ASR Policy Overview

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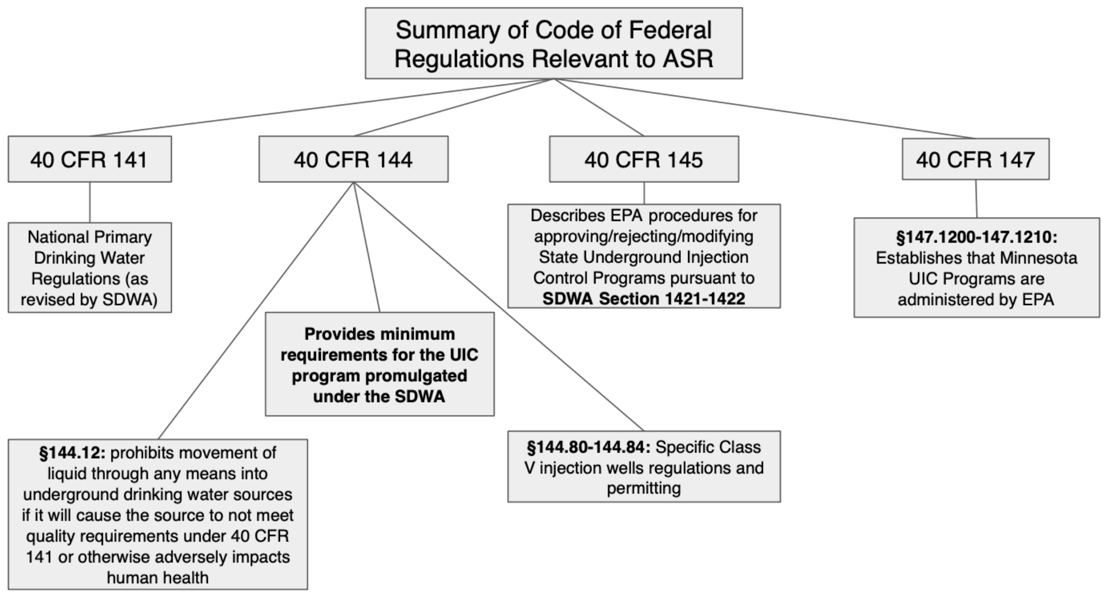
In conducting a policy overview of aquifer storage and recovery (ASR), existing and proposed policies for ASR and managed aquifer recharge (MAR) were identified on multiple jurisdictional levels. This research centered mainly on ASR policies and regulations with a more general overview of MAR. Policies and their interactions were identified on international, national, state, regional and local levels. These policies were then considered in the context of seven assorted ASR case studies across the United States.

Policy review also considers drivers and barriers for implementation, specifically the establishment of ASR projects. Common policy drivers for ASR include the need for long term, high capacity storage of water in order to address drought resilience as well as the ability to meet peak demand, especially seasonally and where population pressures begin to exceed treatment plant capacity. Existing rules and regulations on multiple levels, but commonly state level, can be preventative or prohibitive. The possibility of adverse chemical interactions with the injection of non-native water into native groundwater must be considered as must the suitability of an identified aquifer for ASR activities. Community relations and anticipated trans-boundary impacts on water quality from ASR projects may also be barriers. An expanded discussion of drivers and policies is found later in this section.

Policy alternatives to ASR should be considered to provide context for the decision-making process. Some alternatives include above-ground water storage (i.e. storage in reservoirs and storage tanks) and the expansion of existing water-treatment facilities or construction of new ones to meet demand. The policy decision-making process evaluates costs and benefits, and suitability of solutions for the communities in which they are being applied.

