ASR Experience in Iowa

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What will we cover?

- Would a PWS want an ASR well?
- Do they work?
- Are there problems?
- What is the regulatory background?
- What does it cost?

What is an ASR Well?

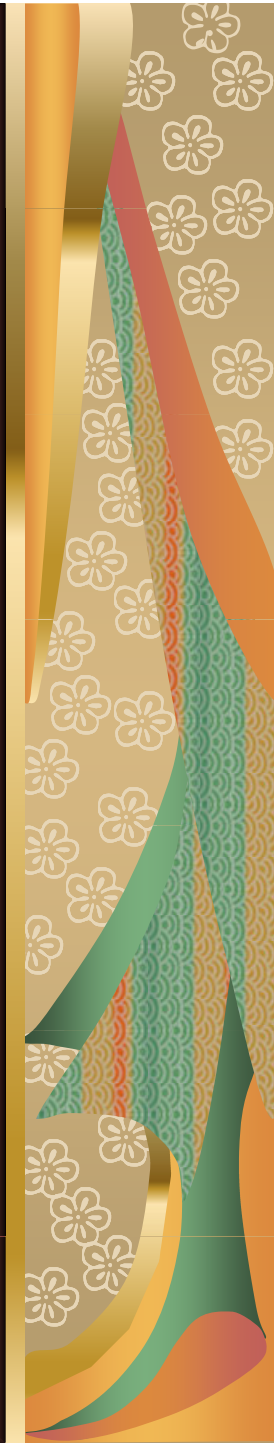
- ASR stands for **A**quifer **S**torage and **R**ecovery (or “retrieval”)
- Typical usage is for temporary treated (excess) H_2O **Storage**, either seasonal or long-term
- This potable water is usually injected via a well as a "bubble“ into a (relatively) brackish water aquifer,

Concept Introduction

- Aquifer storage and recovery (ASR) is H_2O management technology where water is stored underground in suitable wells and recovered at later time from the same wells when water is needed.

National Trends

- In Iowa, ASR is only allowed for potable uses.
- In other States, also used for tertiary effluent disposal and to prevent rocket fuel migration.
- In 1994, 23 ASR systems operational, ~ 40 in development.
- In 2010, ~ 350 operational…
- ASR wells have been operating in Florida since 1983. At least 65 ASR wells in 13 ASR well fields are in operation, and more than 25 other ASR well fields are in various stages of development.
- Less common in Midwest



Why would a PWS want one?

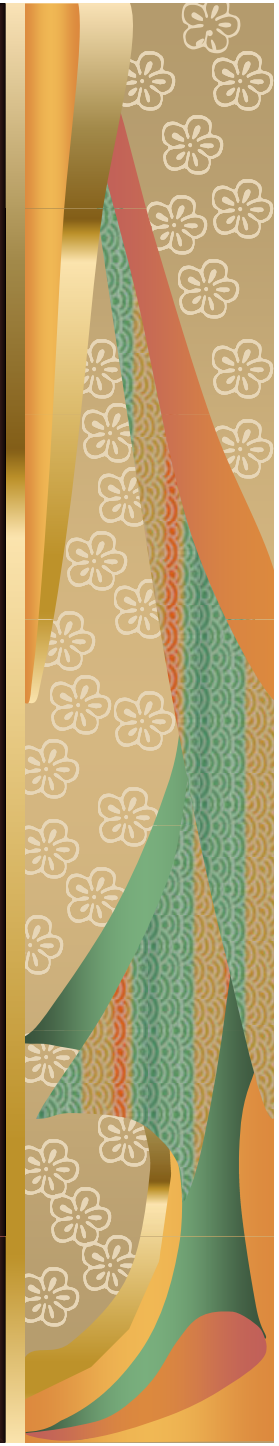
- H_2O systems typically designed to provide source and treatment for Peak Day Use.
- Peak Day Use is Typically 2x Average Day Use.
- Large volume storage can be problematic due to land costs, development demands
- ASR costs “can” be quite favorable

What About Cost?

