricultural, and forested lands in northern Sonoma County and southern Mendocino County.
- The watershed is prone to droughts and floods. The floods are due in large part to frequent atmospheric rivers, which comprise more than 50% of precipitation.
- Basins in the RRW rely on both surface water and groundwater to meet increasing water-supply demands.

Resource managers in the Russian River Watershed (RRW) face an array of challenges, including managing flows for fisheries, responding to extreme climatic events, meeting increasing water demands, preventing streamflow depletion, and ensuring long-term groundwater sustainability.

To help managers address these complex challenges, the U.S. Geological Survey (USGS), in cooperation with the California State Water Resources Control Board (Water Board), Sonoma County Water Agency (Water Agency), the City of Ukiah, County of Mendocino, Mendocino County Russian River Flood Control and Water Conservation Improvement District, Upper Russian River Water Agency, and Redwood Valley County Water District, is conducting a hydrologic study of selected areas of the RRW. The study goals are to provide new information and understanding of the quantity and quality of the surface-water and groundwater systems in parts of the watershed. Study results will help local groundwater sustainability agencies (GSAs) create groundwater sustainability plans (GSPs), as mandated by California's Sustainable Groundwater Management Act (SGMA).

The study will characterize a large part of the watershed's geology and water system (Figure 1), and include the development of an integrated hydrologic model of the Russian River Watershed.

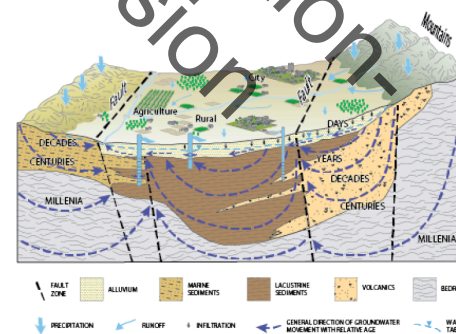
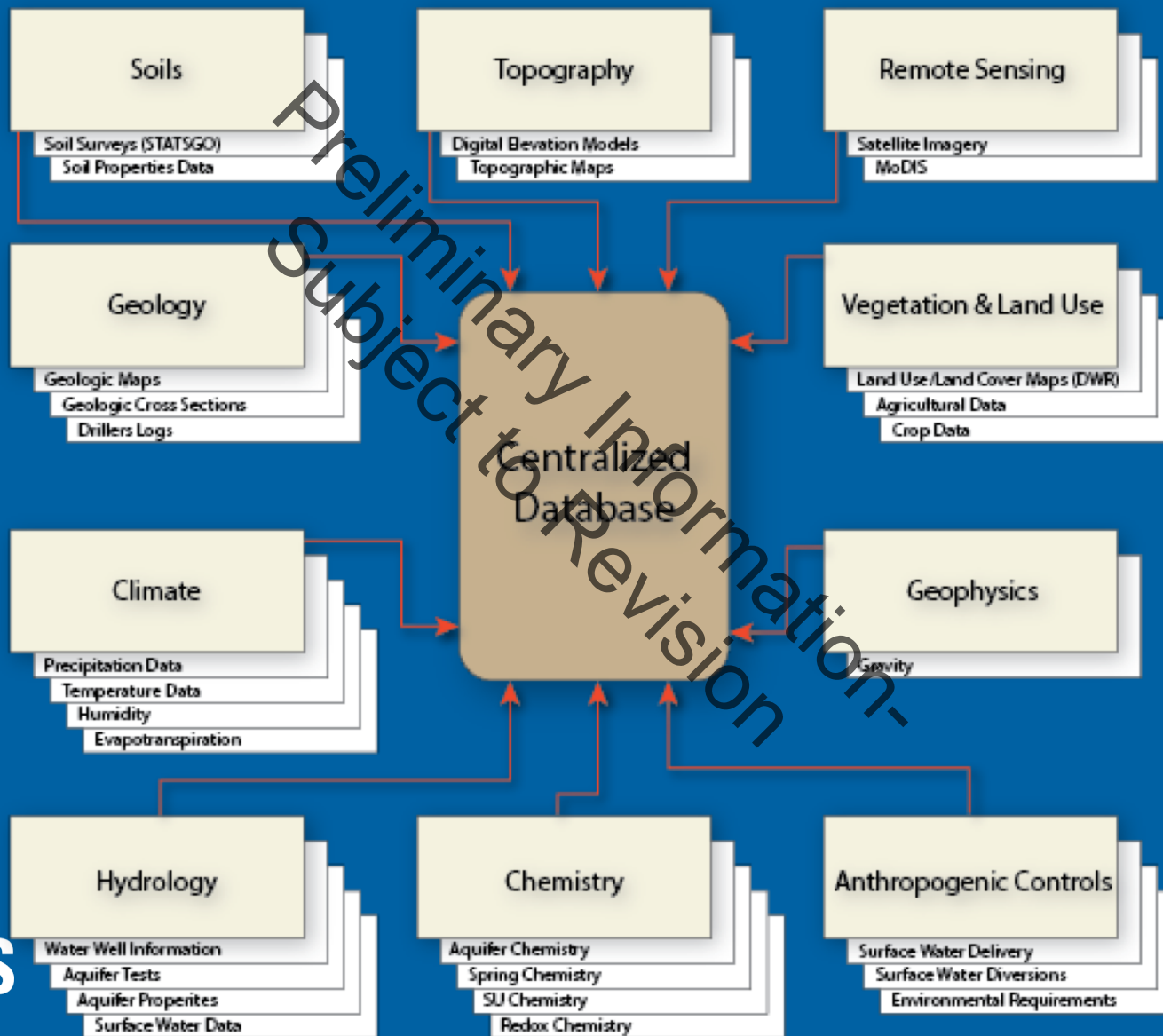


Figure 2. Example of a conceptual model of a hydrologic system.