Federal policies that impact ASR

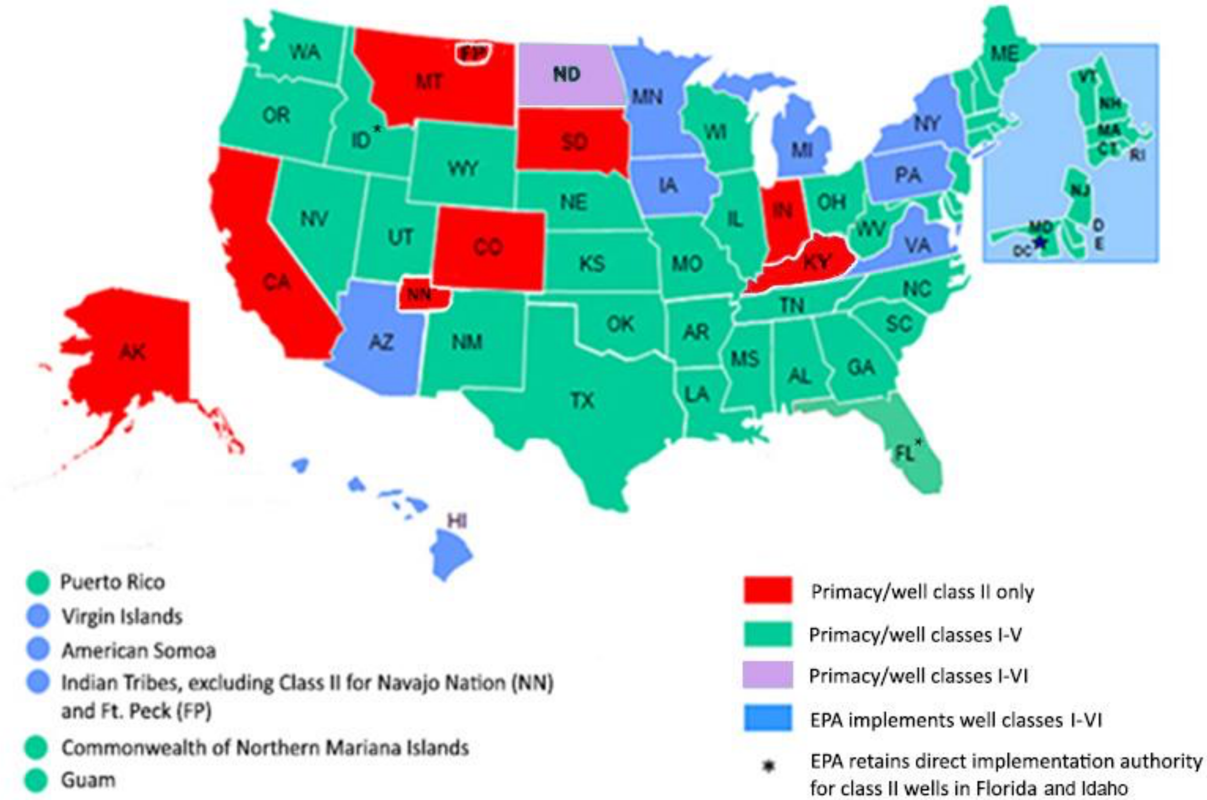
The United States Environmental Protection Agency (USEPA) houses the Underground Injection Control program (UIC), established under 40 CFR 144-148. (CFR refers to Code of Federal Regulations.) Injection wells are separated into six classes based on context of usage; ASR wells are classified as Class V wells under the UIC (EPA Underground Injection Control, n.d.). As of 2013, 204 ASR sites exist across 27 different states in the US, though many of these states have only one or two sites and sites may include wells that are no longer operational (Bloetscher, 2014; American Water Works Association Manual M63, 2015). The authority of the Safe Drinking Water Act (SDWA) was used to establish the Code of Federal Regulations (CFR) sections that comprise the UIC program. It is important to note that the UIC program does not regulate infiltration basins, which are used in ASR operations across the country and world (EPA 2016). Figure 1 summarizes CFR related to ASR.



[Figure 1: Summary of CFR related to ASR. Source: EPA, 2016]

Primary enforcement authority or "primacy" over injection wells of any type defaults to the USEPA. Some states have applied for and received primacy over Class V type wells under SDWA 1422. This allows those states to issue permits or approve wells by rule rather than having the relevant regional USEPA office have direct authority. However, state rules and regulations may not supersede the Federal drinking water standards.