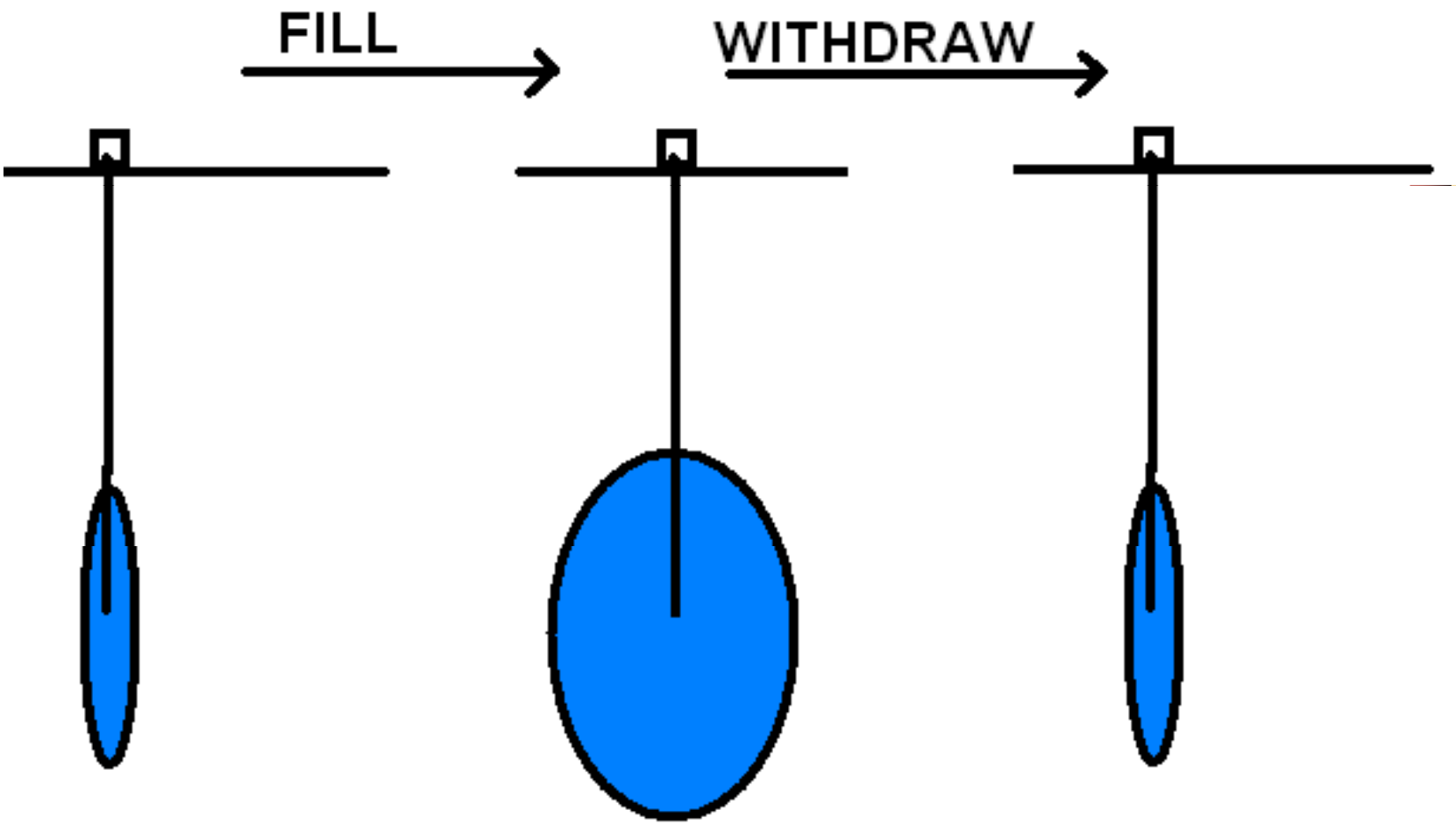
- Current Project in Ankeny for 3 MGD ASR Well has total Construction Cost of About $3 Million.
- Project in North Liberty for 1.7 MGD ASR Well total Construction Cost of About $2 Million
  - Grimes, IA similar
- So In General about $1 per Gallon.
- Using Jordan Aquifer, Cost for Well is ~ ½ of Total & remaining Cost is Pump, Controls, Chemical Feed and “Housing” Building.

