Harney Basin Groundwater Investigation:
Continuing the OWRD-USGS Collaboration Legacy of
Ken Lite and Marshall Gannett

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Abstract

Basin-scale groundwater investigations with flow modeling for the Oregon Water Resources Department (OWRD) advanced from contracting with the U.S. Geological Survey (USGS) to conduct the entire investigation and modeling prior to 1985, to partial OWRD participation during the late 1980s, to full OWRD-USGS collaboration since 1990. The collaborative studies in the Upper Deschutes Basin and the Klamath Basin under the co-leadership of Ken Lite (OWRD) and Marshall Gannett (USGS) benefited from their complimentary and ever-expanding professional skills, scientific inquisitiveness, willingness to use updated and new methods, professional respect, and a nearly 35-year friendship. They set an exemplary model and standard for subsequent basin-scale groundwater investigations in Oregon, including the current investigation in the 5,000 square-mile Harney Basin being co-investigated by a new set of OWRD and USGS staff. The Lite-Gannett collaborative model and legacy will be presented as well as how their model and legacy informs and sets the standard for the current Harney Basin study.

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Presentation Notes

Slide 1: Title Page

Slide 2: 1980s Hydrogeology, Time of Transition

- From formal to casual office attire
- From 2-wheel sedans and station wagons to 4-wheel drive SUVs & pickup trucks
- Advances in physical and chemical methodologies to distinguish volcanic units
- From hand calculators and mainframe computers to basic desk-top computers
- From boxes of punch cards to floppy disks

Slide 3: 1980s Hydrogeology, Time of Transition (continued)

- From Davis & DeWeist to Freeze & Cherry
- From 1-D & 2-D Analytic & Numerical Models (flow & transport)
- To 3-D Finite Difference & Finite Element Numerical Models
- In particular, MODFLOW:
  - Large applications on mainframe computers
  - Small applications with long run-times on desk-top computers
  - None to very rudimentary pre & post processors

Slide 4: 1980s Hydrogeology, Ken Lite & Marshall Gannett

- Both Ken & Marshall began Oregon State service at OWRD in the mid-1980s coming from Private Consulting employment where:
  - Ken did geologic consulting work related to:
    - the Brothers Fault Zone &
    - Washington Nuclear Project (**W**ashington **P**ublic **P**ower **S**upply **S**ystem…Whoops)
  - Marshall did geothermal consulting work
- Ken & Marshall were assigned separate investigations but often assisted each other
  - Marshall was assigned:
    - Annual monitoring of the statewide geothermal network of springs and wells
    - Assessing groundwater availability in the volcanic rock & sediment deposits in the Powell Butte area of central Oregon.
    - Assessing the effects of development on the geothermal aquifer in the Vale area of eastern Oregon.
    - Characterizing the hydrogeology of a contaminated alluvial aquifer in the Ontario-Vale-Nyssa area of eastern Oregon.
  - Ken was assigned:
    - Assessing the hydrogeology of 3 stratigraphically distinct Columbia River Basalt aquifers experiencing a water supply problem in the Mosier area in the Columbia River Gorge.
    - OWRD liaison to the USGS related to the USGS Portland Basin groundwater study and numerical model.
    - Distinguishing the stratigraphy and assessing the groundwater conditions in volcanic and sedimentary deposits in the SE Portland (Sandy-Boring) area using geochemical, neutron activation, and x-ray fluorescence techniques.
- Ken & Marshall often assisted each other with their respective assignments building professional respect, a friendship, and entertaining stories.

