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

- Austrailia – 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

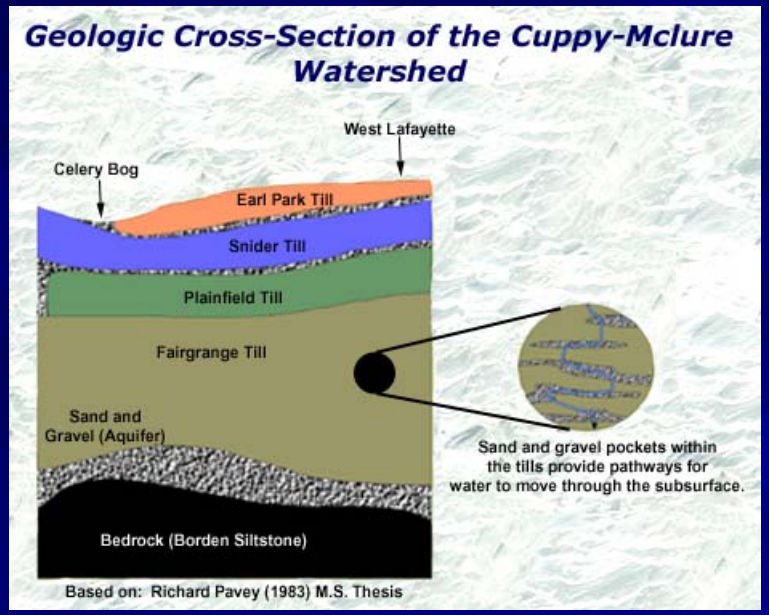
HB 831 Hydrogeologic Requirements (cont.)

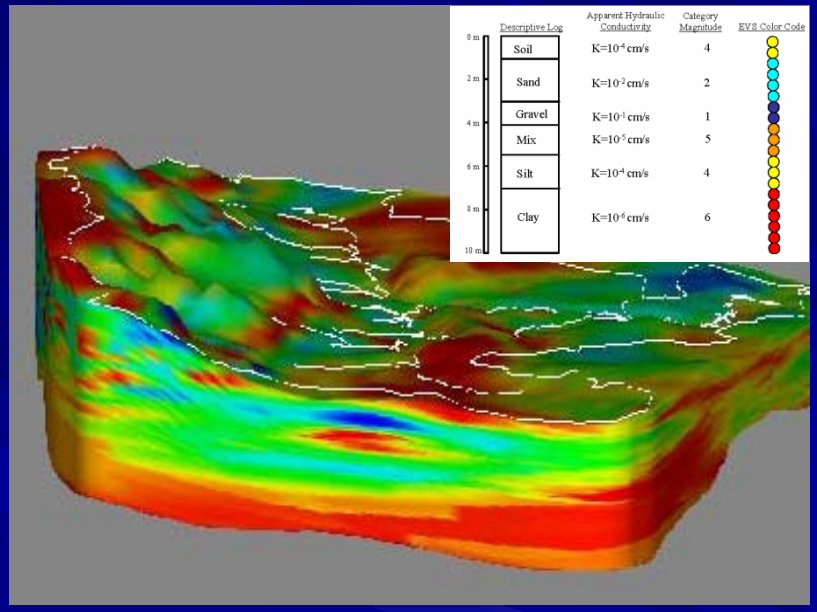
- Requirements typical of investigations in CA, CO, WN, WA, Feds
  - Not codified
  - Negotiated
- Big leap for Montana
  - Practictioners experience limited
  - Practioners have underlying ability

