

## **15A NCAC 02C .0219   AQUIFER STORAGE AND RECOVERY WELLS**

(a) A permit shall be obtained from the Director prior to constructing, operating, or using an Aquifer Storage and Recovery Well. "Aquifer Storage and Recovery Well" means a well that is used to inject potable water for the purposes of subsurface storage and for later recovery of the injected water.

(b) Permit Applications. In addition to the permit requirements set forth in Rule .0211 of this Section, an application shall be submitted, in duplicate, to the Director on forms furnished by the Director and shall include the following:

- (1) A site description that includes:
  - (A) the name of the well owner or person otherwise legally responsible for the injection well, his or her mailing address and telephone number, and whether the owner is a federal, state, private, public, or other entity;
  - (B) the name of the property owner, if different from the well owner, and his or her physical address, mailing address, and telephone number;
  - (C) the name, mailing address, telephone number, and geographic coordinates of the facility for which the application is submitted; and
  - (D) a list of all other injection permits associated with the subject facility.
- (2) Project Description. A description of what problem the project is intended to solve or what objective the project is intended to achieve and shall include the following:
  - (A) the history and scope of the problem or objective;
  - (B) what is currently being done to solve the problem or achieve the objective;
  - (C) why existing practices are insufficient to solve the problem or achieve the objective;
  - (D) what other alternatives were considered to solve the problem or achieve the objective; and
  - (E) how this option was determined to be the most effective or desirable to solve the problem or achieve the objective.
- (3) Demonstration of Financial Responsibility as required in Rule .0208 of this Section.
- (4) Injection Zone Determination. The applicant shall specify the horizontal and vertical portion of the injection zone within which the proposed injection activity will occur based on the hydraulic properties of that portion of the injection zone specified. No violation of groundwater quality standards specified in Subchapter 02L resulting from the injection shall occur outside the specified portion of the injection zone, as detected by a monitoring plan approved by the Director.
- (5) Hydrogeologic Evaluation. If required by G.S. 89E, G.S. 89C, or G.S. 89F, a licensed geologist, professional engineer, or licensed soil scientist shall prepare a hydrogeologic evaluation of the facility to a depth that includes the injection zone determined in accordance with Subparagraph (4) of this Paragraph. A description of the hydrogeologic evaluation shall include all of the following:
  - (A) regional and local geology and hydrogeology;
  - (B) changes in lithology underlying the facility;
  - (C) depth to the mean seasonal high water table;
  - (D) hydraulic conductivity, transmissivity, and storativity of the injection zone based on tests of site-specific material, including a description of the tests used to determine these parameters;
  - (E) rate and direction of groundwater flow as determined by predictive calculations or computer modeling; and
  - (F) lithostratigraphic and hydrostratigraphic logs of test and injection wells.
- (6) Area of Review. The area of review shall be calculated using the procedure for determining the zone of endangering influence specified in 40 CFR 146.6(a), which is hereby incorporated by reference, including subsequent amendments and editions, and can be obtained electronically from the website of the Federal Register at <https://www.ecfr.gov/cgi-bin/ECFR>. The applicant shall identify all wells within the area of review that penetrate the injection or confining zone and repair or permanently abandon all wells that are improperly constructed or abandoned.
- (7) Analyses of the injection zones including:
  - (A) test results of the native groundwater and the proposed recharge water for the parameters listed in Subparagraph (h)(4) of this Rule;
  - (B) geochemical analyses of representative samples of the aquifer matrix to determine the type and quantity of reactive minerals; and
  - (C) evaluation of the chemical compatibility of the native groundwater, injected water, and the aquifer matrix using site-specific geochemical data and hydraulic properties of the

injection zones, and the results of any geochemical or hydrogeologic modeling. The chemical compatibility evaluation shall identify potential changes in groundwater quality resulting from the injection activities within the area of review specified in Subparagraph (6) of this Paragraph.