Basic Advantages specific to a PWS?

- PWS can treat H_2O at Average Flow Rate
- Excess Treated Flow Down the Well to be Stored in the Aquifer
- When Demand exceeds Average Day Demand, Pump treated H_2O out & into distribution system
- Can help with dry season demand

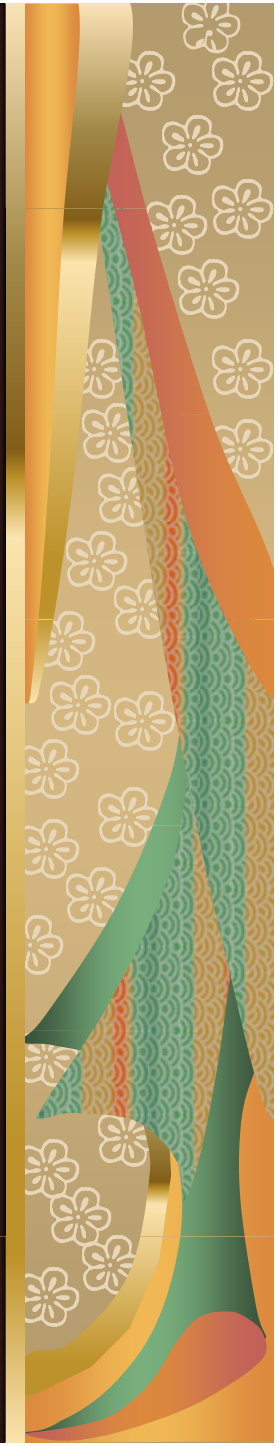


ASR Well Use Cycle Graphic



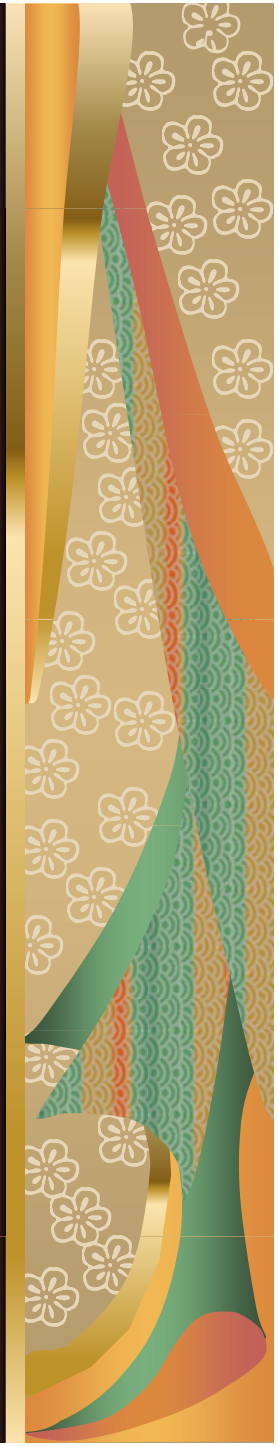
ASR Well Concerns

- Need aquifer to store necessary quantity, & allow recovery at rate needed
- Treated H_2O & aquifer have to be chemically compatible (No Deposition, No Dissolution)
- Need to disinfect again on recovery, possibly add other chemicals