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

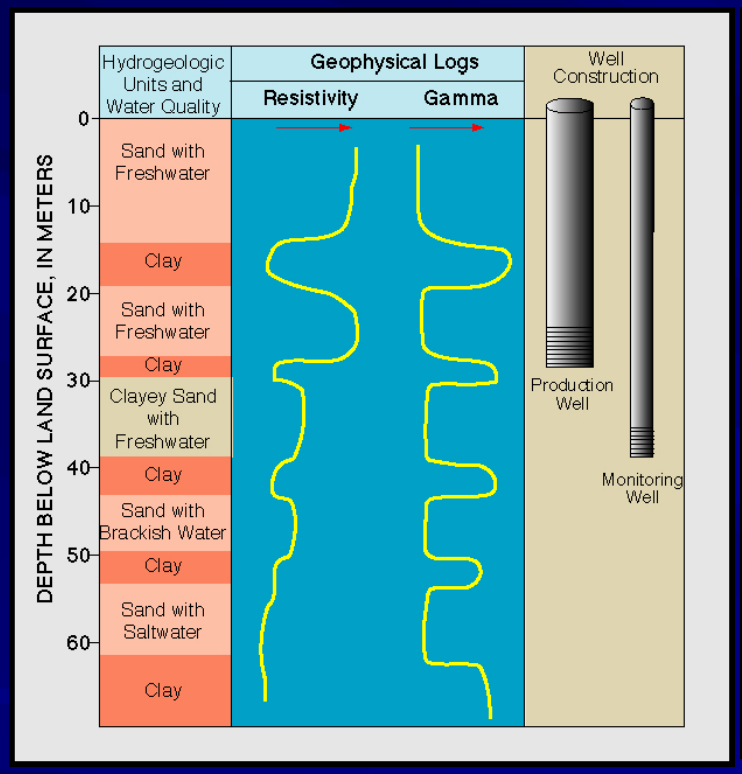


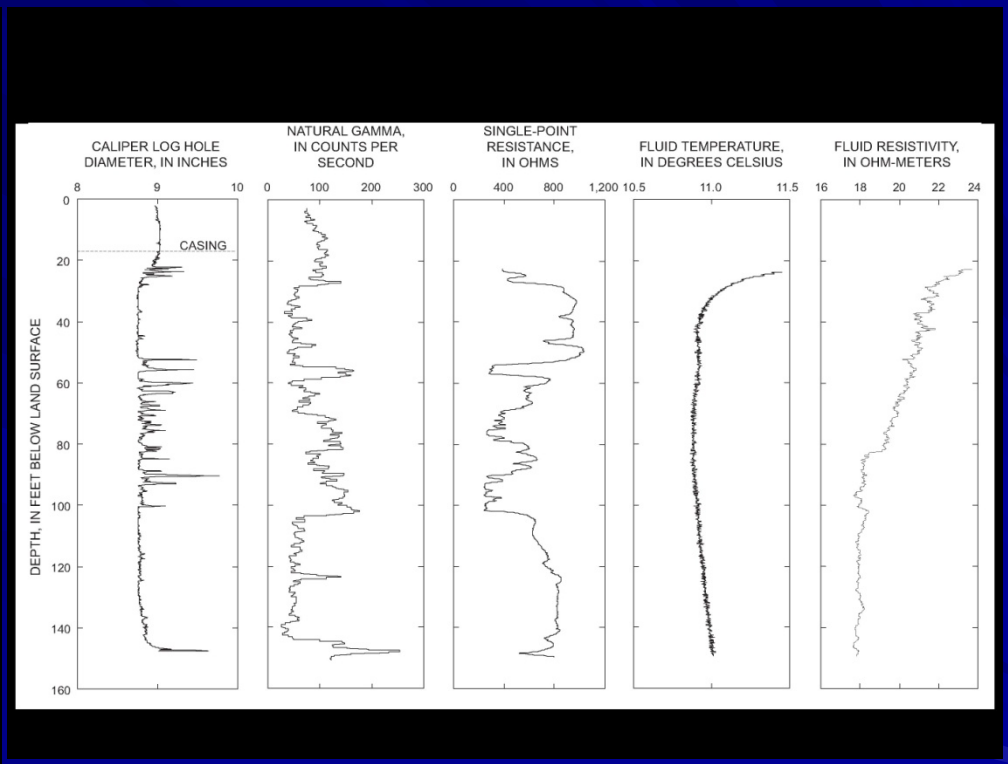


Traditional interpretation based on a few scattered borehole logs

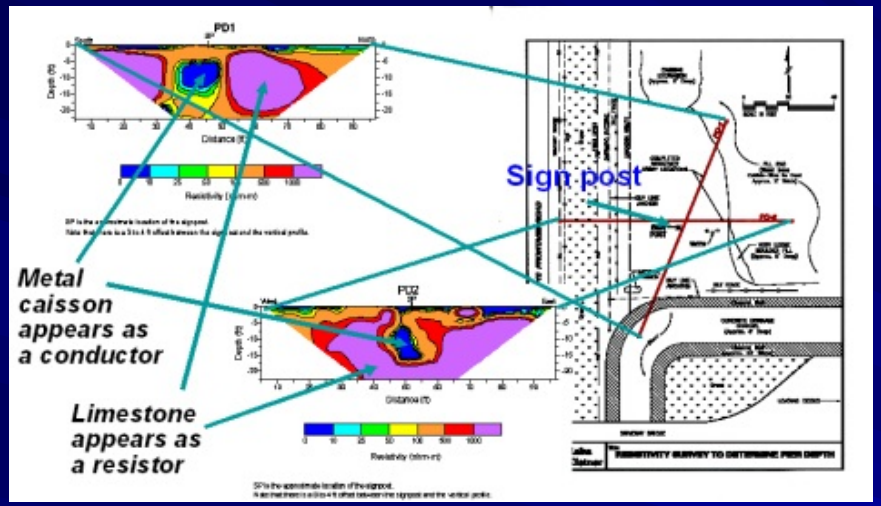
Surface geophysics (ERT) correlated With 243 scattered borehole logs

