

# Water Users Perspective on Monitoring of Mitigation and Aquifer Recharge

# Users Groups Differ

## ■ Water Purveyors

- Private water systems (subdivisions)
- Municipalities

## ■ Water Consumers

- General public
- Industrial/commercial

## ■ Agriculture

# Water Purveyors

- Out of state purveyors accepting of broad range of requirements
- Simply want to know requirements so they can determine costs
- Local purveyors resist change
- Both groups want a clear path to end point
- \$\$\$ is the bottom line

# Water Users

- Water quality is the major issue
- Newcomers expect metered water and willing to pay for reliable high quality water
  - Tolerant of rationing
  - Sensitive about water quality
- Locals resistant to metered water
  - View water as a right
  - Expect high quality but not sensitive
- Metering is the cost recovery mechanism if mitigation/monitoring costs rise

# Agriculture

- Cost
- Availability
- Not the same quality concern as others
- Not likely to engage in mitigation or ASR

# ASR USA

## ■ Florida very active

- Minimal requirements upfront
- Rely on pilot/demonstrations
- Lots of surprises
- No clear trends
  - Very limited monitoring by purveyors
  - Gov't projects provide more data, different picture

# ASR USA (cont.)

## ■ Wisconsin experience

- Green Bay trial
- Strong public scrutiny & resistance
- Standard hydraulic investigation
  - Lead to project failure
  - Underestimated importance of injected WQ
  - High arsenic in recovered water
  - Looked good on paper
- \$1,000,000 cost before abandonment

# ASR USA (cont.)

## ■ California

- Use large recharge basins
  - Recharge winter rain
  - Coastal basins under major metro areas
  - Recharge imported water
- Millions of acre/ft recharged and recovered
- Major WQ issues with industrial contamination
- Increased frequency of GW treatment
- Significant public concern/acceptance

# ASR Worldwide

- Australia – active & research orientated
  - Significant work describing hydrogeology
  - Long term water quality reporting
    - Significant list of constituents
    - Trace elements
    - Water quality changes
  - Geochemistry – rock/water interactions

# ASR Track Record

- Florida – mixed result
  - Some good projects
  - Lost water in saline aquifers, to much mixing
  - Radionuclides, arsenic, mercury
- Wisconsin
  - Poor understanding of geochemistry, arsenic
- California
  - regulatory control poor,
  - industrial contamination

# Montana

- Fresh water aquifers
- Mitigation to offset depletion
  - Very different than traditional ASR
  - Water may not be used by proponent
- Control in unconfined aquifers difficult
- BioGeochemistry

# HB 831 Hydrogeologic Requirements

- At odds with current practice
  - Drillers prefer air & driven casing
  - Drillers method prevent collecting quality data required by HB 831
- More detailed subsurface info needed
  - Downhole geophysics & sampling
  - Monitoring at multiple depths
  - Surface geophysics

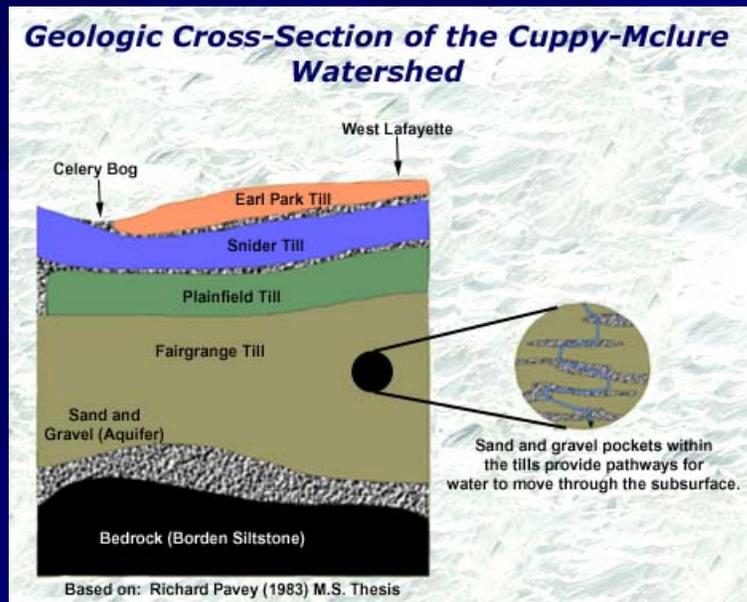
# HB 831 Hydrogeologic Requirements (cont.)