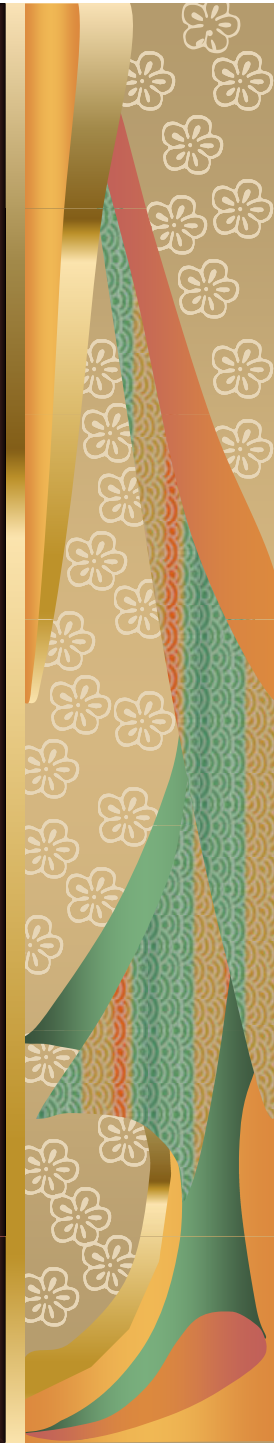
More ASR Well Concerns

- Need access to distribution system for withdrawal and reinjection
- Must consider impacts on nearby users (both permitted & private)
- You don't get all your H_2O back
- Economy of scale – very small systems can't afford



Recovery Efficiency

- Improves with successive cycles. Same volume of H_2O stored in each cycle.
- This is because the residual H_2O not recovered in one cycle tends to form a buffer zone of marginal quality surrounding the stored H_2O in the next cycle.



Building the buffer zone

- Building the buffer zone typically takes 3 to 6 cycles

Quick Rule Credit…

Oregon Water Resources Department, OAR Chapter 690.

Hermiston, OR agricultural ASR caused these rules to be developed. They were adapted from Nevada.

Adapted to fit Existing Iowa H_2O Rights Law (modified riparian).

Fundamental requirements

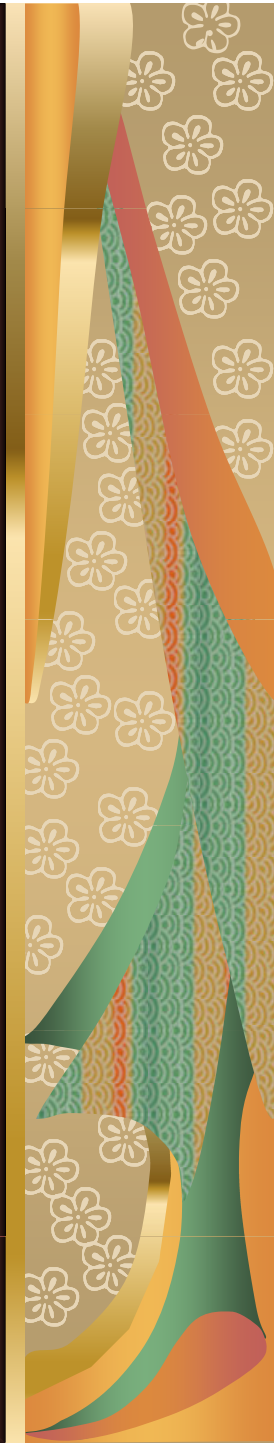
- In Iowa, H_2O which is used for recharging aquifers must meet all primary drinking H_2O quality standards at wellhead prior to recharge.

Iowa's Legislature added...

- Mechanical well integrity concern, without specific instructions…..

IDNR's Safeguards.....

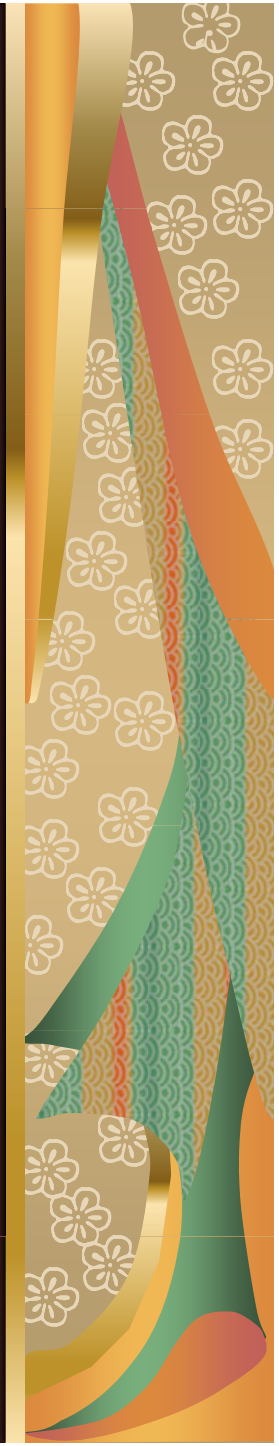
- IDNR won't permit private wells within the storage volume area of an ASR.
- This is recorded with the county recorder.
- IDNR requires permittee to place observation wells if deemed necessary.
- Mechanical integrity definition added.



