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NORTH CAROLINA DEPARTMENT OF
ENVIRONMENT AND NATURAL RESOURCES
DIVISION OF WATER QUALITY

Groundwater Section
February 20, 1998

JAMES B. HUNT JR.
GOVERNOR

WAYNE McDEVITT
SECRETARY

A. PRESTON HOWARD,
JR., P.E.
DIRECTOR

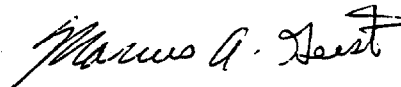
S. Laura Yeh, P.E.
Naval Facilities Engineering Service Center Code ESC 411
1100 23rd Ave.
Port Hueneme, CA 93043-4328

Dear Ms. Yeh:

Responding to your inquiry concerning injected groundwater treatment standards, I am enclosing a Groundwater Section policy statement and the supporting state regulations which address this subject. Page 4 of the enclosed memorandum, dated May 13, 1993; from Groundwater Section Chief Arthur Mouberry specifies a 95% removal efficiency rate for contaminated groundwater treatment systems which discharge to injection wells or infiltration galleries. I have included the state water quality standards regulations (NCAC T15A: 2L.0100, 0200, 0300) which are referenced in this memorandum*. Please contact me if you require any additional copies of the rules or copies of the pertinent state statutory laws.

If you have any questions regarding this letter or the state injection well rules please contact me at (919) 715 - 6166 or Amy Axon at (919) 715-6165.

Sincerely,



Marcus A. Geist
Underground Injection Control Program

Enclosures

* only portions included with FAX, entire regulations included with mailed letter

State of North Carolina
Department of Environment,
Health and Natural Resources
Division of Environmental Management

James B. Hunt, Jr., Governor
Jonathan B. Howes, Secretary
A. Preston Howard, Jr., P.E., Director



MAY 13, 1993

MEMORANDUM

To: Interested Parties

From: Arthur Mouberry, P.E. *AM*
Chief, Groundwater Section

RE: INJECTION WELL / INFILTRATION GALLERY GUIDELINES
--General Criteria for the Design, Location, and Monitoring of Infiltration Galleries and Injection Wells at Groundwater Remediation Sites

I. STATEMENT OF PURPOSE

These guidelines are provided to assist the applicant when preparing a Non-Discharge Groundwater Remediation Permit Application. They are not intended to address every element of the permit. Instead, they focus on the elements specific to groundwater remediation processes. They will be updated as necessary. Additional questions may be addressed to the Groundwater Section at 919-733-3221.

II. DESIGN CONSIDERATIONS

A. GENERAL DESIGN REQUIREMENTS

Unless otherwise excepted, each infiltration gallery (IG) or injection well (IW) shall be designed and operated as an element of a "closed-loop" subsurface system for the remediation of contaminated groundwater. A "closed-loop" system is defined in G.S. 143-215.1A as "a system and attendant processes for cleaning up contaminated groundwater by pumping groundwater, treating the groundwater to reduce the concentration of or remove contaminants, and reintroducing the treated groundwater beneath the surface so that the treated groundwater will be recaptured by the system." The "closed-loop" system should be operated such that the IG or IW:

1. is located within the "capture zone" of an on-site recovery system, AND
2. does not cause or contribute to (a) the migration of contaminants into previously uncontaminated areas, or (b) a violation of groundwater quality standards beyond the boundaries of the property on which the source of pollution is located.

If the IG or IW is part of a proposed corrective action plan, it should be noted that corrective action plans are subject to other DEM permitting requirements such as NPDES, Non-Discharge, and Air Quality.

B. INJECTION WELL / WELL SYSTEMS

Wells must:

1. be constructed and operated in accordance with G.S. 143-215.1A¹ (Closed-Loop Groundwater Remediation Systems Allowed), as follows:
 - (a) The concentration of contaminants in the groundwater must be reduced to an acceptable level (see II. E. Effluent Quality Requirements) prior to discharge into an IW.
 - (b) Contaminants introduced into the subsurface via IWs MUST be recaptured by the recovery system (i.e., the remediation system is "closed-loop") as supported by the results of computer modeling or predictive calculations, which are to be submitted with the CAP and with the Non-Discharge Permit Application.
 - (c) The only permit required by the Division of Environmental Management (DEM) for the IG or IW will be a Groundwater Remediation Non-Discharge Permit issued under authority of G.S. 143-215.1. No separate permits for construction and operation of an IW system will be issued.
 - (d) It must be shown by recharge tests and calculations that the injection wells can handle the proposed flow. Uncontaminated groundwater or carbon-filtered public water supply water must be used for the test.
2. be constructed and operated in accordance with the appropriate state rules, as follows:
 - (a) 15A NCAC 2H .0200, "Waste Not Discharged to Surface Waters": Non-Discharge Permit Application must contain, at a minimum, pertinent information specified in Rule 2H .0205(d)(5). Other information may be required based on specific facility design/operation and site specifications.
 - (b) 15A NCAC 2C .0200, "Criteria and Standards Applicable to Injection Wells": Pertinent application information, specified in Rule 2C .0211, will be requested as a part of (and must be submitted with) the Non-Discharge Permit Application. The permittee must also meet the design/operation criteria of Rule 2C .0213(d)-(h).
 - (c) 15A NCAC 2L, "Classifications and Water Quality Standards Applicable to the Groundwaters of North Carolina": Operation of an IW system cannot be permitted if it would contravene Rule 2L .0103.