Borehole Geophysics

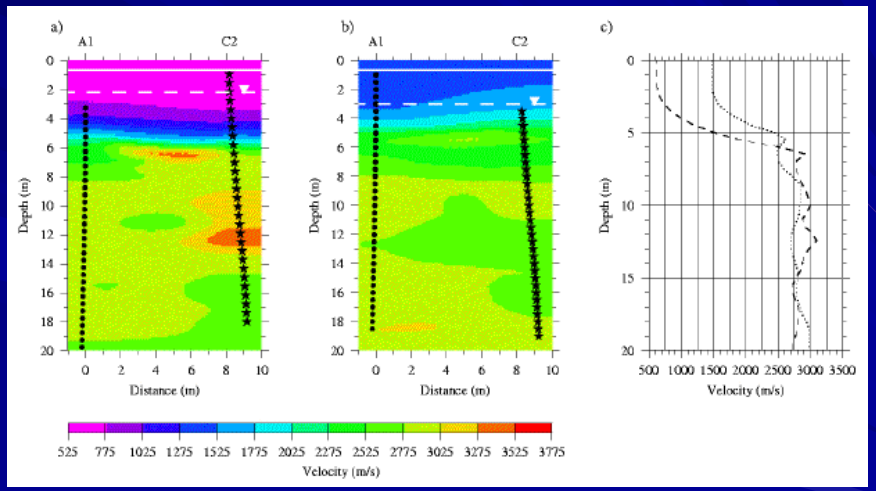


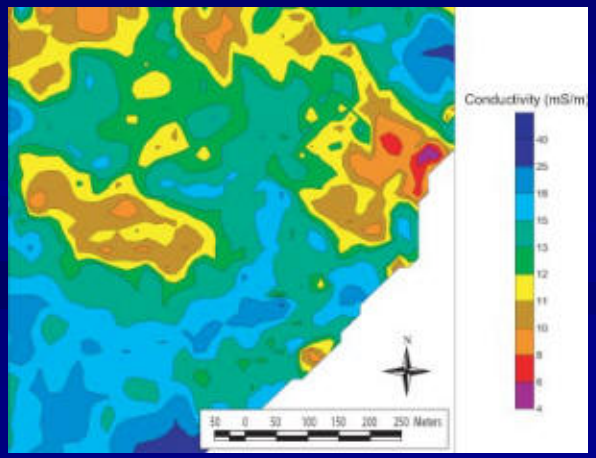


Surface Geophysics & Tomography



Surface methods indicate variability
Between boreholes, depth limited





Borehole tomogaphy 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 $$$