Artificial Recharge of Ground Water Workshop
October 28, 2007 ♦ Phoenix, Arizona

Presented by Herman Bouwer and R. David G. Pyne

Course Description

The need for enhanced recharge of ground water is increasing worldwide as populations and water demands increase. Water resources are finite and subject to change as climates may change, and dams for surface storage are increasingly difficult to build because of site limitations and unfavorable environmental, technical, sociocultural, and sustainability aspects. Also, evaporation losses cause dams to be inefficient for long-term storage which may be necessary to cope with changes in climate.

Enhanced or artificial recharge systems are engineered systems where surface water is put on or in the ground for infiltration and subsequent movement to underlying ground water, or put into wells for direct injection into aquifers. Their main function normally is short or long-term storage of water. Other objectives or side benefits include reduction of sea water intrusion or land subsidence and quality improvement of the water as it flows through vadose zones and aquifers. This so-called soil-aquifer treatment or geopurification plays an important role in water reuse, especially where sewage effluent is used for potable purposes. Artificial recharge systems are interdisciplinary and their design and management are based on geology, geochemistry, hydrology, engineering, and biology principles. Social aspects such as public involvement and public acceptance can also be very important.

This course includes discussions of the various recharge processes (natural, incidental, enhanced, induced, artificial), the types of systems for artificial recharge, (surface basins, vadose zone trenches or shafts, wells), physics of infiltration of water into soil, measuring infiltration rates for recharge system design, formation of clogging layers at the infiltrating surface, flow through the vadose zone, development of perched ground water, ground water mounding, water sources, including sewage effluent, soil-aquifer treatment processes, role of recharge in water reuse, use of floodwaters for recharge, and pretreatment of water. Well recharge will also be discussed, including types, objectives, and sources of water for well recharge systems.

The course will lead the participants through the planning, designing, operating, and management phases of systems for artificial recharge. Principles will be illustrated with practical examples.

What You Will Learn

- How to select sites for artificial recharge
- How to select the best system
- How to predict infiltration rates and hydraulic capacities
- How to predict effects of water depth in basins and ground water levels on infiltration rates
- How to predict perched and ground water mounding
- How to use pilot systems
- How to design large scale systems
- How to manage clogging in surface systems and wells
- How to design and manage recharge systems for soil-aquifer treatment and water reuse
- How to design and manage aquifer storage recovery wells

Learning Objectives

This course will give the participants a working knowledge of how to plan, design, and manage systems for artificial recharge of ground water and their role in integrated water management. Intensive interaction between participants and instructors is encouraged. Presentations will be illustrated with slides and field experiences.

Education Level

The course is designed for introductory and intermediate professionals. Because artificial recharge of ground water is interdisciplinary, some conceptual knowledge about geology, underground water movement, chemistry, and microbiology is desirable.

Who Should Attend

- Engineers, hydrologists, geologists and public health officials
- Consultants and planners
- Water and waste water specialists in municipalities, water districts, and state and federal government agencies

What You Will Receive

- A notebook with reprints of pertinent articles on artificial recharge of ground water, including review papers

Course Instructors

Herman Bouwer, Ph. D., P.E. is a ground water consultant and past chief engineer and director of the U.S. Water Conservation Laboratory, ARS-USDA, Phoenix, Arizona, where he worked for 42 years until his retirement in early 2002. He is also a faculty member of the University of Arizona, Tucson, and Arizona State University, Tempe, where he has taught a ground water hydrology course for about 20 years. He developed the Bouwer and Rice equation for performing slug tests, and authored more than 300 publications including 12 book chapters and the textbook *Ground Water Hydrology*. Most of his research work has been on underground water movement with emphasis on artificial recharge, water reuse, and surface and ground water interactions. He has received awards from the American Society of Civil Engineers, including a certificate of appreciation this year for his work on the ASCE Recharge Standards and for teaching courses in artificial recharge. He also received a certificate of appreciation from the Arizona Hydrological Society in 2001 for "contributions as a pioneer in ground water recharge in Arizona." Other awards have been from the American Society of Agricultural Engineers, the U.S. Department of Agriculture, the National Ground Water Association (1992 Honorary Life Membership), the Arizona Hydrological Society (1997 Lifetime Achievement Award), the 2004 Prince Sultan Bin Abdulaziz International Prize for Water of Saudi Arabia in the Groundwater Branch, and appointed Honorary Diplomate in the American Academy of Water Resources Engineers in 2005.

R. David G. Pyne, P.E. is president of ASR Systems LLC. He has pioneered the development of aquifer storage recovery technology during the past 25 years, and has either directed or participated in the development of a majority of the more than 50 operating ASR systems in the United States, plus several in other countries. He is the author of *Groundwater Recharge and Wells: A Guide to Aquifer Storage Recovery*, which is the only book published on the subject of ASR. He has authored numerous papers and presentations, and has provided consultant and turnkey ASR project delivery services throughout the United States and many other countries. Three of the ASR projects that he has directed or in which he has participated have received major national awards from the American Consulting Engineers Council Engineering Excellence Competition. He is currently heavily involved with the extension of ASR technology to other countries, and with the proposed subsurface storage of treated surface water in the United States as a cost-effective and environmentally desirable alternative to surface reservoir storage.