Guidance for Regulation of

Aquifer Storage and Recovery

January 2019

GEORGIA
DEPARTMENT OF NATURAL RESOURCES
ENVIRONMENTAL PROTECTION DIVISION

Guidance for Regulation of Aquifer Storage and Recovery

The purpose of this document is to provide guidance on permitting of aquifer storage and recovery (ASR) systems under the rules and regulations that currently guide the relevant programs at the Georgia Environmental Protection Division. The document addresses permitting and regulation of projects that involve injecting water, which has been treated as needed, into groundwater via an injection well and then, after a certain amount of time, recovering the injected water from the same well.[1]

From a regulatory standpoint, the first step in development of aquifer storage and recovery in Georgia is completion of a Preliminary Notice of ASR Design, included here as Attachment A. This notice should be submitted prior to conducting any cycle testing or completing any permit applications. As described in Attachment A, this preliminary notice should be based on readily available data, and should specify items for which available data are insufficient for full project design or evaluation for permitting purposes. Field tests or surveys should be planned to collect additional data for these items.

Attachment A does not presume that all necessary information will be available at this preliminary stage. The intent is for applicants to submit the information that is readily available to address specific items and then explain what will be done on what schedule to address the other listed items. That submission can include information from another site that the applicant believes demonstrates an item is already sufficiently addressed for the proposed site and project. All submitted information will be subject to EPD review and acceptance.

Upon receipt of a Preliminary Notice of ASR Design, EPD will designate a specific individual in the Watershed Protection Branch to coordinate permitting and communication about the potential project. The information provided as part of the Preliminary Design packet will be reviewed by EPD staff. Additional information may be requested if needed to complete review of the Preliminary Notice of ASR Design.

After review, EPD will respond with concurrence that additional data need to collected and that no technical or regulatory impediments to data collection have been identified, if sufficient information has been provided to allow this conclusion. This concurrence

[1] This document does not address permitting and regulation of projects for artificial recharge (AR), which may involve injecting treated water into injection well(s) and then recovering the injected water from a separate extraction well or wells or the placement of treated water into a surface basin or galleries to artificially recharge the aquifer from which water extraction subsequently occurs. While any proposed AR project would be regulated under the same rules that apply here, these types of projects may have different technical requirements and regulatory considerations and, consequently, are not directly addressed in this document.

authorizes the applicant to proceed with data collection, such as cycle testing, to support full project design and subsequent permitting processes.

Data to design the ASR system and the monitoring system necessary during and after operation will depend on the complexity of the target aquifer for ASR recharge. If the target aquifer is a porous media aquifer with primary porosity, such as sand, the aquifer can be assumed to be homogenous and isotropic and the flow from the injection point will be radial. Mathematics can be used to describe such radial flow in a fair amount of detail which will make the design of a monitoring system easier. If the target aquifer is a media characterized by secondary porosity, such as bedrock fractures or solution cavities in a carbonate, the aquifer cannot be assumed to be homogenous and isotropic and the flow from the injection point will be biased along the directions of the secondary porosity. This will make the design of a monitoring system difficult and will require more characterization of the pre-operation target aquifer than if it is a porous media aquifer. The applicant should be prepared to address potential adverse impacts to the host water that may reasonably be anticipated as a result of the injection.

A 2016 publication from USEPA titled *Decision Support System for Aquifer Recharge (AR) and Aquifer Storage and Recovery (ASR) Planning, Design, and Evaluation - Principles and Technical Basis*[2] should be consulted as an information resource. Adherence to all recommendations or provisions of this document will not be required, but it provides a good introduction to items that might be necessary before moving forward.

Permitting of an ASR project will require involvement from some or all of the following EPD programs: Water Supply Program; Wastewater Regulatory Program; and the Drinking Water Program. These programs have core responsibilities for regulation of ASR as described in the September 2017 report *HR 1198 Review of Regulations Related to Aquifer Storage and Recovery* (https://epd.georgia.gov/regulation-aquifer-storage-and-recovery). An underground injection control (UIC) permit under DNR Rule 391-3-6-.13 will be required for injection of groundwater or surface water source water into an ASR well. In addition, land disturbance permits or other permits related to site development may also be required. It is the applicant's responsibility to determine the full suite of permitting requirements.