- (8) Injection Procedure. The applicant shall submit a description of the proposed injection procedure that includes the following:
  - (A) the proposed average and maximum daily rate and quantity of injectant;
  - (B) the average maximum injection pressure expressed in units of pounds per square inch (psi);
  - (C) calculation of fracture pressures of confining units expressed in units of psi; and
  - (D) the total or estimated volume to be injected.
- (9) Injection well construction details including:
  - (A) the number and depth of injection wells;
  - (B) an indication of whether the injection wells are existing or proposed;
  - (C) the depth and type of casing;
  - (D) the depth and type of screen material;
  - (E) the depth and type of grout; and
  - (F) the plans and specifications of the surface and subsurface construction of each injection well or well system.
- (10) Monitoring Wells. Monitoring wells shall be located so as to detect any movement of injection fluids, process byproducts, or formation fluids outside the injection zone as determined by the applicant in accordance with Subparagraph (4) of this Paragraph. The monitoring schedule shall be consistent with the proposed injection schedule, pace of the anticipated reactions, and rate of transport of the injected fluid. The applicant shall submit a monitoring plan that includes the following:
  - (A) a list of monitoring parameters and analytical methods to be used;
  - (B) other parameters that may serve to indicate the progress of the intended reactions;
  - (C) a list of existing and proposed monitoring wells to be used; and
  - (D) a sampling schedule for monitoring the proposed injection.
- (11) Well Data Tabulation. A tabulation of data on all existing or abandoned wells within the area of review of the injection wells that penetrate the proposed injection zone, including water supply wells, monitoring wells, and wells proposed for use as injection or monitoring wells. The data shall include a description of each well's type, depth, and record of abandonment or completion.
- (12) Plan of Action. A proposed plan of action to be taken if the proposed injection operation causes fracturing of confining units, results in adverse geochemical reactions, or otherwise threatens groundwater quality.
- (13) Maps and Cross-Sections. Scaled, site-specific site plans or maps depicting the location, orientation, and relationship of facility components including the following:
  - (A) area map based on the most recent USGS 7.5' topographic map of the area, at a scale of 1:24,000, and showing the location of the proposed injection site;
  - (B) topographic contour intervals showing all facility related structures, property boundaries, streams, springs, lakes, ponds, and other surface drainage features;
  - (C) all existing or abandoned wells within the area of review of the injection wells listed in the tabulation required in Subparagraph (11) of this Paragraph that penetrate the proposed injection zone, including water supply wells, monitoring wells, and wells proposed for use as injection wells;
  - (D) potentiometric surface maps of each hydrostratigraphic unit in the injection zone(s) that show the direction of groundwater movement, and all existing and proposed wells;
  - (E) cross-sections that show the horizontal and vertical extent of the injection zones, lithostratigraphic units, hydrostratigraphic units, and all existing and proposed wells, complete with casing and screen intervals; and
  - (F) all existing sources of potential or known groundwater contamination, including waste storage, treatment, or disposal systems within the area of review of the injection well or well system.
- (14) Any other information necessary for the Director to ensure compliance with G.S. 87-84.

(c) Injection Volumes. The Director may establish maximum injection volumes and pressures necessary to assure that:

- (1) fractures are not initiated in the confining zones;
- (2) injected fluids do not migrate outside the injection zone or area;
- (3) injected fluids do not cause or contribute to the migration of contamination into uncontaminated areas; and
- (4) there is compliance with operating requirements.

(d) Injection.

- (1) Injection may not commence until construction is complete, the permittee has submitted notice of completion of construction to the Director, and the Director has inspected or reviewed the injection well and finds it in compliance with the permit conditions. If the permittee has not received notice from the Director of intent to inspect or otherwise review the injection well within 10 days after the Director receives the notice, the permittee may commence injection.
- (2) Prior to granting approval for the operation, the Director shall consider the following information:
  - (A) all available logging and testing data on the well;
  - (B) a demonstration of mechanical integrity pursuant to Rule .0207 of this Section;
  - (C) the proposed operating procedures;
  - (D) the results of the formation testing program; and
  - (E) the status of corrective action on defective wells in the area of review.

(e) Well Construction.

