

State of the Art Techniques in Hydraulic Property Characterization and Monitoring for Groundwater Recharge Projects

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ISMAR6 – Phoenix, Arizona**

This short course will cover techniques and methods for characterizing and monitoring vadose zone hydraulic properties. The techniques will be illustrated with case studies. The following is an outline of the course.

I) Characterization and Monitoring in Groundwater Recharge Investigations (30 minutes)

- Why, when and what characterization is needed?
- Why, when and what monitoring is needed?

II) Review of Important Hydraulic Processes (30 minutes)

- Hydraulic properties of porous media:
 - Saturated hydraulic conductivity
 - Unsaturated hydraulic conductivity
 - Capillarity and water movement
 - Water content and pressure potential
 - Moisture retention characteristic relation

III) Hydraulic Parameter Characterization (30 minutes)

- What are the characterization goals?
- The pyramid approach for representative sample collection
 - Physical->Saturated hydraulic tests-Unsaturated tests (cheap -> expensive)
 - Integration of laboratory and field testing
 - Hydraulic Parameter Scaling

BREAK (15 minutes)

IV) Near-surface Field Methods for Hydraulic Characterization (60 minutes)

- Hydraulic conductivity
 - Cylinder infiltrometers
 - Permeameters
 - Others?
- Bulk density (nuclear density gage and cone penetrometer)
- Small infiltration basins

- Recommendations for near-surface hydraulic testing
 - When to use what test and case studies

V) Sub-surface Methods for Hydraulic Characterization (60 Minutes)

- Drilling/Coring to minimize sample and formation disturbance

- Sample collection and logging
- Geophysical techniques
- Borehole instrumentation for in-situ sampling and testing
 - Nested water and air piezometers
 - Nested vacuum lysimeters
- In-situ testing methods
 - Borehole permeameter
 - Atmospheric pressure wave air permeability

- Recommendations for subsurface methods
 - When to use what test and case studies

LUNCH (75 minutes)

VI) Laboratory Methods for Hydraulic Characterization (30 Minutes)

The sample type defines the method:

- Saturated hydraulic conductivity
- Moisture retention characteristics
- Unsaturated hydraulic conductivity
- Effective porosity/specific yield
- Leaching studies (water quality)

Recommendations for near-surface hydraulic testing
When to use what test and case studies

VII) Integration of Test Results and Modeling (60 minutes)

What do the results really mean?
Building the conceptual model
Case Studies

BREAK (15 minutes)

VIII) Subsurface Monitoring – Pilot or Full Scale Project (90 minutes)

Planning for instrumentation and monitoring

Groundwater monitoring

 Continuous elevation, temperature and EC

 Water quality

Vadose zone monitoring –

 Pressure potential (advanced tensiometers)

 Other sensors

 Water content (neutron logging)

Recommendations for instrumentation and monitoring

 Where and when to monitor

 Instrument calibration issues

 Data collection and automation

 Calibration and integration with other data

 Case studies

The course will be conducted by the following personnel of GeoSystems Analysis, Inc.



Robert C. Rice

Mr. Rice is GSA's hydraulic conductivity testing expert. He has spent over 40 years developing methods to measure the hydraulic conductivity and other properties of soils and aquifer material. The methods he helped develop are accepted by government agencies, engineers, and scientists throughout the United States. In addition, Mr. Rice's extensive research and practical applications in groundwater recharge and soil-aquifer treatment, have received world-wide recognition. He has also conducted extensive research on spatial variability of solute transport and preferential flow phenomenon in the vadose zone.



Dale P. Hammermeister, PhD

Dr. Hammermeister has 29 years of experience designing and implementing site-characterization investigations to determine hydrogeologic processes in soil and water in a variety of settings throughout the western United States. He has directed numerous hydrogeologic and geotechnical investigations related to groundwater recharge and waste disposal. As part of this work he has developed special expertise in characterizing and monitoring flow and transport in both the unsaturated and saturated zones.



Michael A. Milczarek

Mr. Milczarek has more than 18 years' experience developing, implementing, and managing vadose zone, hydrogeologic, and geochemical studies. He has a broad range of expertise in vadose zone hydrology, aqueous chemistry, and hydrogeologic investigations. Most recently, Mr. Milczarek has been responsible for evaluating surface water capture and groundwater recharge systems, designing in-situ vadose zone and groundwater monitoring systems, and evaluating groundwater quality impacts from enhanced and artificial recharge projects.