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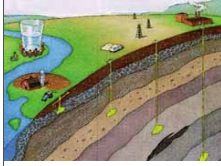
Aquifer Storage & Recovery: Policy Considerations

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1

Acronyms used in this presentation include the following:

ASR	Aquifer storage and recovery
CFR	Code of Federal Regulations
DBP	Disinfection by-product
EPA	United States Environmental Protection Agency
MCL	Maximum contaminant level; specific concentration of a contaminant identified in the National Primary Drinking Water Regulations
SDWA	Safe Drinking Water Act
UIC	Underground Injection Control
USDW	Underground source of drinking water

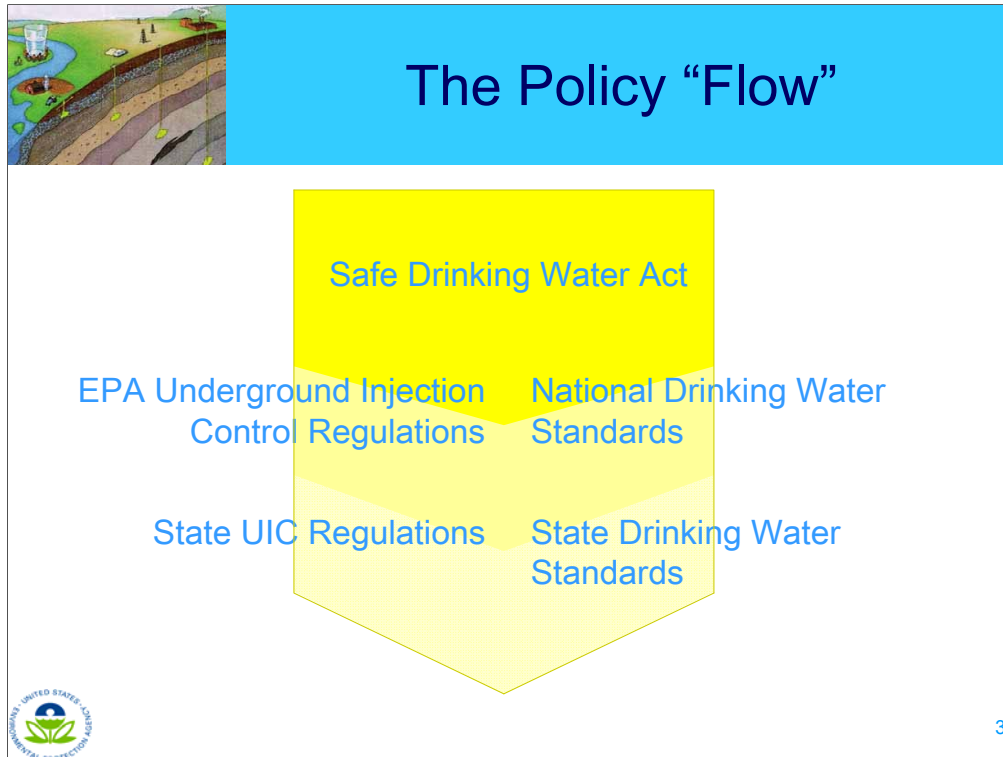


Contents

- Legal framework
- How ASR is Regulated in the UIC Program
- ASR Wells in the US



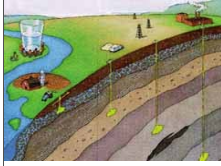
To adequately discuss the policy considerations of ASR, we need to start at the beginning – the Safe Drinking Water Act (SDWA). SDWA is the basis for the way the UIC program regulates ASR injection activities. We'll wrap up with the latest inventory of ASR wells in the US.



The Safe Drinking Water Act (SDWA) was originally enacted by Congress in 1974, and later amended in 1986 and 1996. As the name implies, the law was meant to protect sources of drinking water – both surface and ground water. SDWA required EPA to develop minimum federal requirements for injection practices that protect public health by preventing injection wells from contaminating underground sources of drinking water (USDWs). Injection wells are overseen by either a state agency or one of EPA's regional offices. States and tribes may apply for primary enforcement responsibility, or primacy, to implement the UIC Program within their borders. In general, state and tribal programs must meet minimum federal UIC requirements to gain primacy.

The drinking water standards that EPA's Underground Injection Control (UIC) program uses are the National Primary Drinking Water Regulations, also authorized by SDWA. States (including territories) and authorized Tribes may have drinking water standards that are even more stringent than the National regulations if they choose. States that have primacy for their UIC program and their Public Water System program use their State Drinking Water Standards in considering whether an injection well may endanger USDWs.