- (1) Wells shall not be located:
  - (A) where surface water or runoff will accumulate around the well due to depressions, drainage ways, or other landscapes that will concentrate water around the well;
  - (B) if a person would be required to enter confined spaces to perform sampling and inspection activities; or
  - (C) if injectants or formation fluids would migrate outside the approved injection zone as determined by the applicant in accordance with Subparagraph (b)(4) of this Rule.
- (2) The methods and materials used in construction shall not threaten the physical or mechanical integrity of the well during its lifetime and shall be compatible with the proposed injection activities.
- (3) The well shall be constructed in such a manner that surface water or contaminants from the land surface cannot migrate along the borehole annulus either during or after construction.
- (4) The borehole shall not penetrate to a depth greater than the depth at which injection will occur unless the purpose of the borehole is the investigation of the geophysical and geochemical characteristics of an aquifer. Following completion of the investigation, the borehole beneath the zone of injection shall be completely grouted to prevent the migration of any contaminants.
- (5) Drilling fluids and additives shall contain only potable water and may be comprised of one or more of the following:
  - (A) the formation material encountered during drilling;
  - (B) materials manufactured specifically for the purpose of borehole conditioning or well construction; or
  - (C) materials approved by the Director, based on a demonstration of not adversely affecting human health or groundwater quality.
- (6) Only grouts listed under Rule .0107 of this Subchapter shall be used with the exception that bentonite grout shall not be used:
  - (A) to seal zones of water with a chloride concentration of 1,500 milligrams per liter or greater as determined by tests conducted at the time of construction; or
  - (B) in areas of the State subject to saltwater intrusion that may expose the grout to water with a chloride concentration of 1,500 milligrams per liter or greater at any time during the life of the well.
- (7) The annular space between the borehole and casing shall be grouted:
  - (A) with a grout that is non-reactive with the casing or screen materials, the formation, or the injectant;
  - (B) from land surface to the top of the gravel pack and in such a way that there is no interconnection of aquifers or zones having differences in water quality that would result in degradation of groundwater quality in any aquifer or zone; and

- (C) so that the grout extends outward from the casing wall to a thickness equal to either one-third of the diameter of the outside dimension of the casing or two inches, whichever is greater; but in no case shall a well be required to have an annular grout seal thickness greater than four inches.
- (8) Grout shall be emplaced around the casing by one of the following methods:
  - (A) Pressure. Grout shall be pumped or forced under pressure through the bottom of the casing until it fills the annular space around the casing and overflows at the surface;
  - (B) Pumping. Grout shall be pumped into place through a hose or pipe extended to the bottom of the annular space that can be raised as the grout is applied. The grout hose or pipe shall remain submerged in grout during the entire application; or
  - (C) Other. Grout may be emplaced in the annular space by gravity flow to ensure complete filling of the space. Gravity flow shall not be used if water or any visible obstruction is present in the annular space at the time of grouting.
- (9) All grout mixtures shall be prepared prior to emplacement per the manufacturer's directions with the exception that bentonite chips or pellets may be emplaced by gravity flow if water is present or the chips or pellets are otherwise hydrated in place.
- (10) If an outer casing is installed, it shall be grouted by either the pumping or pressure method.
- (11) The well shall be grouted within seven days after the casing is set or before the drilling equipment leaves the site, whichever occurs first. If the well penetrates any water-bearing zone that contains saline water, the well shall be grouted within one day after the casing is set.
- (12) No additives that will accelerate the process of hydration shall be used in grout for thermoplastic well casing.
- (13) A casing shall be installed that extends from at least 12 inches above land surface to the top of the injection zone.
- (14) Wells with casing extending less than 12 inches above land surface shall be approved by the Director only when one of the following conditions is met:
  - (A) site specific conditions directly related to business activities, such as vehicle traffic, would endanger the physical integrity of the well; or
  - (B) it is not operationally feasible for the well head to be completed 12 inches above land surface due to the engineering design requirements of the system.
- (15) Multi-screened wells shall not connect aquifers or zones having differences in water quality that would result in a degradation of groundwater quality in any aquifer or zone.
- (16) Prior to removing the equipment from the site, the top of the casing shall be sealed with a water-tight cap or well seal, as defined in G.S. 87-85, to preclude contaminants from entering the well.
- (17) Packing materials for gravel-and sand-packed wells shall be:
  - (A) composed of quartz, granite, or other hard, non-reactive rock material;
  - (B) of uniform size, water-washed and free from clay, silt, and toxic materials;
  - (C) disinfected prior to subsurface emplacement;
  - (D) emplaced such that it will not connect aquifers or zones having differences in water quality that would result in the deterioration of groundwater quality in any aquifer or zone;
  - (E) evenly distributed around the screen and shall extend to a depth at least one foot above the top of the screen. A one-foot or greater thick seal, comprised of bentonite clay, shall be emplaced directly above and in contact with the packing material.
- (18) Each injection well shall have a well identification plate that meets the criteria specified in Rule .0107 of this Subchapter.
- (19) A hose bibb, sampling tap, or other collection equipment shall be installed on the line entering the injection well such that a sample of the injectant can be obtained prior to its entering the injection well.
- (20) If applicable, all piping, wiring, and vents shall enter the well through the top of the casing unless it is based on a design demonstrated to preclude surficial contaminants from entering the well.
- (21) The well head shall be completed in such a manner as to preclude surficial contaminants from entering the well, and well head protection shall include:
  - (A) an accessible external sanitary seal installed around the casing and grouting; and
  - (B) a water-tight cap or seal compatible with the casing and installed so that it cannot be removed without the use of hand or power tools.