For the core regulatory programs, Attachment B presents a checklist of the general permitting steps expected for an ASR project. Specific requirements will depend on the individual project and its location, design, and other site-specific factors, including the

[2] EPA/600/R-16/222, July 2016. Office of Research and Development, Water Supply and Water Resources Division. www.epa.gov/research. Downloaded May 17, 2018.

availability of existing data. The importance of site-specific factors cannot be over-stated and, while the checklist below is intended to provide some certainty in advance, there are many unknowns that cannot be addressed until specifics are defined for an individual project.

Recent legislation encourages EPD to "consider the availability of other water supply sources in the permitting of any potential [ASR] project" (see HR 1198 adopted in 2016). Applicants should document the availability of other water supply sources in their Preliminary Notice of ASR Design and should recognize that, depending on site-specific considerations, additional evaluation of this factor may be required. The general complexity of an ASR project, and the number of distinct permits required for such a project, underscores the value of such consideration.

To address the site-specific aspects of a project, an applicant may schedule a meeting with EPD for a preliminary consultation prior to submission of any documents. An applicant will be required to schedule a consultation with EPD after submission of the Preliminary Notice of ASR Design and before proceeding with the permitting process. The purpose of the consultation is to develop a comprehensive site-specific and project-specific roadmap that clarifies expected timing, data and information submissions, and regulatory requirements. Through this consultation, EPD will specify the regulatory pathway that applies to the details of that specific ASR project and clarifies the applicant's responsibilities. The project-specific roadmap can then serve as a basis for public information as well as providing guidance on actions by the applicant and agency as permitting and project development proceeds. An applicant's failure to complete this consultation may delay progress in the permitting process until the consultation is held.

For a specific project, existing permits may already be in place for certain components. However, modification of these permits or review of system changes due to ASR operations may still be required. For an specific project, the details of which permits are required, which may require modification, and which compliance activities may be required under existing permits, would all be clarified in the consultation with EPD that is required after submission of the Preliminary Notice of ASR Design and before submission of any permit applications.

Applicants should recognize that completion of permitting packages is expected to be iterative, with multiple exchanges between the applicant and EPD about the information provided, information gaps, project design and permit requirements. The applicant should expect that special conditions may be linked across the different permits required for the project. In addition, public notice and comment opportunities for the different permits required for the project will be coordinated to ensure that the public can review

and comment upon the project as a whole. Specifically, public notice and comment for UIC permits associated with ASR projects will be undertaken in conjunction with public notice for the other permit(s) required for the project.

ATTACHMENT A:
PRELIMINARY NOTICE OF DESIGN OF AQUIFER STORAGE AND RECOVERY PROJECT

Submit notice and supporting information to:
Underground Injection Control Program
Georgia Environmental Protection Division
Suite 1152 East Tower
2 Martin Luther King Jr. Drive SE
Atlanta, GA 30334

Project Name: _____ Date Submitted: _____

Submitted by: _____

Address: _____

_____

_____

Precise GPS coordinates:

Latitude: _____ Longitude: _____

Contact: Phone: _____

Email: _____

This preliminary notice is to be used for an Aquifer Storage and Recovery system that involves injecting water, which has been treated as needed, into an injection well and then, in a certain amount of time, recovering the injected water from the same well. It is not to be used for a project which uses artificial recharge (AR), which could involve injecting treated water into injection well(s) and then recovering the injected water from a separate extraction well or wells, or the placement of treated water into a surface basin or galleries to artificially recharge the aquifer from which water extraction occurs.

Prior to submitting any permit application or conducting any cycle testing, provide a report describing the rationale for choosing ASR and the approach to the project. Document the availability of water supply sources other than the proposed ASR system in the report.