Develop Database

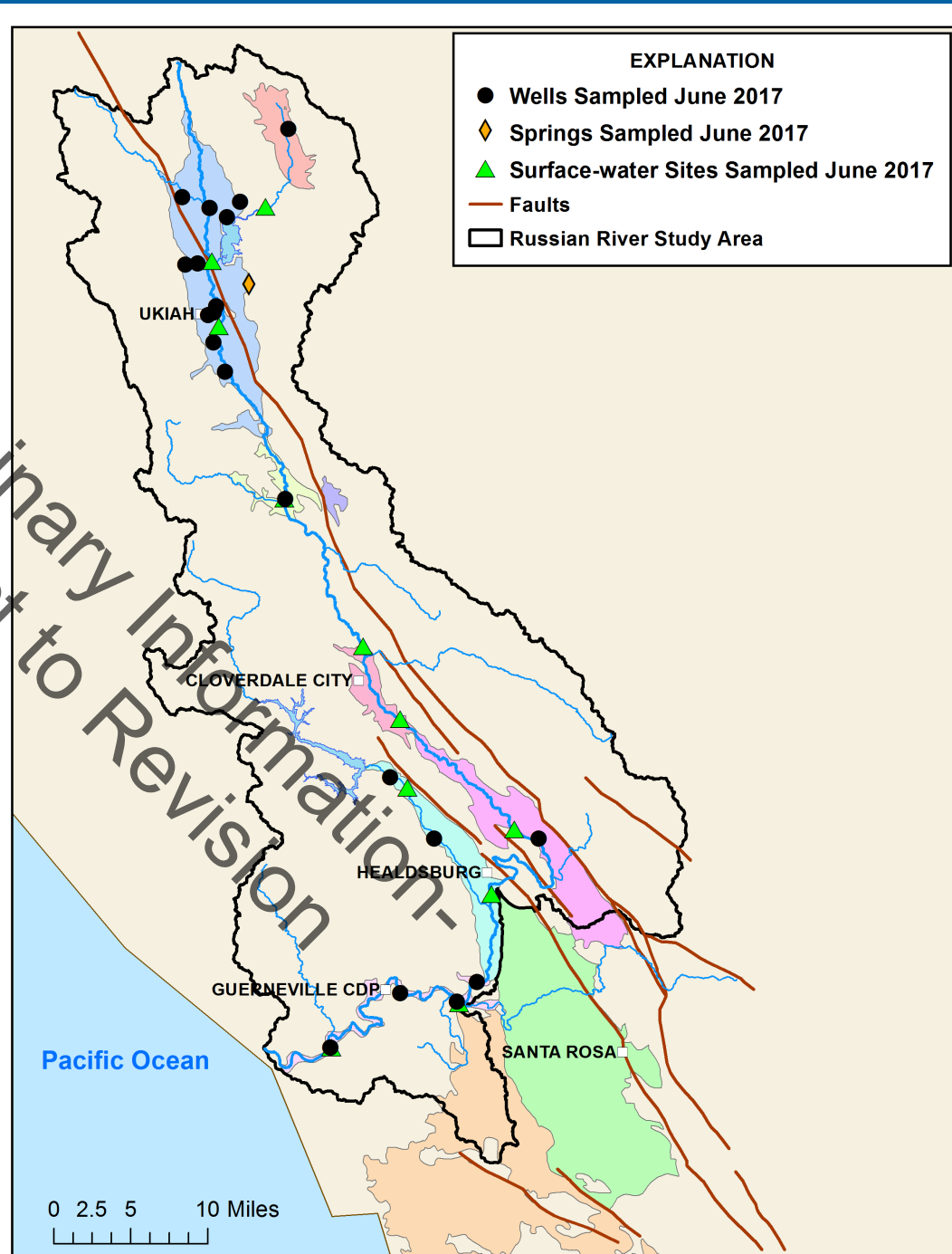


Data Collection and Analysis Goals

- Identify sources of groundwater recharge
- Identify groundwater flowpaths
- Refine the hydrogeologic framework model
- Identify losing or gaining reaches for the Russian River and the main tributaries
- Identify areas where wells may capture river underflow

USGS sampling: June 2017

- 24 Wells
- 1 Spring
- 11 Surface-water Sites
- Sampled for:
 - Major Ions
 - Trace Elements
 - Stable Isotopes
 - Age-Dating Parameters