(f) Testing.

- (1) Well logs and other tests conducted during the drilling and construction of the wells shall be submitted to the Director after completion of well construction. A descriptive report interpreting the results of such logs and tests shall be prepared by a log analyst and submitted to the Director after completion of the tests. The accuracy and usefulness of the logs and tests shall be determined by the Director based on the intended function, depth, construction, and other characteristics of the well, and availability of similar data in the area of the drilling site. Such logs and tests shall include:
  - (A) lithostratigraphic logs of the entire borehole;
  - (B) hydrostratigraphic logs of the entire borehole; and
  - (C) deviation checks conducted on all holes where pilot holes and reaming are used at sufficiently frequent intervals to assure that vertical avenues for fluid migration through diverging holes are not created during drilling.
- (2) When the injection zone is a water-bearing formation, the following information concerning the injection zone as determined by the applicant in accordance with Subparagraph (b)(4) of this Rule shall be submitted to the Director:
  - (A) fluid pressure;
  - (B) fluid temperature;
  - (C) fracture pressure;
  - (D) other physical and chemical characteristics of the injection zone;
  - (E) physical and chemical characteristics of the formation fluids; and
  - (F) compatibility of injected fluids with formation fluids.
- (3) When the injection formation is not a water bearing formation, only the fracture pressure and other physical and chemical characteristics of the injection zone shall be determined or calculated and submitted to the Director after completion of the determinations.
- (4) Tests for mechanical integrity shall be conducted prior to operation and every 10 years thereafter in accordance with Rule .0207 of this Section. The Director may require more frequent mechanical integrity testing as set out in Rule .0207 of this Section.

(g) Operation and Maintenance.

- (1) Pressure at the well head shall be limited to a maximum that will ensure that the pressure in the injection zone does not initiate new fractures or propagate existing fractures in the injection zone, initiate fractures in the confining zone, or cause the migration of injected or formation fluids outside the injection zone or area.
- (2) There shall be no injection between the outermost casing and the well borehole.
- (3) Monitoring of the operating processes at the well head and protection against damage of the well head during construction and use shall be provided for by the well owner.

(h) Monitoring.

- (1) Monitoring of the groundwater quality by the permittee shall be required by the Director to demonstrate protection of the groundwaters of the State.
- (2) In determining the type, density, frequency, and scope of monitoring, the Director shall consider the following:
  - (A) physical and chemical characteristics of the injection zone;
  - (B) physical and chemical characteristics of the injected fluids;
  - (C) volume and rate of discharge of the injected fluids;
  - (D) compatibility of the injected fluids with the formation fluids;
  - (E) the number, type, and location of all wells, mines, surface bodies of water, and structures within the area of review;
  - (F) proposed injection procedures;
  - (G) expected changes in pressure, formation fluid displacement, and direction of movement of injected fluid;
  - (H) proposals of corrective action to be taken in the event of a failure in any phase of injection operations that renders the groundwaters unsuitable for their best intended usage as defined in Rule .0204 of this Section; and
  - (I) the life expectancy of the injection operations.
- (3) Samples and measurements taken for the purpose of monitoring shall be representative of the monitored activity.