Failures

Failures

- Green Bay, WI
- White Sands, NM
- Attribute to either geological quality problems or failure to develop wells properly
- Can’t just develop these wells like monitoring wells



Upper casing

The upper casing is cement-grouted into place to prevent "washing" outside the casing due to water levels which can fluctuate by pumping and injection. The upper casing is preferably made of stainless steel, although mild (low carbon) steel is also used to keep costs down.

Injection & downhole valves

The well head piping generally incorporates a magnetic flow-meter which is bi-directional to measure the injection and pumping flows. When water levels are deeper than 20-50 feet, the downhole pump column piping requires a downhole flow control valve and a check valve.

Downhole Control Valves

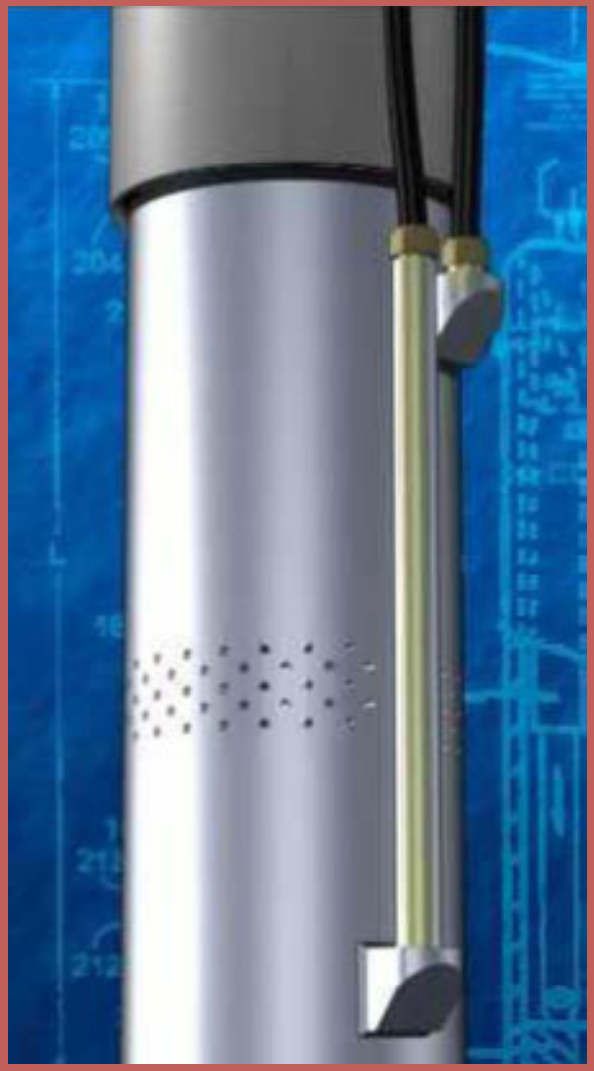
- The SIGNIFICANT advantage of downhole control valves is the small diameter of the valve, and the specialized usage for ASR systems