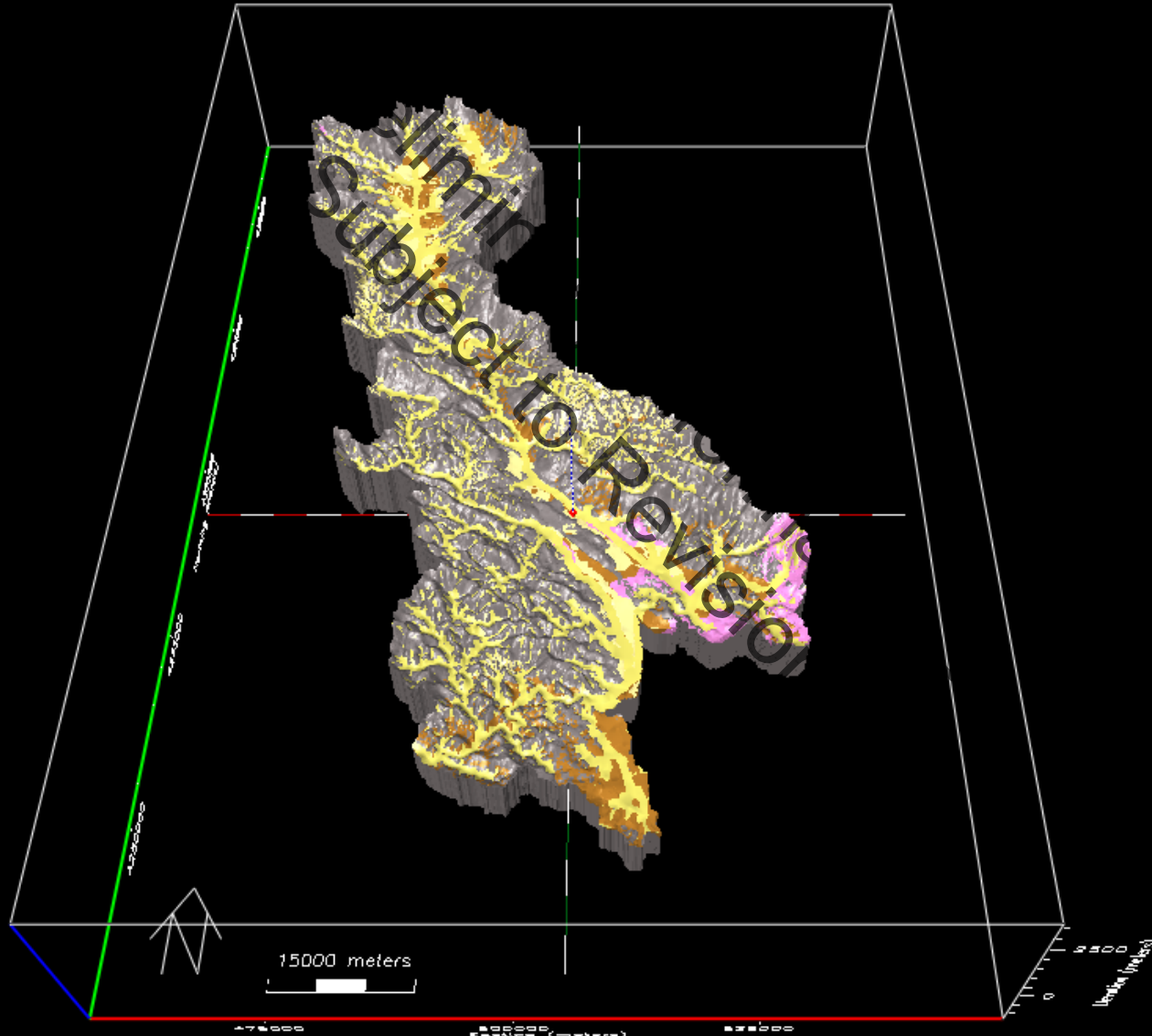
Hydrogeologic Units

- Channel Alluvium
 - Unconsolidated river/stream deposits
- Younger Sediment
 - Alluvium, terrace deposits
- Older Sediment
 - Poorly to moderately consolidated
 - Continental and marine deposits
 - Glen Ellen, Wilson Grove Fms
- Sonoma Volcanics
 - Lava flows with volcaniclastic layers
- Basement
 - “Hard” rock
 - Franciscan Formation
 - Igneous, metamorphic, sedimentary