The report should be based on readily available data, and should specify items for which available data are insufficient for full project design and evaluation for permitting purposes. Field tests or surveys should be planned to collect additional data for these items. Applicants should compile the information that is readily available to address items listed below, identify items for which available data are insufficient, and then explain the steps that will be taken and the schedule to provide the information needed to address the those items. The submission can include information from another site that the applicant believes demonstrates an item is already sufficiently addressed for the proposed site and project. All submitted information will be subject to EPD review and acceptance.

The report must address or include, but is not limited to, the following items:

a) Purpose of the project and plan for end use of water
b) Delineation of source of the injection water and sufficient water availability assured
c) Assessment of sufficient source water availability (including description of method used for assessment)
d) Description of consideration of availability of other water supply sources
e) Proposed treatment of water prior to injection for storage
f) Target aquifer to be used for water storage
g) Whether the target aquifer is a porous media aquifer such as sand or a media with secondary porosity such as fractures or solution cavities
h) The time of recovery from the same well after recharge injection
i) Hydrologic characteristics of the storage aquifer that allow for injection and recovery of water
j) Geochemical properties of the source water, groundwater currently in the storage aquifer, and the aquifer matrix
k) Physical properties of the aquifer to be used for calculating a proposed maximum injection pressure
l) A recent potentiometric map of the storage aquifer in the proposed ASR area
m) A map of the estimated potentiometric surface while water is stored in the storage aquifer
n) Depth, diameter, and construction details of proposed ASR wells
o) Plan that identifies conditions for initiating source withdrawal, injection for storage, and storage withdrawal
p) Retention time or storage capability of source water prior to injection
q) Plans for sequence and cycle times of withdrawals and injections, including proposed recharge, storage, and recovery days
r) Total projected storage volume
s) Anticipated flow volume (gpd) and rate (gpm)
t) Modeling of potential reactions between the injected water and native waters and between the injected water and aquifer matrix to evaluate potential for oxide formation such as oxides of arsenic, barium, zinc, uranium, and others. The injected water will most likely have a different chemistry than the native waters in the aquifer and models can be done using U.S. Geological Survey (USGS) equilibrium chemicals models such as PHREEQC, WATEQ4F, or another model available on the USGS Water Resources Geochemical Software web site to determine how the injected water may react with minerals in the aquifer matrix. Some laboratory testing of samples of aquifer matrix may be useful for model input data and model calibration. Such modeling and testing can also be done to test the potential swelling of clay minerals within the aquifer matrix due to the injected water to determine how such swelling may affect permeability of the aquifer. Identification and swelling of clay minerals can also be tested on samples of aquifer matrix. Other aquifer reactions to the injected water can be similarly modeled.

u) Plan for measuring and reporting all withdrawals and injections
v) Proposed treatment of water prior to distribution for end use
w) Proposed monitoring plan (including but not limited to monitoring of ASR wells)
x) Safety plans: failure of water treatment; emergence of adverse aquifer impacts or other concerns
y) Financial assurance for project

To be signed by the applicant:

The information provided here is accurate to the best of my knowledge. I request concurrence with the field tests and surveys described here to collect additional data to support project design and permitting.

Signature: _____

Title: _____

ATTACHMENT B. CHECKLIST OF GENERAL PERMITTING STEPS EXPECTED FOR AN ASR PROJECT

Section A (See Note 1)

1 For all source water wells:

	Well Name	Existing/Proposed	Aquifer(s) used	Rate of withdrawal	Active permit Y/N? If Y, type

Provide a well data sheet for each existing well and similar information for each proposed well.
Video surveys, geophysical logs, and similar data may be submitted to support verification of well construction details.
Note: Wells may be considered as "groundwater under the influence of surface water" depending on well construction information or the lack of well construction information.