Slide 5: 1980s Hydrogeology, USGS-OWRD Cooperative Groundwater Studies in Oregon

- Morgan (published 1988): Geohydrology and Numerical Model Analysis of Groundwater Flow in the Goose Lake Basin, Oregon & California.
  - Single report.
  - Initiated in response to concern related to increased groundwater development and subsequent groundwater level decline.
  - Scope of work: Used Numerical Model to:
    - Assess adequacy of existing data and prioritize future data collection.
    - Test conceptual understanding of the groundwater flow system.
    - Estimate worst case impact of groundwater development.
  - OWRD involvement limited to co-defining scope of work and reviewing final report
- McFarland & Ryals (published 1991): Adequacy of Available Hydrogeologic Data for Evaluation of Declining Groundwater Levels in the Fort Rock Basin, South-Central Oregon.
  - Single report.
  - Initiated in response to concern related to increased groundwater development and subsequent groundwater level decline following OWRD study.
  - Scope of work: Used Numerical Model to:
    - Assess adequacy of existing data and prioritize future data collection.
    - Test hydrogeologic understanding
  - OWRD involvement limited to co-defining scope of work and reviewing final report
- Morgan, McFarland, and others (series of reports published early to mid 1990s): Portland Basin Hydrogeology & Numerical Model.
  - Series of reports
  - More cooperators:
    - USGS & OWRD
    - City of Portland and Clark County
  - Initiated in response to growing reliance on groundwater to meet the growing water demand in the basin.
  - Scope of work: Used Numerical Model to:
    - Test and refine conceptual understanding of the groundwater flow system.
    - Estimate past and future human effects on groundwater recharge-discharge, groundwater levels, and streamflow
    - Prioritize future data collection to improve model utility and accuracy.
  - Greater OWRD involvement-collaboration:
    - SE Portland-Sandy-Boring area groundwater data collection and analyses
    - Ken Lite's geology thesis investigation (stratigraphy & structure)
    - OWRD consultation and review throughout the study

Slide 6: 1990s & 2000s, USGS-OWRD Cooperative-Collaborative Groundwater Studies in Oregon

- 1990: Marshall Gannett moves from OWRD to USGS.
- OWRD and USGS staff collaborate in conducting the investigation and writing the reports.
- Gannett, Lite, and others: Upper Deschutes Basin Hydrogeology & Numerical Model.
  - Study began in 1993
  - Initiated in response to a concern about an increasing demand on groundwater to meet the water demand of a burgeoning population that tripled from 1970 to 1998.
  - More cooperators:
    - USGS & OWRD
    - Cities of Bend, Redmond, and Sisters
    - Counties of Deschutes and Jefferson
    - Confederated Tribes of the Warm Springs Reservation of Oregon
    - U.S. EPA
  - Series of reports from 1998 to 2004, then 2013 and 2017
    - Chemical study of GW-SW interaction
    - Geologic framework
    - Groundwater hydrology
    - Numerical Model
    - Analysis of subsequent groundwater level changes
    - Simulation of subsequent groundwater level changes
  - Used Numerical Model to evaluate how groundwater system and streams respond to:
    - Groundwater pumping.
    - Canal lining.
    - Drought.
    - Other stresses.
- Gannett, Lite, and others: Upper Klamath Basin Hydrogeology & Numerical Model.
  - Study began in 1999
  - Initiated in response to shift in surface water management to protect species resulting in increased groundwater use and demand exacerbated by subsequent droughts.
  - Fewer Cooperators: USGS, OWRD, USBOR, USFWS
  - Series of Reports from 2007 to 2015
    - Groundwater hydrology
    - Numerical Model
    - Optimization Numerical Model
  - Used Numerical & Optimization Models to evaluate:
    - Groundwater system, surface water, and agricultural drain response to groundwater pumping.
    - Groundwater management strategies to meet groundwater & surface water management requirements (groundwater levels, lake levels, stream flows).
- Conlon, Herrera, Wozniak, and others: Willamette Basin Hydrogeology & Numerical Model.
  - Study began in 1996
  - Series of reports from 1999 to 2014