¹ SENATE BILL 1156 (an act to allow closed-loop groundwater remediation systems), passed during the 1991 session of the NC General Assembly and effective June 29, 1992, (1) amended G.S. 143-214.2(b) so as to allow the use of injection wells in the remediation of contaminated groundwater, and (2) added a new section (G.S. 143-215.1A) to Article 21, Chapter 143 of the General Statutes defining the design/operational considerations and permitting processes applicable to approval of the use of wells to inject treated contaminated groundwater into the subsurface.

C. INFILTRATION GALLERIES

The galleries must:

1. be constructed and operated in accordance with the following general criteria:
 - (a) The concentration of contaminants in the groundwater **MUST** be reduced to an acceptable level (see II. E. Effluent Quality Requirements) prior to discharge into an IG.
 - (b) Contaminants in excess of the groundwater standard introduced into the subsurface via IGs must be recaptured by the recovery system (i.e., the remediation system is "closed loop").
 - (c) IG design flow must be based on site specific test calculations (e.g., rate of infiltration). Measurements should be made of both the saturated zone and the point of infiltration (i.e., where fluids leave the gallery and begin to enter the soil). Tests must be adequate to show that the system will work as designed.
 - (d) IG design flow must not result in saturated conditions within one vertical foot of the excavated bottom of the gallery.
 - (e) A Groundwater Remediation Non-Discharge Permit application will be required pursuant to G.S. 143-215.1.
2. be constructed and operated in accordance with the appropriate state rules, as follows:
 - (a) 15A NCAC 2H .0200, "Waste Not Discharged to Surface Waters": Non-Discharge Permit Application must contain the information specified in Rule 2H .0205. The IG system must meet the design criteria specified in Rule 2H .0219(n).
 - (b) 15A NCAC 2L, "Classifications and Water Quality Standards Applicable to the Groundwaters of North Carolina": Operation of an IG system cannot be permitted if it would contravene Rule 2L .0103.

D. ENHANCED BIODEGRADATION

If biodegradation of the contaminants is an anticipated or proposed additional level of treatment, the addition of nutrients and/or an additional oxygen source may be desirable. Approximately three parts oxygen per one part hydrocarbon, by weight, is generally required to ensure that adequate oxygen is available for biodegradation.

It must be demonstrated that the type and quantity of additives emplaced (including bacteria) will be removed or will attenuate to or below 15A NCAC 2L standards at the compliance boundary. A successful demonstration should include, but not be limited to, the following information:

1. for microbial additives:

- (a) documentation (including published reports, pilot studies, etc.) to support expected metabolic functions which would contribute to the breakdown of contaminants to non-toxic metabolites;
- (b) quantities and schedules of additives to be used;
- (c) epidemiological data.

2. for nutrient enhancement:

- (a) baseline data of the contaminated groundwater including an analysis of pH, oxygen, nitrogen, phosphorous, and inorganics;
- (b) specific types, quantities, and rate of subsurface introduction of nutrients proposed to be used;
- (c) testing data from published reports or pilot studies of remediation sites where the nutrients had previously been used (including nutrient concentrations left in the water after the remediation process is complete). Pilot studies should be of a site with comparable conditions.

E. EFFLUENT QUALITY REQUIREMENTS

The quality of the treated effluent, prior to its discharge into the IG or IW, must meet the following criteria:

- 1. For IGs or IWs (a) on the same property as the contaminant source(s) AND (b) within the compliance boundary of the disposal facility AND (c) discharging into the contaminant plume (both vertically and horizontally):

Concentration of contaminants in the effluent discharged to the IG or IW MUST either meet the groundwater standards specified in 15A NCAC 2L OR be no greater than 5% of contaminant levels influent to the above-ground treatment system (i.e., the treatment system must remove 95% of the contaminants).