- Requirements typical of investigations in CA, CO, WN, WA, Feds
  - Not codified
  - Negotiated
- Big leap for Montana
  - Practitioners experience limited
  - Practitioners have underlying ability

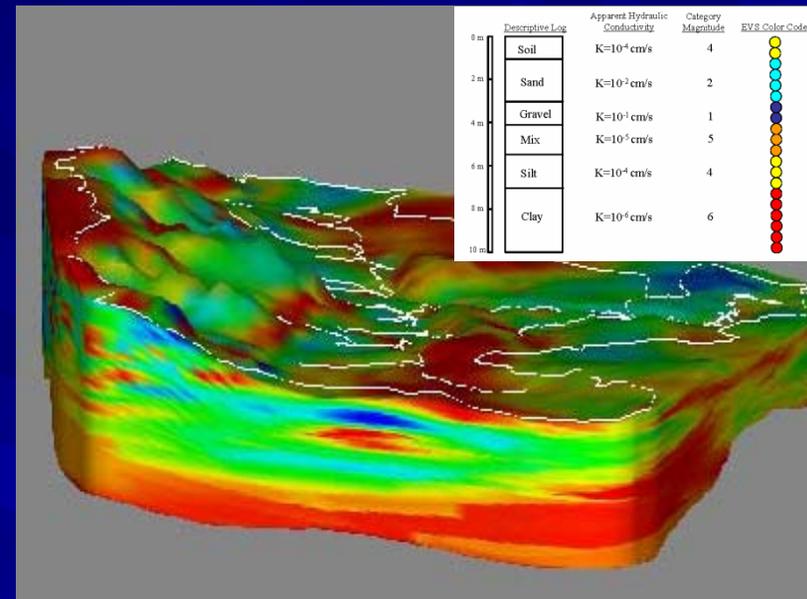
# Montana Hydrogeology

- Homogeneous systems assumed, but
  - Do not exist in the real world
  - Glacial/intermontane - very heterogeneous
- Heterogeneous systems dominate
  - Monitoring for change in water quality difficult
  - GW flow related to aquifer structure
  - Fractured rock aquifers more difficult
- Need to think differently about monitoring

