Aquifer Storage and Recovery Optimization

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Abstract. Increasing demands for water and finite resources are driving a need for more efficient water storage systems. An emerging strategy is aquifer storage and recovery (ASR). With ASR, seepage and evaporation loses can be minimized. Furthermore, peak capacities of key infrastructure elements such as surface water storage, water treatment plants, and pipelines can be reduced. Unfortunately, resolving necessary infrastructure and timing of aquifer storage and recovery is a complex process. Key factors governing infrastructure and operations include timing of water delivery, water quality, and timing of demands. The focus of this presentation is to discuss development of an ASR optimization model that can be used as a tool for developing municipal ASR systems.
The model has two main components: 1) hydraulics and 2) costs. Hydraulic model inputs include: number of years for system operation, per capita water demands, irrigation water demands, the initial population, population growth rate, the reservoir stage-storage relationship, initial reservoir volume, evaporation and seepage loss rates, and maximum water treatment plant capacity. The outputs of the hydraulic model include: long-term water demands, surface reservoir volumes, volume of delivered water to the water treatment plant, injection/recovery volumes from ASR wells, and resolution of required infrastructure needed for ASR operation. The cost model inputs include: cost per production well, cost per ASR well, capital costs for reservoir construction, water treatment plant construction, pipeline construction, operations and maintenance costs for each component of the water distribution system, and interest rate. The outputs of the cost model include: estimates of the capital costs, operation and maintenance costs, life-cycle costs, and present-worth costs of the ASR system being evaluated. Optimization techniques are applied to the model to minimize the overall cost while optimizing reliability of the ASR system. Different water availability scenarios can be evaluated using the model to determine the optimal pumping/injection schedule as well as provide an estimation of the cost of developing an ASR well field.