Suggestions

- Baski, Inc. (Denver) www.baski.com
- VoSmart Valve (Anaheim) www.VoValve.com

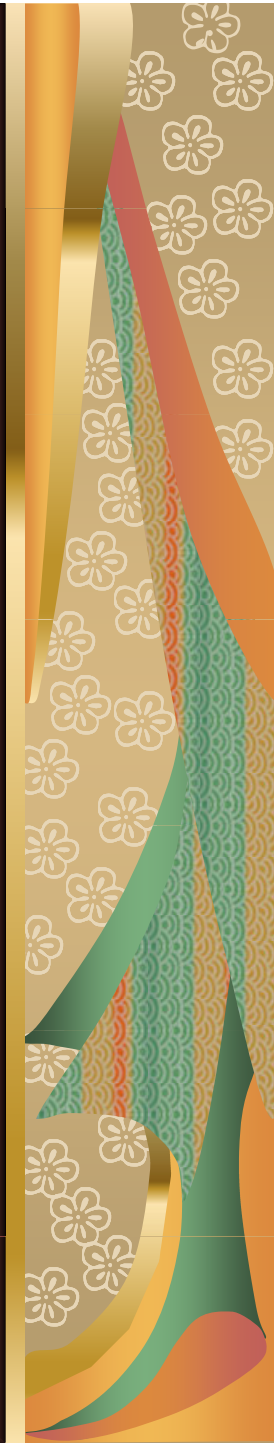
The Baski Valve is a bladder-type design. The VOV valve is an external slide valve.

External view of 3R Valve…



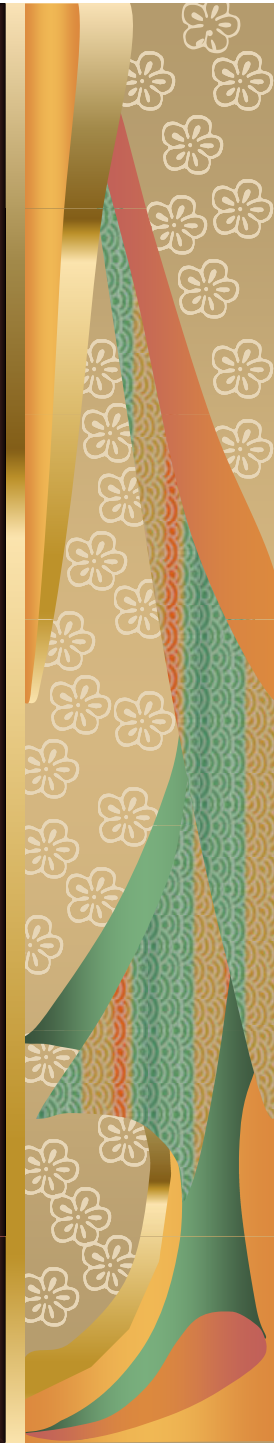
Now, let's talk about preliminary studies

- A hydrogeologic study SHOULD evaluate several subsurface storage zones
- Idea is to select a geologic interval for dispersion
- Won't necessarily be the highest capacity zone -> you're looking for hydraulic properties that emphasize separation of H_2O



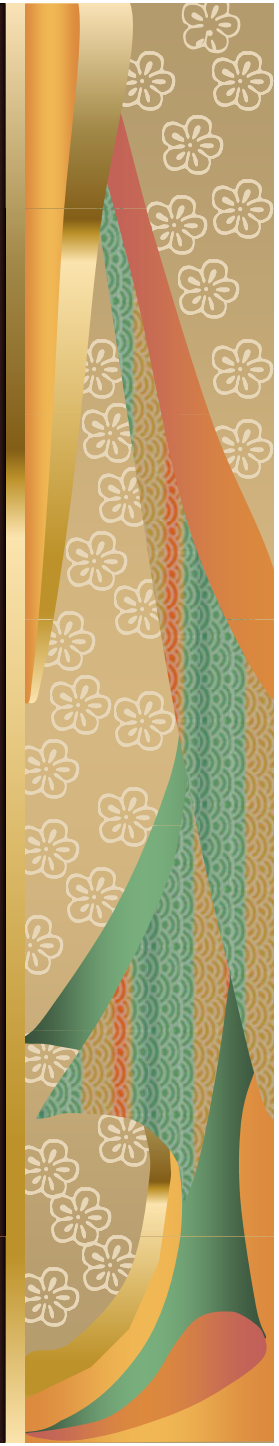
Geochemical & Microbial

- Geochemical and microbial processes tend to occur close to the ASR well
- Usually w/in 10 feet
- In Iowa, biggest concern is Arsenic leaching. That scuttled the “Milford project”.



More detail…

- Research has shown that HAAs disappear within a few days, primarily due to aerobic microbial reactions occurring underground in the ASR storage zone (Dillon et al, in press; Pyne et al, 1996). THM concentrations are eliminated over a few weeks, primarily due to anaerobic microbial reactions w/in a few days after recharge.