The flow from Congress-enacted statute to Federal and State policy is a matter of details. Congress provided a framework for protecting drinking water sources in the SDWA, and EPA was instructed to fill in the details and implement the program. States may choose to add more detail beyond EPA's implementation strategy, but State regulations must be at least as strict as federal regulations.



Legal Framework

- Safe Drinking Water Act Section 1421(d)(2)
 - Endangerment occurs if injection “...may result in the presence...of any contaminant in underground water”
- UIC regulations 40 CFR 144.12
 - No owner/operator may perform an “injection activity...that allows the movement of fluid containing any contaminant into underground sources of drinking water”



4

Section 1421(d)(2) of the SDWA defines the term endangerment as follows:

“Underground injection endangers drinking water sources if such injection may result in the presence in underground water, which supplies or can reasonably be expected to supply any public water system, of any contaminant, and if the presence of such contaminant may result in such systems not complying with any national primary drinking water regulation or may otherwise adversely affect the health of persons.”

The UIC regulations, as developed to implement the requirements to protect USDWs (Part C of the SDWA), clarify the statutory requirements further and read, at 40 Code of Federal Regulations Section 144.12 (a), as follows:

“No owner or operator shall construct, operate, maintain, convert, plug, abandon, or conduct any other injection activity in a manner that allows the movement of fluid containing any contaminant into underground sources of drinking water, if the presence of that contaminant may cause a violation of any primary drinking water regulation under 40 CFR Part 142 or may otherwise adversely affect the health of persons.”



UIC Class V Wells

- ASR wells are part of the Class V universe
- Class V Injection Wells
 - Characterized by the fluids they do NOT receive
 - Rule-authorized until permitted
 - Owner/operator must submit inventory info
 - May not endanger USDW



5

Injection wells used for ASR are classified as Class V wells under EPA's regulations. EPA has no UIC regulations that are specifically for the operation of ASR wells.

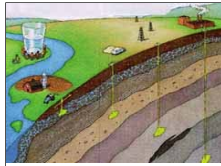
UIC Class V wells are broadly defined by the types of fluids they do not receive. Class V wells inject non-hazardous fluids unrelated to industrial or hazardous waste disposal, oil and gas production, and solution mining. Many Class V wells inject fluids above USDWs, but some Class V wells are much deeper therefore construction requirements as determined by the UIC director are well-specific and broad-ranging.

Under EPA's UIC regulations and State regulations that conform to EPA's regulations, Class V wells are authorized by rule if

- the owner or operator submits inventory information to EPA or a primacy agency,
- the injection activity does not allow the movement of fluid containing any contaminant into USDWs, if the presence of that contaminant may cause a violation of primary drinking water standards or otherwise adversely affect the health of persons. (This applies to well construction, operation, maintenance, conversion, plugging, closure, or any other injection activity.)

The UIC Director may ask for additional information or require the well to be permitted if there is potential for endangerment.

UIC regulations governing Class V wells authorize the Director to take additional actions. Section 144.82(a)(2) provides that "If the Director of the UIC Program in your State or EPA Region learns that your injection activity may endanger USDWs, he or she may require you to close your well, require you to get a permit, or require other actions listed in 144.12(c),(d), or (e)." Section 144.12(c)(1) provides that "...if at any time the **Director** learns that a Class V well may cause a violation of primary drinking water regulations under 40 CFR part 142, he or she shall: (1) require the injector to obtain an individual permit; (2) order the injector to take such actions (including, where required, closure of the injection well) as may be necessary to prevent the violation...; or (3) take enforcement action." [40 CFR 144.12(c)] Sections 144.12(d) and (e) authorize additional actions if the Class V well is otherwise adversely affecting the health of persons or if there is an imminent or substantial endangerment to the health of persons.



UIC Regs & ASR

- ASR wells are part of the Class V universe
 - ASR allowed if not endangering
 - UIC only regulates injection, not recovery
- UIC Class V Study (1999) found no contamination incidents
- Contaminants of concern include arsenic, metals, radionuclides, DBPs

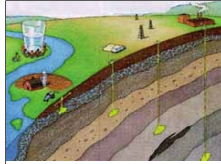


6

ASR injection wells are not prohibited under EPA's UIC program as long as the injection activity does not allow the movement of fluid into a USDW that might cause endangerment.

Many ASR injection wells receive treated, potable water, which meets National Primary Drinking Water regulations at the point of injection, and also recover a high quality product.. No reported cases of contamination from ASR injection activities were reported in the UIC Class V Study published in 1999. Changes in the water quality of a receiving aquifer have been noted, however. In some cases, ambient water quality has improved in brackish aquifers or aquifers with poor water quality.