# Two Approaches

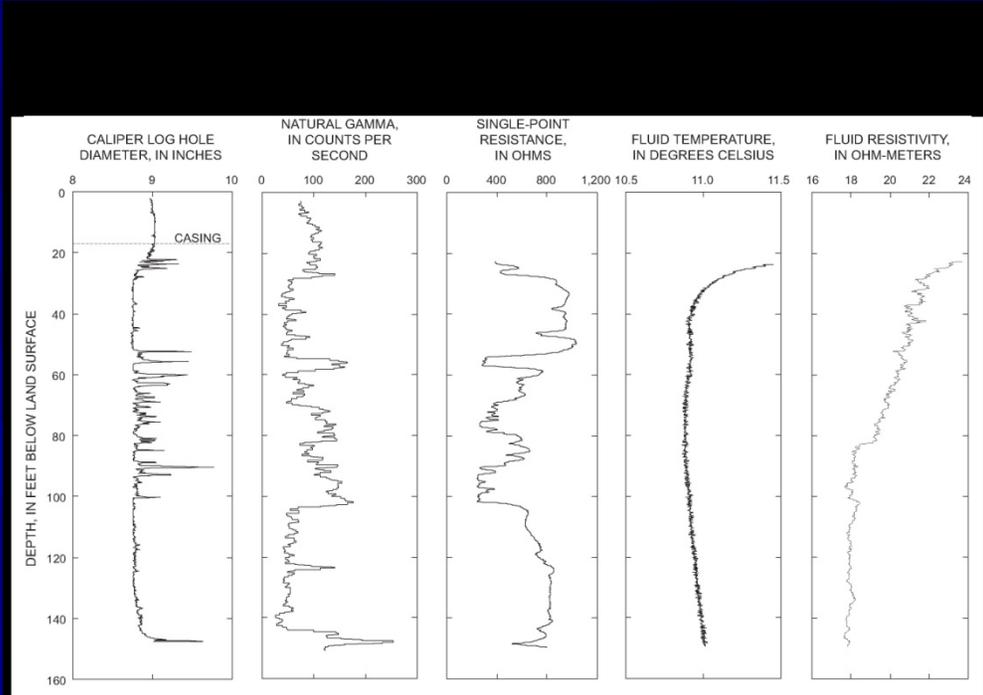
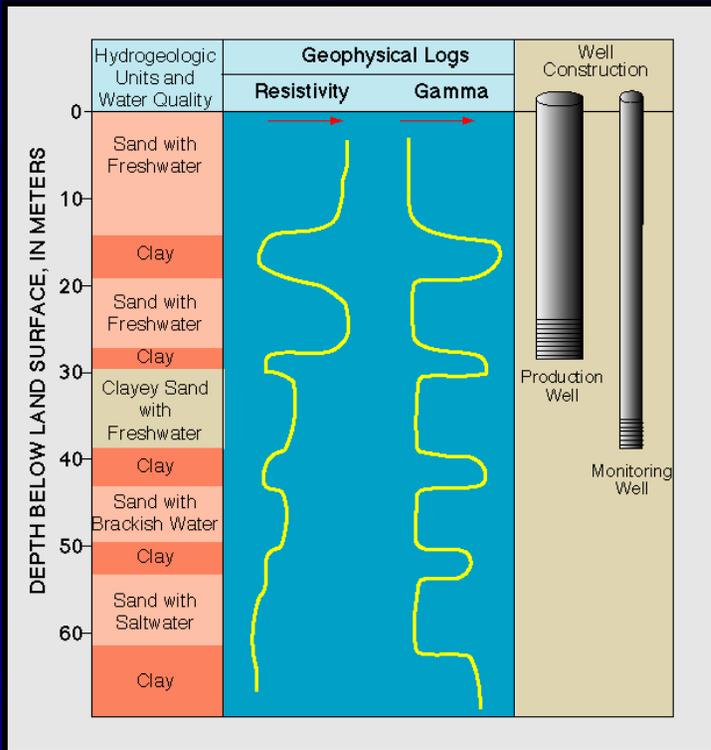