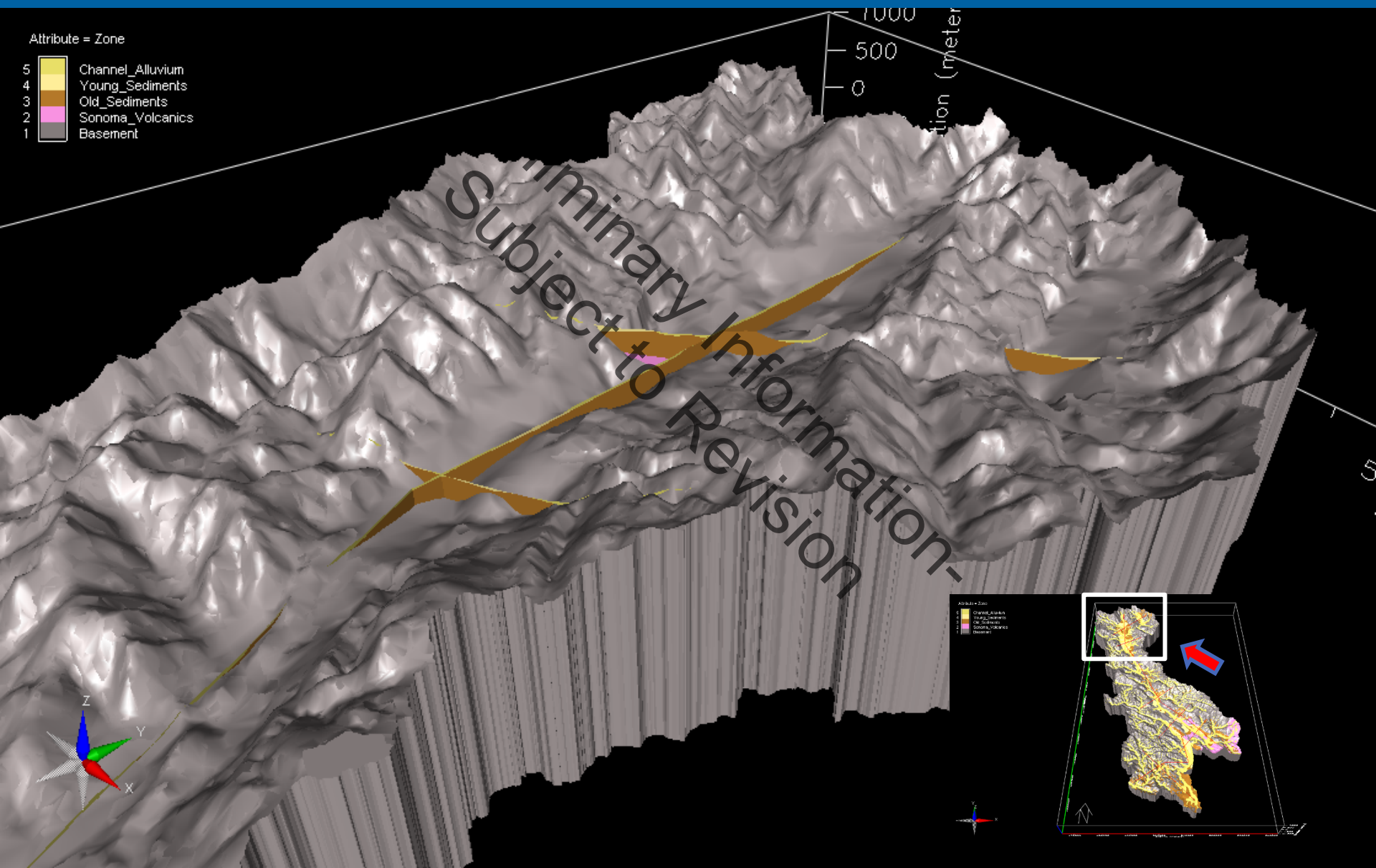
Preliminary Hydrogeologic Framework

Attribute = Zone

- | | |
|---|------------------|
| 5 | Channel_Alluvium |
| 4 | Young_Sediments |
| 3 | Old_Sediments |
| 2 | Sonoma_Volcanics |
| 1 | Basement |



Preliminary Hydrogeologic Framework



GSFLOW: Coupled groundwater and surface-water flow model



PRMS

Model Area

Russian River study-area boundary

GSFLOW model grid:

300-m resolution

411 rows and 253 columns

Each grid cell is a Hydrologic Response Unit (HRU)

Each HRU is assumed to be homogeneous with respect hydrologic and physical characteristics