2 For all surface water intakes:

	Intake Location Name	Existing/Proposed	Source Name	Rate of withdrawal	Active permit Y/N? If Y, type

3	Provide Source Water Assessment Plan for sources above (refer to the EPD Source Water Assessment Implementation Plan, 3/28/2000)
	Delineate areas to be assessed or protected
	Inventory potential sources of contamination with delineated areas
	Determine water source susceptibility to identified potential pollution sources
	Incorporate this information in the system's operating plan
	Modeling of potential reactions between the injected water and native waters and between the injected water and aquifer matrix must be done to allow evaluation of the potential for oxide formation, swelling of clays, and other adverse water quality and aquifer reactions. Sufficient data must be obtained to allow running of a USGS standardized geochemical model (see description in the Preliminary Notice of Design of Aquifer Storage and Recovery Project).
4	Prepare Industrial Use Withdrawal permit application for each source identified in #2 and #3 above.
Section B	
5	Submit plan to treat water sources identified in Section A to drinking water standards.
	Procedures & requirements of 391-3-5-.06(1)(c) must be met for surface water sources.
	Procedures & requirements of 391-3-5-.06(1)(d) must be met for groundwater sources.
	Procedures & requirements of 391-3-5-.06(1)(e) must be met for ground water sources under the influence of surface water.
Section C	
6	Submit application to discharge any wastewater generated during treatment of water to be injected. Depending on project specifics, these steps may be combined with those under Section G.
	Request wasteload allocation for discharge. Identify the receiving water, the specific location of the proposed discharge, requested flows (MGD), and waste characteristics of the waste stream, including any testing of the waste stream that has been completed.
	Complete application for an NPDES permit based on EPD response to wasteload allocation request.
Section D	
7	Submit a UIC application to conduct injection for cycle testing purposes.
8	Provide information based on readily available data to meet general requirements and design requirements for cycle testing permit for underground injection of water that has been treated as needed:

	Statement of the purpose.
	Comprehensive Geological Report.
	Comprehensive Hydrogeological Report and aquifer characteristics including assessment of the baseline hydraulic gradients within the target aquifer under pre-operation conditions.
	Calculate the natural rate of groundwater movement (Darcy flux and average liner velocity of groundwater movement) and calculate how the cone of impression from the injection well will alter the natural groundwater flow system
	Aquifer chemistry of the baseline target aquifer and anticipated changes to the geochemistry after injection of the source water.
	Supply water chemistry.
	Detailed engineering design of ASR and monitoring wells (deep and shallow).
	Anticipated stabilized groundwater chemistry after injection.
	Assessment of the time between injection of the recharge water and recovery of the injected water and estimates of the movement of the injected bubble of water before it is recovered
	If the ASR system is designed to store a fresh water bubble in a target aquifer containing saline or brackish water, or a fresh water bubble in an otherwise non-potable target aquifer, estimation of the size of the transition zone between the fresh water and the saline/brackish/non-potable water and an estimation of the percentage of injected fresh water that will be recoverable.
	The design must include information on the complexity of the target aquifer, whether it is characterized by primary or secondary porosity, and this must be considered when estimating the impact of the cone of impression resulting from recharge of injected water, and the design of the post-operation monitoring system. It is possible that complex target aquifers characterized by secondary porosity will require more monitoring points than a less complex target aquifer characterized by primary porosity.
9	Meet construction and testing requirements for injection wells, including provision of information on the following:
	Drilling and construction schedule.
	Layout of drilling pads and pad monitoring well locations.
	Sampling and geophysical logging
	Blow-out preventer or flow control devices.
	Additives for grouting, lost circulation, or any other reasons.
	Approved % for bentonite gel to cement casing or tubing.
	Identification of confining units.
	Compliance with drinking water well construction standards for any ASR well intended for use as a drinking water source (DNR Rule 391-2-5-.07 and O.C.G.A. 12-5-134).
10	Amend initial application based on monitoring and cycle testing results:

	Upon completion of monitoring and ASR well installation, all information provided under item 8 must be field verified or amended and submitted to EPD.				
	If the applicant cannot or does not rigorously demonstrate that the downgradient groundwater will not be degraded by the injected water using an evaluation period of at least 30 years, then the applicant must demonstrate the ability of the ASR to capture more than 95% of that injected water before it moves beyond the capture zone of the ASR well(s). The applicant may or may not use the recaptured water, but will need to use, store, or discharge the water in compliance with applicable rules and permits.				
	Depending on project specifics, the owner/operator may also be asked to include a risk management plan to address specific concerns or operational scenarios identified during project review.				
11	Document the following:				
	Plan for operational testing and reporting				
	Cycle testing and reporting				
	ASR permitting and reporting				
	Any GW flow modelling to support estimates of storage/availability for withdrawal at proposed intervals				
12	Submit application for UIC permit for treated water.				
Section E (see Note 2)					
13	Provide information on withdrawal (recovery) of stored water.				
	Well Name	Existing/Proposed	Aquifer(s)	Rate of withdrawal	Active permit Y/N? If Y, type
	Provide a well data sheet for any existing well and similar information for each proposed well.				
14	Submit a withdrawal application for the ASR well(s) based on the final purpose, (i.e. end use)				
	For municipal / drinking water wells:				
	Submit source approval request				

	Submit a preliminary wellhead protection evaluation request
	For withdrawal rates of 100,000 gpd or more, submit withdrawal permit application
	For agricultural wells:
	For withdrawal rates of 100,000 gpd or more, submit withdrawal permit application
	For industrial wells:
	For withdrawal rates of 100,000 gpd or more, submit withdrawal permit application
	Other:
Section F	
15	If the final use for water sources identified in Section E is drinking water:
	Submit plan to treat water sources identified in Section E to drinking water standards.
	Application for a permit to operate a public water system
	Include proposed treatment Engineering Report, Pilot Test Plans and Construction Plans and Specs as required.
Section G	
16	Submit application to discharge wastewater generated during project operations, including treatment of water in Section F.
	Evaluate eligibility under the current NPDES General Permit for Filter Backwash Discharges Associated With Water Treatment Activity With Sludge Handling Capability; submit Notice of Intent if eligible. If the proposed discharge does not meet the eligibility criteria in the current NPDES General Permit, request wasteload allocation for discharge. Identify the receiving water, the specific location of the proposed discharge, requested flows (MGD), and waste characteristics of the waste stream, including any testing of the waste stream that has been completed.
	Complete application for an NPDES permit based on EPD response to wasteload allocation request.

Note 1 – Withdrawal of Source Water:

- All appropriate water withdrawal application requirements and conditions must be met for the source water withdrawal. Groundwater withdrawal permitting details can be found at: O.C.G.A. §12-5-90 and DNR Rule 391-3-2 and surface water withdrawal permitting requirements can be found at: O.C.G.A. §12-5-31 and DNR Rule 391-3-6-.07.
- Withdrawal of source water will be permitted as non-farm/industrial.
- In groundwater withdrawal permitting, aquifer challenges and unreasonable impacts are evaluated up front.
    - For Non-Farm (M&I) withdrawals, an applicant requests a specific permit limit which is usually set on monthly and annual averages, but in this case a daily limit may also be established. This requested withdrawal limit is based on actual anticipated water demand projections, aquifer capacity to provide that amount of water, and a determination of impacts on the aquifer, other aquifers, or nearby users. Using criteria established in 12-5-96, EPD analyzes the submission and may grant a permit in the amount requested or at a reduced limit or may deny the permit altogether. A designated time frame for water withdrawals may also be established.
        - The applicant must provide data and information supporting their withdrawal proposal, to be checked and quality controlled by the permitting unit using known information from the USGS, state information, additional localized well / aquifer analysis, etc. The applicant must show limited unreasonable impacts on the aquifer and on other nearby permitted users.
        - The amount of water requested for a withdrawal permit is established up-front and hard-wired into the permit. A permit cannot be issued for an open-ended amount of potential water withdrawal, either from the original source or at the time of water recovery.
- Note that these up-front assessments are only as good as the available hydrologic data. The applicant should evaluate data gaps, identify critical information needs, and specify plans to collect requisite data to address those gaps. EPD will review all submitted data and may identify other critical information needs and required data collection and analysis to be conducted by the applicant.
- For withdrawal permitting, site-specific information generated from initial drilling and well testing, which is required for successful design and operation of an ASR program, will be required for the determination of impacts and potential approval of withdrawal permitting. In most cases without this extensive testing, sufficient site-specific information is not readily available. Results of cycle testing will indicate how the ASR system will behave over time. The permit application must include a plan for cycle testing including the time of the cycle test, the number of cycles that will be tested, the source water that will be used for the cycle test, and how results of the cycle test will be measured and documented.
- Monitoring can be easily required as needed for standard groundwater or surface water withdrawal permits. Monitoring requirements will be defined based on existing data on aquifer characteristics; information from initial drilling; test well results; existing and

planned aquifer uses; and other factors identified during project-specific consultation and data review.