Since 1999, EPA has become aware of some occurrences of endangerment of USDWs, however. The dissolution of metals such as arsenic, manganese, and iron have been issues in some ASR facilities along the East Coast and northern Midwest. Radionuclides and disinfection by-products are also potential USDW contaminants from ASR injection activities although no such contamination issues have been reported.



Primacy State Regulations

- Sixteen states have ASR regulations (2007)
- State regulations vary regarding injectate quality



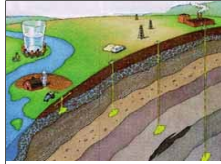
7

Sixteen states had regulations for ASR using injection wells as of 2007. Regulations regarding the quality of water injected varied by State with some states requiring treatment to meet state or federal standards, “fully consumable and/or reusable”, or no requirement to meet standards. States allowing the injection of effluent for ASR have specified effluent be treated to State primary standards or recycled water criteria. Types of injectate used in ASR include treated and untreated surface and ground water, reclaimed water, and effluent.

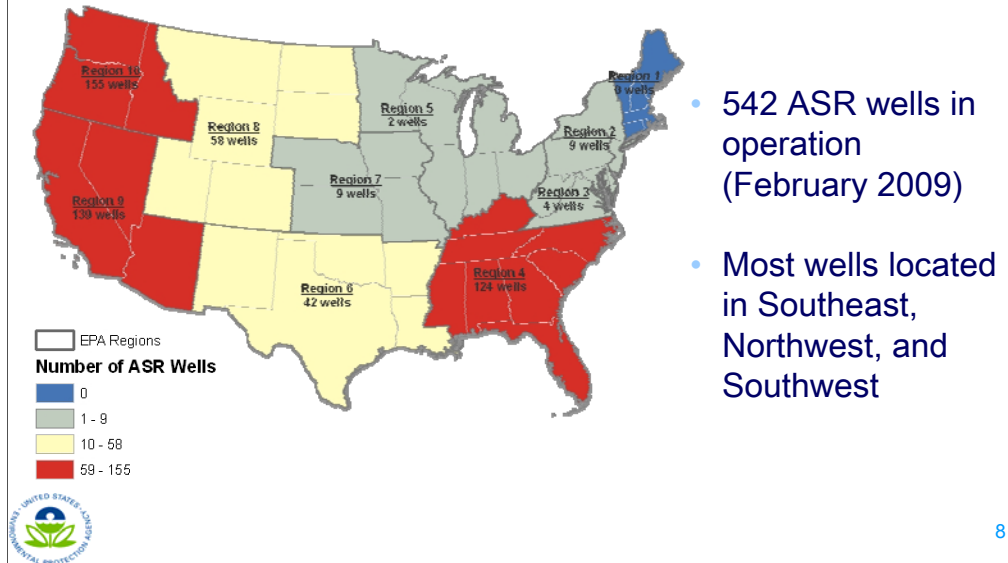
However, State regulations do not supercede the requirements of the primacy UIC program and SDWA that the injection activity does not endanger USDWs.

Some states also have regulations that address the following:

- Detailed permitting processes
- Pilot study, system development, and ASR operation requirements
- Restriction of ASR to municipal systems
- Facility operations
- Prohibition of ASR in certain areas, e.g. agriculture water use



ASR Wells in the US



Five hundred forty-two ASR wells are operating or capable of operation in the US as of February 2009. The majority of the wells are located in the Pacific Northwest, Southwest, and Southeast US (denoted in red on the above map; EPA Regions 4, 9, and 10).



Final Observations

- ASR is a growing industry
- Further inquiries
 - Well screen clogging and recovery rates
 - Geochemical interactions
 - Disinfection by-products
 - What practices are working
- We all want safe drinking water!



9

Increasing demands on water supply from growing populations and static or decreasing water resources are causing communities to reassess their future strategies for providing drinking water to citizens. ASR is therefore becoming a mainstream option for water management in many areas of the US.

With growing use of ASR, concerns and technical issues arise. Further inquiry into the following issues is warranted:

- Well construction design and testing requirements;
- Potential failure issues associated with the conversion of wells from drinking water withdrawal wells to ASR;
- Potential for particle rearrangement and aquifer porosity alteration in the aquifer due to injection and withdrawal;
- Trihalomethane degradation and concentration in aquifers with ASR wells;
- Leaching of metals from aquifer materials due to ASR wells; and
- Gathering and sharing of any additional lessons learned which will help in improving how AR and ASR wells are regulated

Regulators, operators, and consumers all want a high quality, reliable source of drinking water!