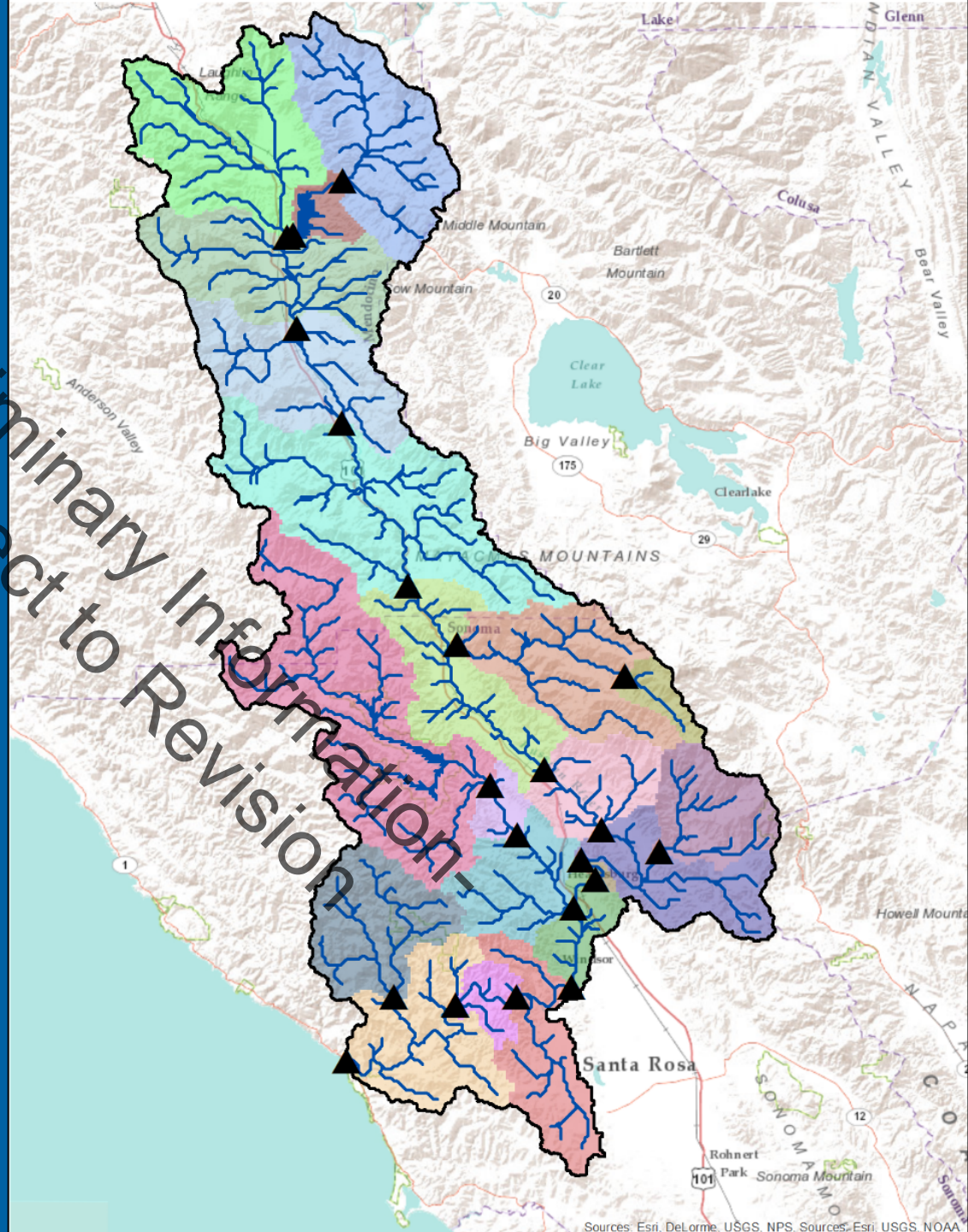
Preliminary Information-
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Stream Network

Data from 21 streamgages have been collected and processed

Estimated unimpaired streamflow used to calibrate BCM will be used to calibrate the PRMS model



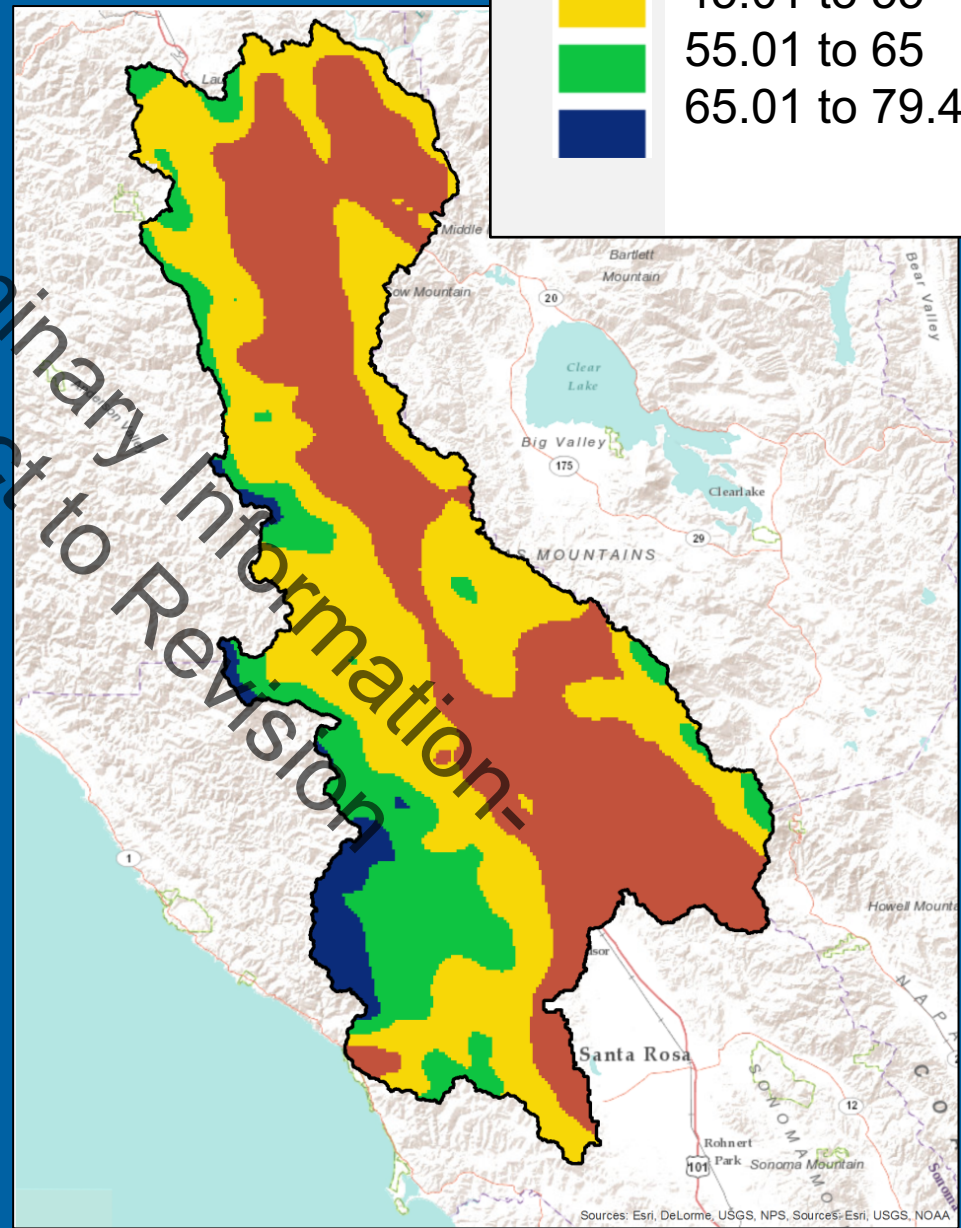
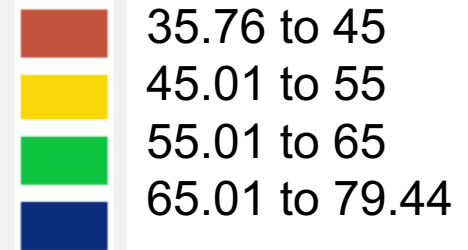
Preliminary Information - Subject to Revision