The main priority of these Federal policies is protecting and maintaining the quality of underground sources of drinking water (USDW). The injection of water into an aquifer must not cause it to violate National Primary Drinking Water Regulation standards, as revised by the SDWA. Even where sources haven't been formally identified as USDW, they are presumed to be as such if there is any possibility that they may be used as such in the future (AWWA Manual M63, 2015). Some states run joint UIC programs with the USEPA where the state may have primacy for only one class of injection well or for all but one class of injection well (primarily states shown in red in Figure B). Others have UIC programs that are fully USEPA led (blue in Figure B), or fully state-run (green and purple in Figure B). Tribal nations work directly with their region's EPA office, but may also apply for primacy—the Navajo Nation, for example, has Class II primacy.



[Figure 2: Primacy for UIC wells by state, EPA, n.d., accessed 2020.

It is also worth noting that there is significant variety in the structure of drinking water and environmental agencies between states. In Minnesota, for example, responsibilities for water governance are divided by type of water (surface or ground) and the use of that water. For (for example, drinking water is monitored and enforced by the Minnesota Department of Health while water quality concerns with recreational activities such as fishing are regulated by the Minnesota Department of Natural Resources. Wisconsin ASR projects are regulated under the Wisconsin Department of Natural Resources while in Washington State, the Department of Ecology regulates ASR sites. In California, which has a robust permitting and regulation structure despite not having primacy for Class V wells, Regional Water Quality Control Boards oversee local ASR projects under the California Environmental Protection Agency.

State of Minnesota policies that impact ASR

Managed aquifer recharge has only recently been developed in the state of Minnesota. We are aware of only two functional MAR-related projects in the state, only one of which qualifies as ASR.

Minnesota's sole operational ASR facility is located in St. Michael, Minnesota and is run by the Joint Powers Water Board (JPWB) of Albertville, Hanover, and St. Michael. The feasibility of the ASR project was first studied in 2006 and construction of the facility began in 2009 in response to a need to meet peak seasonal demand in summer months when water use is elevated. A series of three pilot studies was conducted between 2009 and 2011 and 8 full-scale ASR cycles from injection to recovery have been completed since 2012.

In order for the JPWB to gain approval and permits to establish the ASR project, they were approved and received a permit from the EPA and also a variance from Minnesota Department of Health (MDH) allowing for the injection of water treated to drinking water standards into the aquifer. Minnesota is not a primacy state for Class V wells, meaning that the Environmental Protection Agency (EPA) maintains primary enforcement authority over underground injection control activities. (Established under 40 CFR 147.1200-1210.) MDH granted a variance to the state of Minnesota's well code, specifically Minnesota Administrative Rule 4725.2050, that disallows wells or borings from being used for injection or disposal of surface water or groundwater. The JPWB did not obtain variances for any water quality standards under MDH.

A more thorough summary of this facility is included as one of the seven case studies in the appendix of the full project report.

The East Bethel Water Reclamation and Reuse Facility is a MAR, however it is not an ASR. This facility has an infiltration pond which infiltrates treated wastewater through shallow, soil-covered basins. The treated effluent percolates through granular material at the bottom of the basins and continues to move through the unsaturated zone before recharging the aquifer. The facility is operated by the Metropolitan Council and there is no intention of recovering the water that they infiltrate, nor are they infiltrating with any goal of remediating or raising the level in the receiving aquifer. Instead, it is simply used as a convenient disposal site.

Local Policies that may impact ASR

This project did not examine specific local or tribal policies that may impact proposed ASR projects. Local policies and regulations or the application of Federal policies such as finding a protected or endangered species during a local site survey, could possibly prohibit or limit the use of ASR. In addition, water management across watershed, aquifer, political and community boundaries could present potential conflicts. Therefore, when future comprehensive site studies are performed for potential ASR development, any tribal and local land use and water management systems and policies need to be examined and included.

Policy Drivers and Barriers for ASR

Drivers

Several aspects come into consideration when debating whether ASR is the correct water-management policy fit for each individual circumstance. The Federal Emergency Management Agency considers the primary benefit of ASR projects to be drought mitigation, however reviews of the literature show broad and varied motivations and drivers to adopt ASR practices (Federal

Emergency Management Agency, 2016). Utilizing pre-existing aquifers for storage instead of using reservoirs or above-ground tanks for water storage can have benefits in reduced water loss to evaporation (circumstantially, depending on aquifer properties) and lower price points (Pyne, 2014; However, Yang and coauthors (2016) note in a report for the USEPA that the value of space to store water in an aquifer is often miscounted for and may be difficult to directly compare. That said, ASR is "often preferred for large-scale, long-term and economic water storage and recovery" to reservoirs or above-ground storage facilities (Yang et al., 2016).