Slide 7: Lite & Gannett Accomplishments

- Advancing the Characterization and Understanding of Basin-Scale Groundwater Systems in Complex Volcanic Terrains with Significant Surface Water Interaction.
  - Multiple geologic provinces (Cascade, Basin & Range)
  - Multiple volcanic, fluvial, and lacustrine deposits
  - Multiple tectonic structures
  - Significant groundwater-surface water interaction
- Applying Cutting Edge Scientific and Numerical Tools
  - Geologic and Hydrologic Tools:
    - Surface & sub-surface geologic mapping
    - Surface & sub-surface borehole geophysics
    - Isotopic analyses
    - Satellite imagery
  - Numerical Tools:
    - Most recent numerical tools for groundwater flow, groundwater recharge, and groundwater-surface water interaction.
    - Most recent numerical optimization tools for identifying groundwater management strategies that achieve groundwater management goals
    - Marshall invited to co-teach at the USGS National Training Center in Denver
- Setting the Standard for Successful USGS-State Collaborative Groundwater Studies:
  - Teamwork
  - Communication
  - Applying most current knowledge and tools
  - Solid results that endure and withstand intense scrutiny

Slide 8: Harney Basin Groundwater Study: Overview

- Study officially began December 2016
- Initiated in response to rapid groundwater development in the 1970s and after 2000 resulting in persistent groundwater level decline in some areas causing concern the permitted groundwater use in the basin exceeds the capacity of the resource
- Study goal: improve the understanding of the basin's hydrogeology and water budget sufficiently to inform state and county efforts to manage groundwater use sustainably.
- The study requires characterizing and understanding a basin-scale groundwater system in a complex volcanic terrain with complex groundwater-surface water interaction.
  - Multiple geologic provinces (Blue Mountain, Basin & Range)
  - Multiple volcanic, fluvial, lacustrine, and other deposits
  - Multiple tectonic structures
  - Complex groundwater-surface water interaction

Slide 9: Harney Basin Groundwater Study: Team Effort

- Definitely a federal-state team effort
- Reports Anticipated:
  - Groundwater hydrology (Phase 1)…state rule mandated December 2020 deadline
  - Water Budget (Phase 1) …state rule mandated December 2020 deadline
  - Numerical Model (Phase 2)…anticipated completion December 2022
- State rule requires involvement of a local Citizen Advisory Committee…OWRD-USGS report study progress quarterly, receive feedback, and answer questions
- Includes data sharing and/or coordination with other studies: PSU, UW, DEQ, DOGAMI

Slide 10: Harney Basin Groundwater Study: Applying Best Available Tools (Potentiometric Map)

- Previous studies: control for potentiometric map limited
- Current study: much more input for control:
  - 196 project groundwater measurement wells
  - 194 permit condition groundwater measurement wells
  - Harney Council Watershed Council groundwater measurement wells
  - 2120 OWRD GW database wells
  - 4067 OWRD Well log database wells
  - 2550 springs
  - Survey Grade GPS and Lidar Elevations
  - Available surficial and borehole geology

Slide 11: Harney Basin Groundwater Study: Applying Best Available Tools (Evapotranspiration)

- Previous studies:
  - 1990s:
    - OWRD water right database: POA & POU
    - Tie specific well to specific POU
    - Identify crop type for each POU
    - Apply crop water requirements to calculation
    - Apply irrigation efficiency to calculation
  - 2000s:
    - OWRD water right database: POA & POU
    - Tie specific well to specific POU
    - Satellite imagery to confirm irrigated acres
    - Satellite imagery to identify crop type
    - Apply crop water requirements to calculation
    - Apply irrigation efficiency by irrigation method to calculation
  - Harney Basin:
    - Phreatophytes & Irrigated Agriculture
    - Satellite imagery to identify:
      - ✓ Irrigated acres
      - ✓ Phreatophytes
    - Satellite imagery input to model evapotranspiration
    - OWRD water right database to identify SW acres vs GW acres
    - Tie specific well to specific POU
    - On ground validation:
      - ✓ Pumping measurements
      - ✓ Covariance and/or Agri-Met station measurements

Slide 12: Closing Slide