PRMS Data

- Input data
 - Daily precipitation
 - Daily min and max temperature
 - Soils
 - Land use
- Calibration data
 - Estimated unimpaired streamflow
 - Measured streamflow

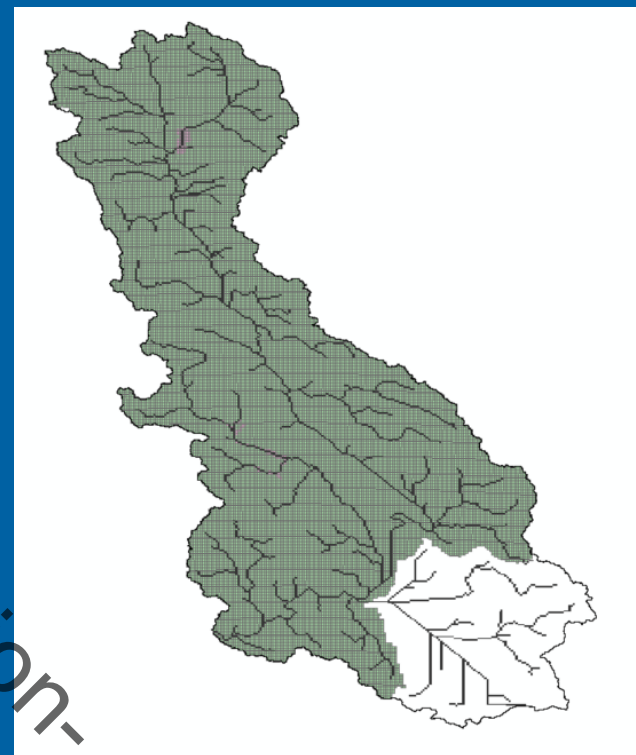


Mean Annual Precip. (in.)



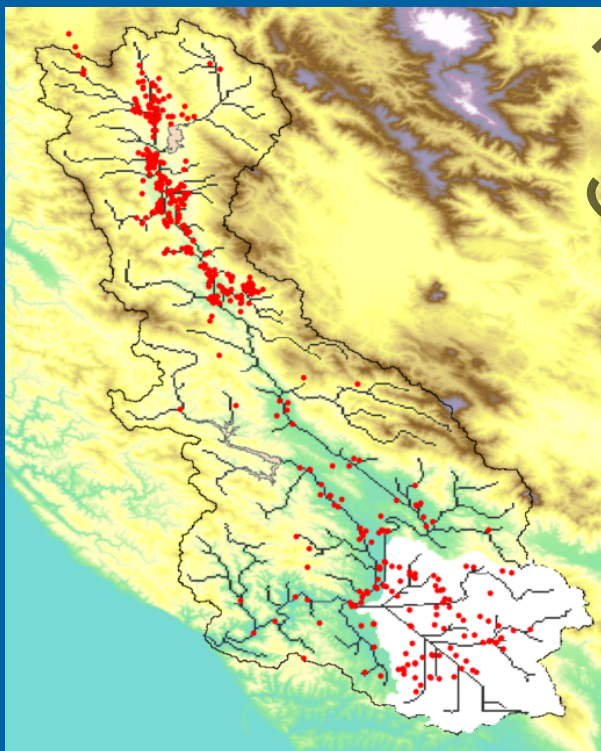
Groundwater Model

- Based on geologic framework
- Simulation period 1990-2015
- Monthly stress-period
- Horizontal cell size is (300m by 300m).
- Top will be land surface
- Bottom will be bedrock
- Multiple layers will be used to capture aquifer stratigraphy.
- Stresses include domestic pumping, agricultural pumping, and recharge.
- Calibrated to groundwater-level and streamflow data