- (4) The following analytical parameters shall be included:
    - (A) disinfectants and disinfection byproducts;
    - (B) radium, radionuclides, and gross alpha radiation;
    - (C) Reduction Potential (Eh), pH, Total Dissolved Solids (TDS), Biological Oxygen Demand (BOD), Total Oxygen Demand (TOD), Chemical Oxygen Demand (COD), temperature, conductivity, and dissolved oxygen;
    - (D) coliform, Escherichia coli (E. Coli), Giardia, and Cryptosporidium;
    - (E) parameters based on the source water, injection zone formation materials, native groundwater, and any other parameters necessary for the Department to ensure compliance with G.S. 87-84; and
    - (F) other parameters for which National Primary and Secondary Drinking Water Standards have been established.
  - (5) Analysis of the physical, chemical, biological, or radiological characteristics of the injected fluid shall be made monthly or more frequently, as necessary in order to provide representative data for characterization of the injectant.
  - (6) Continuous recording devices to monitor the injection pressure, flow, rate, and volume of injected fluid shall be installed.
  - (7) Monitoring wells associated with the injection site shall be monitored quarterly or on a schedule determined by the Director to detect any migration of injected fluids from the injection zone to ensure compliance with G.S. 87-84.
  - (8) Monitoring wells completed in the injection zone and adjacent to the injection zone may be affected by the injection operations. If affected, the Director may require additional monitor wells be installed outside the injection zone to detect any movement of injection fluids, process byproducts, or formation fluids outside the injection zone as determined by the applicant in accordance with Subparagraph (b)(4) of this Rule. If the operation is affected by subsidence or catastrophic collapse, additional monitoring wells shall be located so that they will not be physically affected and shall be of an adequate number to detect movement of injected fluids, process byproducts, or formation fluids outside the injection zone or area. In determining the number, location, and spacing of monitoring wells, the following criteria shall be considered by the Director:
    - (A) the population relying on the groundwater resource affected, or potentially affected, by the injection operation;
    - (B) the proximity of the injection operation to points of withdrawal of groundwater;
    - (C) the local geology and hydrology;
    - (D) the operating pressures;
    - (E) the chemical characteristics and volume of the injected fluid, formation water, and process by products; and
    - (F) the number of existing injection wells.
- (i) Reporting.
- (1) A record of the construction, abandonment, or repairs of the injection well shall be submitted to the Director within 30 days of completion of the specified activities.
  - (2) All sampling results shall be reported to the Division quarterly or at another frequency determined by the Director based on the reaction rates, injection rates, likelihood of secondary impacts, and site-specific hydrogeologic information.
  - (3) The results of each test required in Paragraph (f) of this Rule shall be submitted to the Director within 30 days of the completion of the test.
- (j) Public Notice. Public notice of intent to issue permits for applications submitted pursuant to this Rule shall be given prior to permit issuance.
- (1) Such notice shall:
    - (A) be posted on the Division website and given in press releases via media outlets having coverage within the area of review;
    - (B) provide 30 days for public comments to be submitted to the Director; and
    - (C) include a description of details of the project, such as the permit applicant; the location, number, and depth of injection wells; and the injectant type, source, and volume.
  - (2) After the public comment period has ended the Director shall:
    - (A) consider the comments submitted and determine if a public hearing is warranted;

- (B) determine if the draft permit shall be issued, modified, or denied; and
  - (C) post notice on the Division website as of the final permitting action, which shall include the issued permit or the reason for denial if the permit was denied.
- (3) In determining if a public hearing is warranted, the Director's consideration shall include the following:
- (A) requests by property owners within the area of review;
  - (B) potential harm to the public by not having a public hearing;
  - (C) potential harm to the applicant due to the delay in having a public hearing; and
  - (D) the likelihood of obtaining new information regarding the proposed injection.

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