A common policy driver for coastal states considering implementing ASR is the prevention of saltwater intrusion into the groundwater supply due to over extraction and resultant lowering of the water table. ASR using treated water can also be used to improve the quality of a contaminated groundwater source through dilution and mixing. The suitability of the aquifer and compatible source water for recharge must be evaluated to prevent further or new degradation of water quality and must meet standards established under National Primary Drinking Water Regulations and the Safe Drinking Water Act.

Population pressures in rapidly growing areas can put stress on water delivery systems, leading to difficulty meeting peak demand in high water-use summer months. ASR can be used to treat and store excess water during months with greater water availability and lower demand and that excess can be redistributed in the summer months without overwhelming treatment plant capacity and potentially avoiding otherwise necessary costly treatment plant expansions or new developments.

Climate change is encouraging ASR development in many areas as municipalities attempt to increase water security. Shifts in precipitation patterns are expected as a result of climate change. While these anticipated changes vary widely across the US, they are anticipated to add stress to water supplies based on either reduction in net precipitation annually or changes to the timing and intensity of precipitation events—that is to say, a location may be anticipated to have a slight increase in annual precipitation but that precipitation will likely come in intense storms in wetter months rather than providing a steady supply. This relates back to the previous driver where ASR can be used to address that seasonal peak demand using water treated earlier in the year. Many if not most ASR projects do not withdraw an amount greater than 95% of the water they inject, with the goal of providing a buffer amount and in some cases achieving longer-term aquifer recharge.

Barriers

Cost is the most immediate, pressing consideration and barrier for ASR projects. This is discussed in greater detail in Section 5; Economic considerations.

Historically, infiltration basins have been used as a primary technique for artificial recharge. However, they require a large surface area which implies the acquisition of significant land area.

Therefore, land availability and cost are often barriers or determining factors for the method of groundwater recharge in an ASR project.

Extensive environmental considerations need to be made. The native groundwater quality should not and often cannot be negatively impacted by ASR operations nor should the health of the users who use the aquifer as a drinking water source. This requires a thorough understanding of the hydrogeochemical properties of the native groundwater as well as the desired source water and their compatibility to avoid contamination or adverse chemical reactions. There are several well documented cases where reactions from the introduction of non-native groundwater into an aquifer rendered the water unusable. For example, in Green Bay, Wisconsin, where a short-lived ASR project was shut down in the early 2000s because of excess levels of arsenic and manganese. A more thorough summary of this facility is included as one of the seven case studies in the appendix of the full project report. Well clogging is also a common cause of failure for ASR projects though technological improvements in the last decades have reduced the incidence of this for newer wells. More information about these environmental and engineering barriers are discussed in Section 3; Environmental and Engineering Considerations.

Water rights can be a barrier to ASR. The permit holder must own or have the right to withdraw the water that has been recharged (US Geological Survey, n.d.). Often regulators will stipulate that some percentage of the injected volume (e.g. >10%) must be left in the ground, in order to promote aquifer surface-level recovery or to create a buffer zone between stored and native groundwater. In order to assert a right to withdraw, the permit holder needs to be reasonably sure that the water they have recharged is the same water that they are withdrawing. This is fairly easily evaluated by the presence of conservative chemicals but can be confounded if the natural groundwater gradient causes the stored water to be less definable and discrete (Freshwater Society, 2013). A lack of control of the injected water can jeopardize the success of an ASR project and may be reason enough to not conduct operations.

Decision-Making for ASR

Deciding on the suitability for an ASR facility or location can be challenging given national and state policies and a variety of drivers and barriers, The USEPA has created a decision support system (DSS) guidance document (EPA 2016, Figure C) to aid in the process of evaluating ASR as an option. Additionally, the Federal Emergency Management Agency produced a suggested methodology for benefit-cost analysis of individual ASR projects, and suggests that all environmental and hydrological impacts must be considered. The benefits and barriers discussed above should be included to complete an accurate analysis.