Groundwater Calibration Data

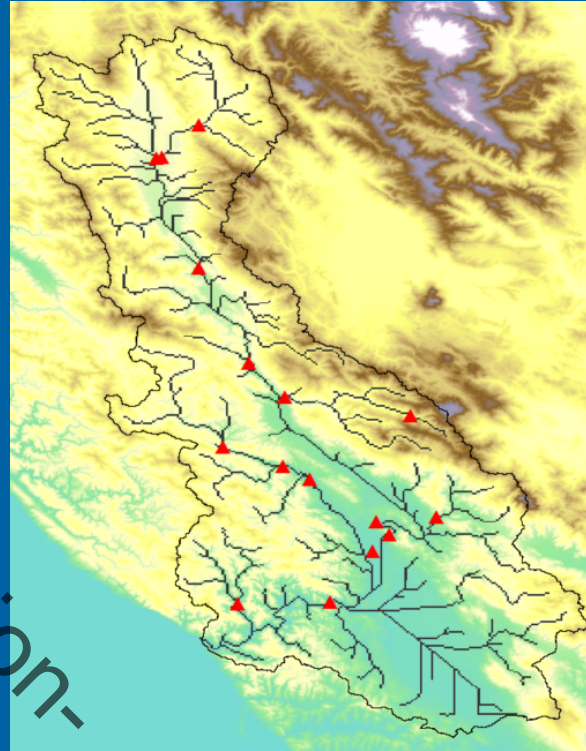
USGS GWL Data



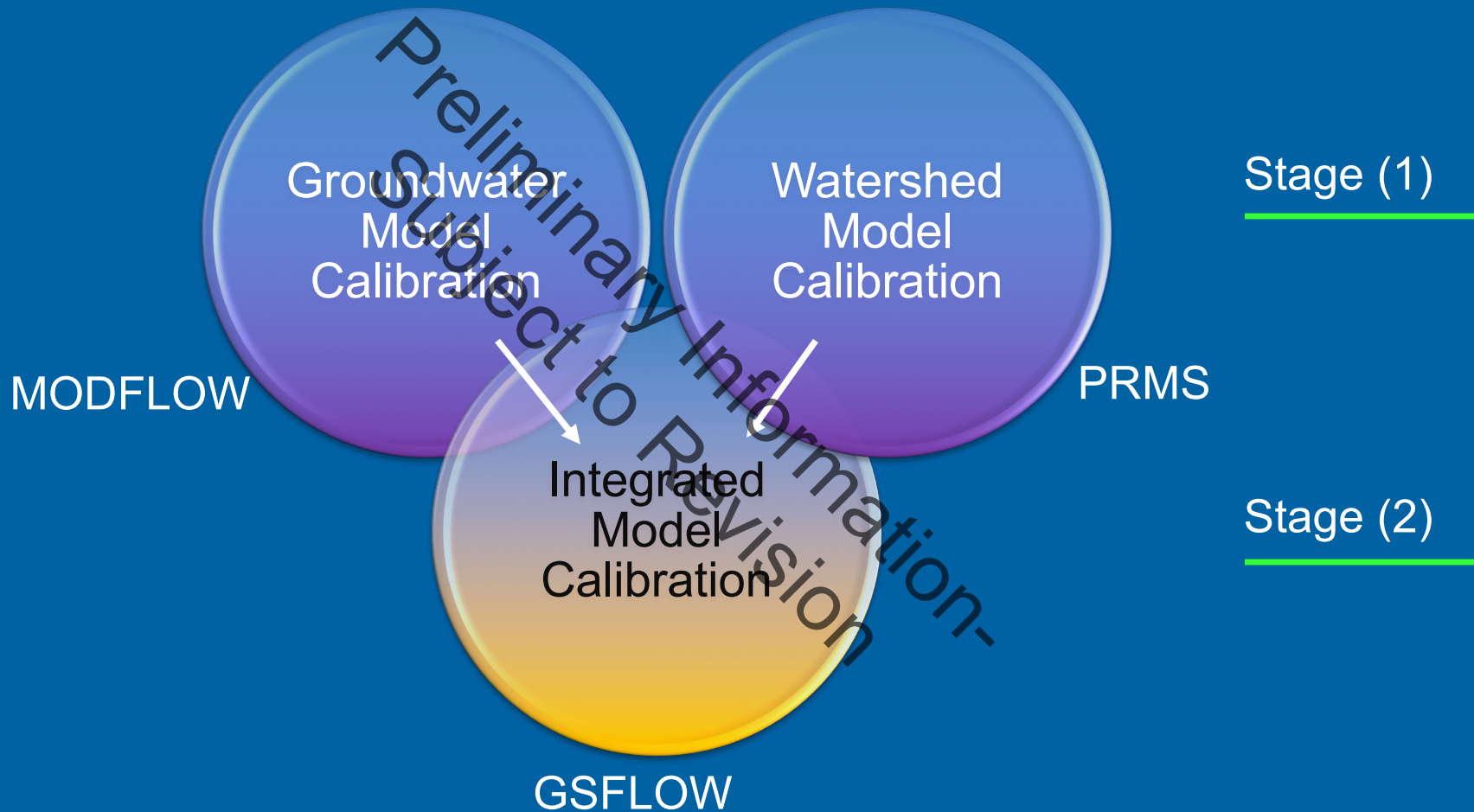
DWR GWL Data



Stream Flow Data



Integrated Model (GSFLOW) Calibration

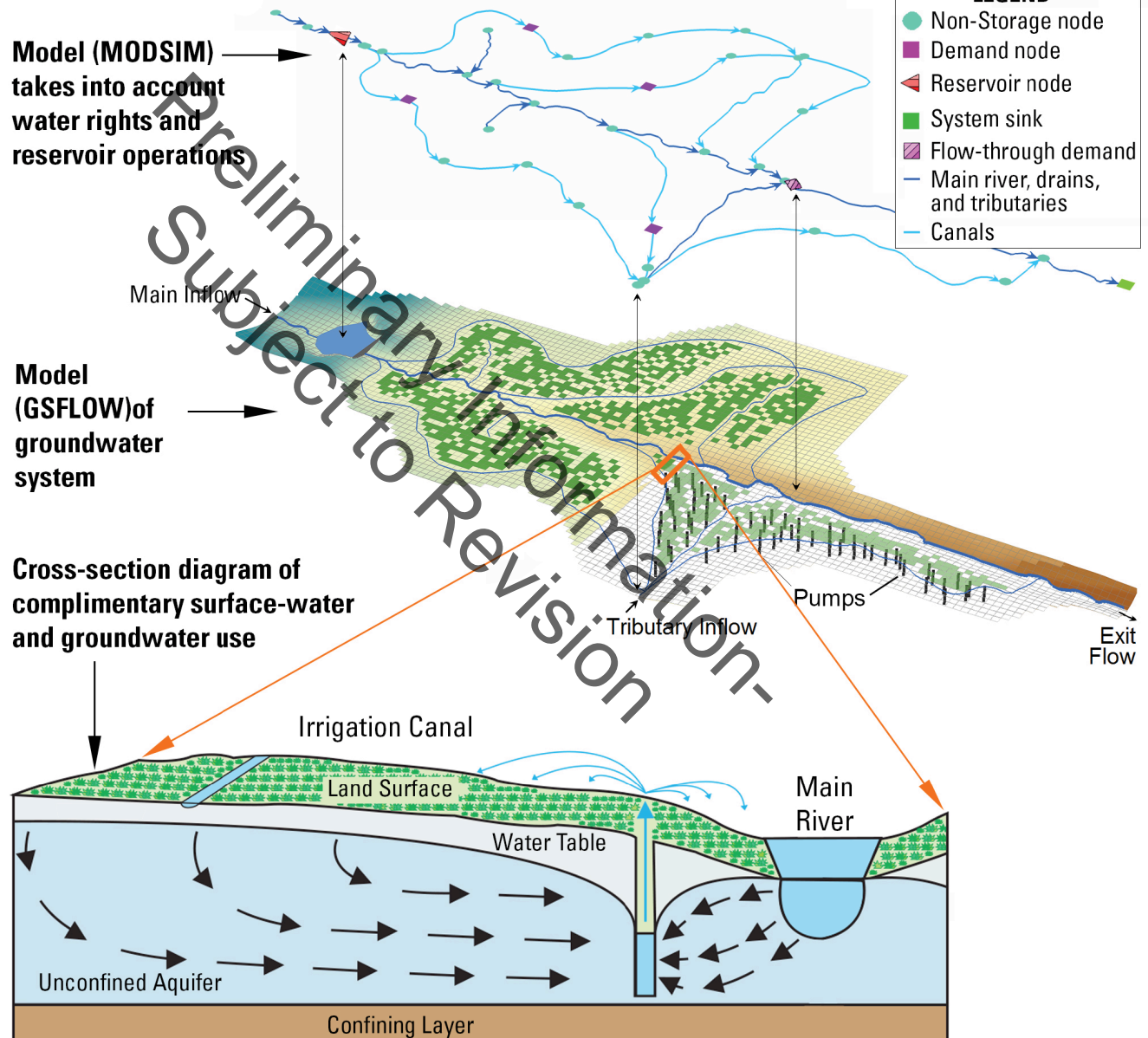
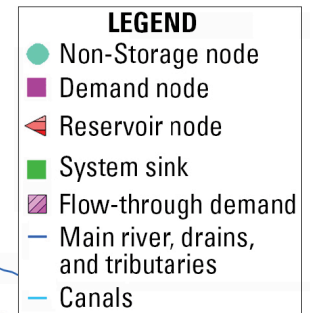


MODSIM

Model (MODSIM)
takes into account
water rights and
reservoir operations

**Model
(GSFLOW) of
groundwater
system**

**Cross-section diagram of
complimentary surface-water
and groundwater use**



Website and Email

<https://ca.water.usgs.gov/projects/russian-river-hydrology.html>

tnish@usgs.gov

USGS Reports

- Cardwell (1965):
<https://pubs.er.usgs.gov/publication/wsp1548>
- Metzger et al. (2006):
<http://pubs.usgs.gov/sir/2006/5115/>
- Nishikawa (2013):
<http://pubs.usgs.gov/sir/2013/5118/>
- Woolfenden and Nishikawa (2014):
<http://pubs.usgs.gov/sir/2014/5052/>

Data Plea

- **Well-related data (confidential)**
 - Drillers' logs
 - Geophysical logs
- **Pumpage data**
 - Agricultural
 - Rural domestic
- **Well access**

Questions?