Demonstration tests

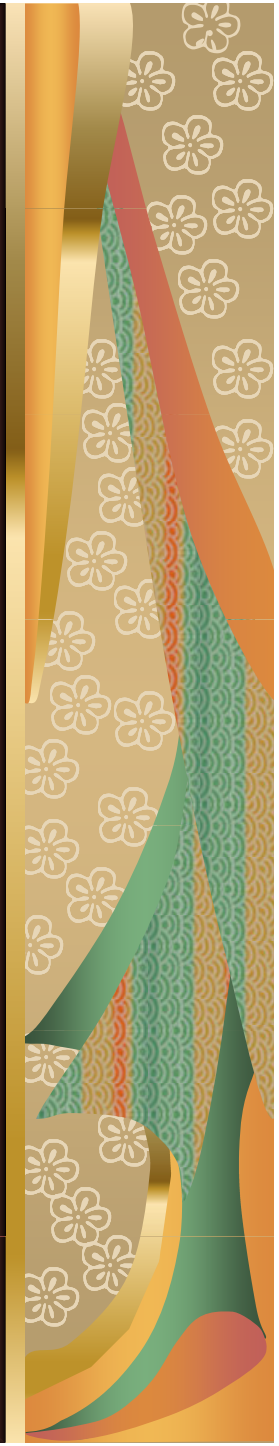
- Process takes a full year (typically)
- Mounding/rise slope/size of bubble
- Clogging (e.g., is it happening?)

What records need to be kept by the ASR permittee?

- Monthly record of injection and recovery
- Instantaneous injection/withdrawal rates
- Total # of hours injected, recovered
- Total metered quantity injected, recovered
- Duration of five years

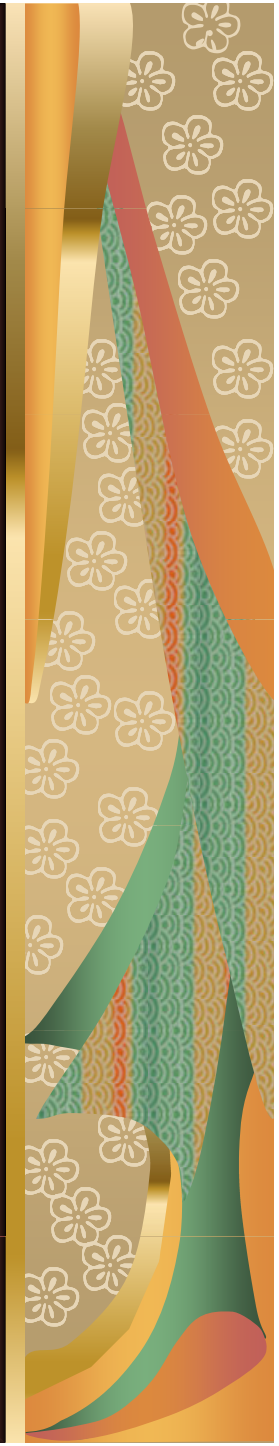
Process in Iowa was driven by the Des Moines Water Works demonstration project at Ankeny

- Cambrian Jordan sandstone aquifer (50 foot thick) --- fine grained sandstone
- City of Ankeny idle production well
- 1995-1998, 4 phases. DMWW spent about 7 months developing the aquifer
- Limited registrations
- Final permit issued in 2008



Ankeny Project Impact

- Transmissivity 13,000 square feet/day
- Measured drawdown and area of influence of the storage volume. No long term regional effect on water levels. Well #5 (1/2 mile west, idle) main monitoring
- Altoona well, 8 miles east.
- Recharge bubble 270-320 feet.
- Lateral migration 4-13 feet seasonally.



How Big is the “Bubble”, commonly?

- In the North Liberty Area – Jordan Aquifer Thickness is 100 ft +.
- At Estimated Jordan Aquifer Porosity of 15% to 25%, the Radius of the Bubble to Store 27 Million Gallons is Between 200 and 300 Feet.

Questions?

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