A more thorough discussion of the economics and cost-benefit calculations is included in the Economics section of the full report.

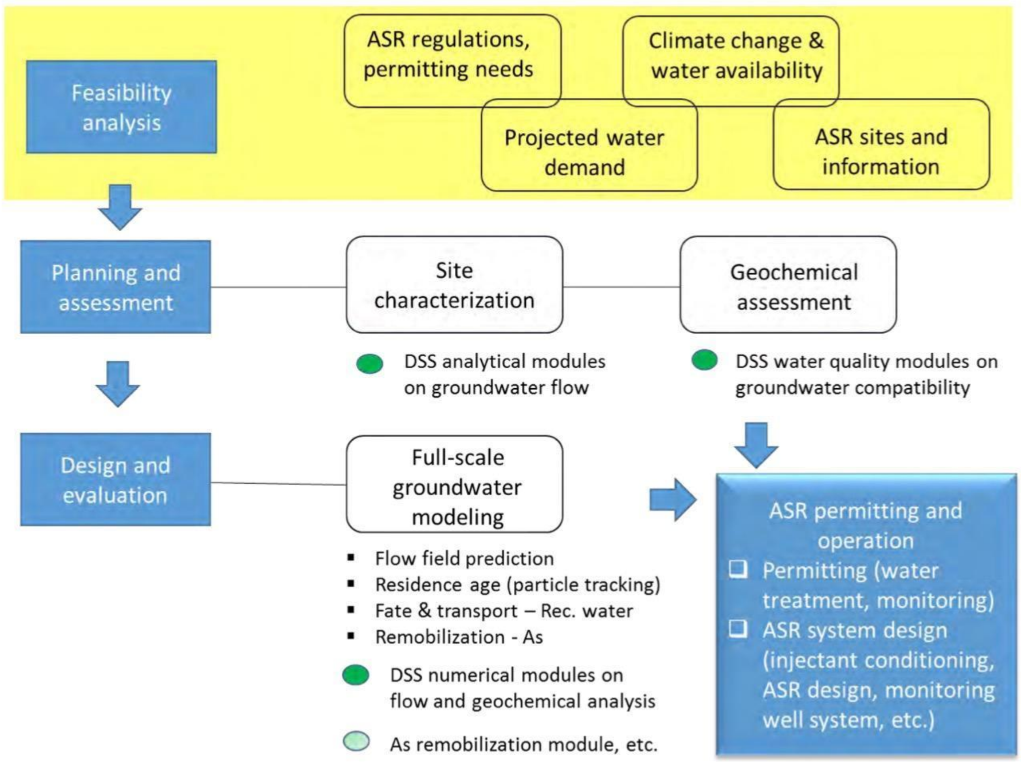


Figure 5 Layout of the ASR DDS framework, consisting of programs in three levels: 1) Feasibility analysis; 2) Planning and assessment; and 3) Design and evaluation.

[Figure 3. EPA Decision Support System for ASR Yang et al., 2016].

Discussion

Multiple drivers such as water storage for future needs encourage the consideration of ASR. At the same time barriers including cost and negative environmental impacts may prevent its use. Examining policies now may provide a clearer roadmap to future decisions for ASR in Minnesota. Policies and rules exist at multiple levels of government including Federal, state, and local jurisdictions and can prevent or limit future ASR projects. Minnesota is not a primacy state for Class V wells, meaning that the Environmental Protection Agency (EPA) maintains primary enforcement authority over underground injection control activities. The State of Minnesota's well code, specifically Minnesota Administrative Rule 4725.2050 disallows wells or borings from being used for injection or disposal of surface water or groundwater. Therefore, considerations for ASR in Minnesota would require Federal and State approvals and variances. Further evaluation of city, county and watershed-related rules is needed.

Recommendations

1. Minnesota should study the feasibility of receiving primacy for Class V injection wells from the EPA.
2. Minnesota should further examine the State's well code for potential changes that could allow for wells being used for injection.
3. Minnesota should adopt and utilize an ASR decision support system. This would allow a comprehensive policy evaluation of proposed ASR projects and could also be beneficial in discussions of future policy changes.
4. Examination of local and tribal policies near potential ASR sites should be performed.

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