- Draft groundwater and surface water withdrawal permits are subject to a minimum 30-day public notice and comment period, with a possibility of public meeting or hearing prior to permit issuance.
- Enforcement actions may be taken for non-compliance with permit conditions.

Note 2 – Recovery of Injected Water

- Withdrawals to recover injected water are expected to be permitted as non-farm/municipal or industrial, unless demonstrated otherwise.
  - For all withdrawals, transmissivity of the producing aquifer, the desired yield, and location of other permitted wells are a consideration for approval. In addition, for farm withdrawals, a letter of concurrence (or permit) is required before permission to drill is given.
  - If recovered water is to be used for drinking water purposes, DNR Rules 391-3-5 and the Georgia Minimum Standards for Drinking Water Systems will apply.
- Recovery of stored water is regulated under the groundwater withdrawal permitting rules and the permitting requirements described in Note 1 also apply here.
- Since assessments at the time of permitting are only as good as the quality of available hydrologic data, it is only after operations begin and run for a while that adverse impacts may be discovered (e.g., unforeseen unreasonable impacts on the aquifer or other existing permitted users). If that occurs, remediation requirements must be determined and responsibility for implementation will rest with the permit holder. Remediation requirements may be specified through permit modification or EPD Order. Examples of remediation steps include reducing/limiting production amounts, establishing time of use restrictions, adding monitoring requirements, and developing a Corrective Action Plan to remediate contamination.
- Recovery of injected water is an operation that goes beyond activities addressed in a typical water withdrawal permit and multiple special conditions are likely to be necessary to establish operational parameters for an ASR project. Such special conditions may establish practical or operational limits and boundaries and enhanced metering such as the following:
  - For ASR, injection from the water source into the storage aquifer should occur before any withdrawals from the storage aquifer for end use.
  - Any injection amount into the storage aquifer should exceed the amount of withdrawals from that aquifer (INJ>OUT) and quantities specified for injection or withdrawal amounts may consider uncertainties in technical information or margins of safety appropriate to the site. The range or boundaries for the actual timing of such operations may have to be clearly established in the recovery withdrawal permit.
  - If a project proposal indicates that the withdrawal from the storage aquifer is expected to exceed the amount injected into that aquifer (INJ<OUT), the groundwater withdrawal permitting may fall under groundwater withdrawal policies that are more restrictive for certain aquifers. If the proposed project is designed such that the amount recovered is

expected to be less than the amount injected, but the converse occurs once the project is in operation, withdrawal permit conditions may be violated and the project may be subject to enforcement actions.

- All waters withdrawn for injection and waters injected for storage should be metered and accounted for, so that the overall mass balance between the water bodies and resulting withdrawals for recovery may be determined.
- The permit should contain conditions designating the time period, aquifer conditions, or surface water flow levels under which water may be withdrawn from the source for injection for storage, or the absolute quantity of water which may be withdrawn from the source for injection for storage, or both.
- Special conditions should be placed in the permit for all other items as necessary or as determined for the specific project.
- Monthly reporting of all withdrawal and injection amounts, by individual aquifer or water source, will be required. Specific reporting requirements will be defined by EPD to fit characteristics of individual projects

- Regulations allow for applicable permits to incorporate any number of specific or defined special conditions. This give considerable flexibility in dealing with any concerns noted during the permitting process and allows for the establishment of practical guidelines and practices for use in the actual operations of an ASR project. The programs involved in permitting of an ASR project will coordinate with each other and complementary or identical special conditions may be included in different permits (e.g., monitoring requirements).
- Enforcement actions may be taken for non-compliance with permit conditions.