- 2. For all other IGs and IWs:

Concentration of contaminants in the effluent discharged to the IG or IW must meet class GA standards (15A NCAC 2L .0202) unless the non-discharge permit applicant can demonstrate, by computer modeling or predictive calculation based on site-specific conditions, that a higher concentration will not result in a contravention of GA standards.

III. LOCATION

- A. The IG or IW must be located immediately upgradient of, and/or within, the capture zone of any groundwater recovery system to be used as part of the same remediation process.
- B. The location of the IG or IW shall meet the buffer zone requirements specified in 15A NCAC 2H .0219(j)(5), "Waste Not Discharged to Surface Waters" for subsurface disposal systems unless it can be demonstrated that (1) these requirements cannot be met, AND (2) that operation of the IG or IW at the proposed location will not result in a contravention of any water quality standards.
- C. The applicant should include a scaled site map that depicts the remediation system relative to buildings, property boundaries, waste treatment or disposal facilities, private or public water supply sources, and surface water bodies.

IV. HYDROGEOLOGY

The permit applicant should produce a set of maps and cross sections that demonstrate a clear understanding of the hydrology, soils, geology and water use of the area in question. The applicant must describe significant changes in lithology and note any restrictive horizons, depth to the mean seasonal high water table, hydraulic conductivity, transmissivity and specific yield of each aquifer unit. If there are any local supply wells which could impact, or be impacted by, the remediation system, those impacts must be quantified. For infiltration galleries, the applicant must also measure the vertical permeability of the unsaturated zone and recommend loading rates for the site.

V. CONTAMINANT PLUME DELINEATION

The contaminant plume must be delineated both horizontally and vertically. This information should be presented in a series of isoconcentration maps and plume cross-sections which include the direction of groundwater flow for both the surface aquifer and any deeper aquifers that may be affected. An approved Corrective Action Plan or Comprehensive Site Assessment does not guarantee that the plume has been delineated sufficiently for permitting. The applicant should consider the following:

- A. Monitoring wells should be positioned to properly delineate the plume both horizontally and vertically.
- B. The entire contaminant plume must be delineated regardless of property lines.
- C. The plume delineation should be carefully reviewed before submittal.

DEMONSTRATION OF HYDRAULIC CONTROL

The applicant must demonstrate complete hydraulic control over the injected fluid and its effects on the contaminant plume. The permit application should:

- A. include sufficient supporting data (e.g., time/drawdown data, pump tests, Theis curves and methods, completed calculations, etc. used to determine aquifer characteristics) to verify complete hydraulic control (vertical and horizontal) of the injected fluid.
- B. demonstrate the presence and magnitude of, or the absence of, any vertical hydraulic gradient at the site. If a vertical hydraulic gradient exists, it should be shown how its direction and magnitude are incorporated in the calculations demonstrating hydraulic control.
- C. indicate the presence and effect of any natural features such as hydraulic boundaries, groundwater recharge or discharge areas, etc., on the proposed hydraulic system. It should be demonstrated that groundwater discharge features will not be impacted by contamination due to the proposed injection system.
- D. contain the following information when using groundwater flow computer models:
 1. purpose or scope of modeling;
 2. description of the model;
 3. statement of limitations;
 4. summary of data required for model (table form);
 5. the conceptual model (include diagram in 2-D & 3-D);
 6. model validation;
 7. summary of input data;
 8. results in printout and graphical representation in reference to scaled site map and features;
 9. discussion of results and analysis to include assumptions and limitations;
 10. conclusion and recommendations based on modeling results.

All model-derived data and maps should be properly labeled and keyed to be clearly understood. The choice of model is up to the applicant.

- E. indicate the pumping rates of all wells within the area of review² whose source is within the same aquifer as the injection and recovery wells, or, if in a different aquifer, may have a potential effect on the recovery/injection system. The hydraulic effect of pumping from these wells on the overall system should be demonstrated.

The area of review for an injection well or injection well system shall be a fixed radius of 3,000 feet (or greater as determined by the Director) around the well or well system.

VII. MONITORING

A groundwater quality monitoring system will be required if it cannot be demonstrated that existing monitoring wells are located and/or constructed such that the impact(s) of the IG or IW can be tracked within, and at, the "compliance boundary". The monitoring system must:

1. be adequate to assess the impact of the discharge on the quality of underlying groundwaters;
2. be based on the results of site-specific hydrogeologic information;
3. be designed so that placement of monitoring wells is adequate for tracking the performance of the permitted remediation system. If adequately located, monitoring wells installed to delineate the site and contaminant plume characteristics, may be utilized to track performance;
4. include water level and flow meter measurements to insure that the system is operating properly.

Required monitoring wells must be sampled initially after construction (prior to use of the IG or IW) and thereafter at least quarterly, unless an alternative monitoring plan has been approved.