Traditional interpretation based on a few scattered borehole logs

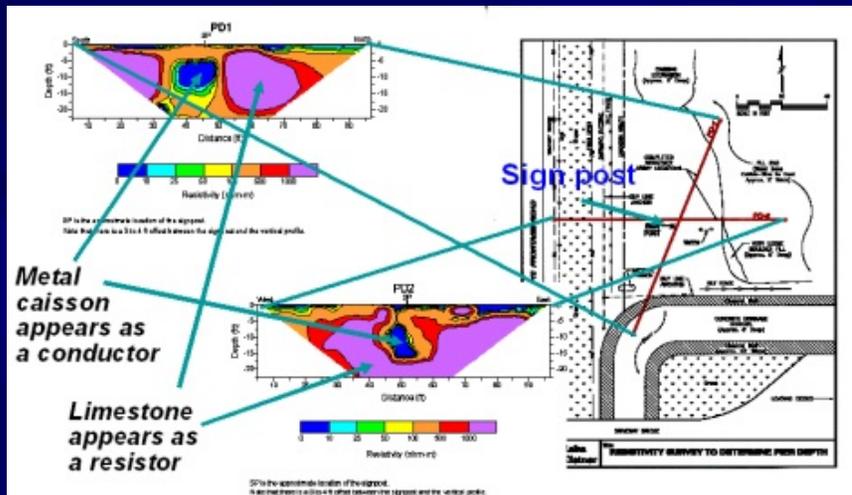


Surface geophysics (ERT) correlated With 243 scattered borehole logs

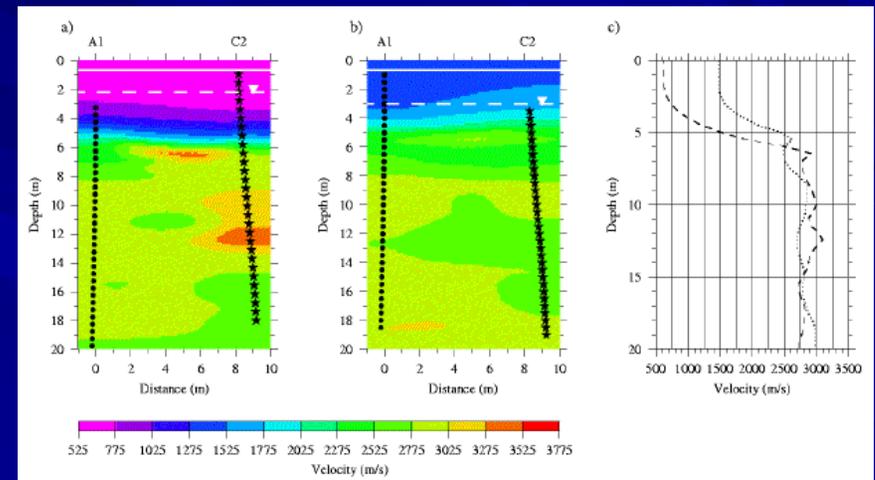
# Borehole Geophysics



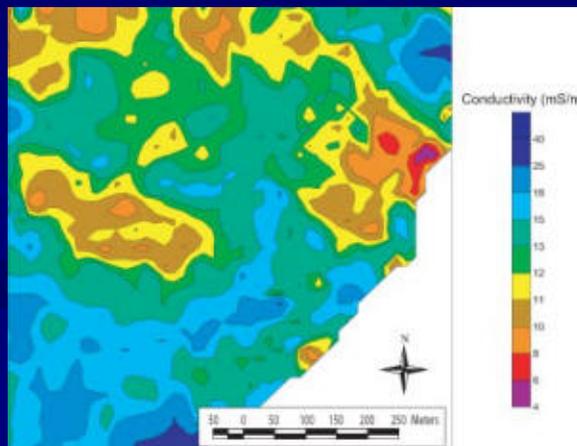
# Surface Geophysics & Tomography



Surface methods indicate variability  
Between boreholes, depth limited



Borehole tomography indicates variability  
Between boreholes, no depth limit



# Point of Detailed Studies

## ■ Water Quality

- Monitoring WQ complex
- Monitoring quantity ~ simple

## ■ Monitoring for Water Quality

- Sensitive to how groundwater flows
- Easy to miss changes if monitoring network not designed correctly

## ■ Successful network is a function of how well hydrogeology understood

# Augmentation by Recharge

- Surface water quality always different than groundwater receiving the recharge
  - Good quality surface water will be more oxidizing than groundwater
  - Water with higher oxidizing potential may cause release of ???
- Monitoring check accuracy of predictions and look for the unexpected

# Augmentation by Recharge (cont.)

- Recharge through injection wells more likely to experience problems
  - Deeper confined basins
- Infiltration basins
  - Generally conducted over unconfined aquifers
  - More like flood irrigation
  - More experience available

# Monitoring Feasibility

- Monitoring possible – many examples of successful programs
- Cost is major issue
  - Capital cost of investigations and network installation
  - Long term cost of water chemistry analysis tends to be greatest expense
- For water quality monitoring expect some degree of monitoring for years

# Who Pays?

- Project owner conducts monitoring
  - Pass through to water users in some cases
- Financial responsibility
  - Owner/user responsibility
    - Sudden need to augmenting quantity ~ easiest
    - Water quality may involve long term treatment
  - Long term liability
    - Groundwater quality problems may last decades

# Dynamic Mitigation Plans & Monitoring

- Iterative process
  - Include backup plans
- Implement proposed plan
  - Monitor performance
- Revise mitigation
  - Revise monitoring if necessary
- Cost cap insurance?

# Prediction & Modeling

- Modeling helps refine prediction about mitigation or augmentation performance
- Monitoring provides proof of performance
- Modeling influences project costs
  - May reduce overall investigation cost
  - May uncover unacceptable uncertainty

# Summary

- HB 831 introduced significant changes to Montana water law
- Provides for a stronger hydrogeologic basis for decisions
- Monitoring for proof of performance
- Improved utilization of water resource
- Water right acquisition \$\$\$