BEFORE THE UNITED STATES
ENVIRONMENTAL PROTECTION AGENCY

Notice of Proposed Rulemaking	)	
Federal Requirements Under the	)	
Underground Injection Control (UIC) Program	)	**EPA-HQ-OW-2008-0390**
for Carbon Dioxide (CO_2)	)	**FRL-8695-3**
Geologic Sequestration (GS) Wells	)	
	)	
	)	
73 Fed. Reg. 43492 (July 25, 2008)	)	
	)	

Comments of:

Clean Air Task Force –
– Clean Water Action –
– Environmental Defense Fund –
– Natural Resources Defense Council –
– Western Resource Advocates

A. Introduction

The Clean Air Task Force, Clean Water Action, Environmental Defense Fund, Natural Resources Defense Council, and Western Resource Advocates (Environmental NGO Group) thank EPA for the opportunity to comment on the Proposed Rule on carbon dioxide sequestration wells under the Underground Injection Control (UIC) Program.

Founded in 1996, the Clean Air Task Force (CATF) is a nonprofit organization dedicated to restoring clean air and healthy environments through scientific research, public education, and legal advocacy.

Founded in 1972, Clean Water Action (CWA) has 1.2 million members and offices in 20 states. Clean Water Action works to improve public health and environmental protection through grassroots organizing, policy research and advocacy.

Environmental Defense Fund (EDF), founded in 1967, is a non-profit organization that represents more than 500,000 members. EDF links science, economics and law to create innovative, equitable and cost-effective solutions to society's most urgent environmental problems.

The Natural Resources Defense Council (NRDC) is a national, nonprofit organization of scientists, lawyers and environmental specialists dedicated to protecting public health and the environment. Founded in 1970, NRDC has more than 1.2 million members and online activists nationwide, served from offices in New York, Washington D.C., San Francisco, Los Angeles, Chicago and Beijing.

Western Resource Advocates (WRA) is a regional non-profit organization using law, economics and policy analysis to protect the land, air and water of the Interior Western United States.

The planet's climate is changing fast. Greenhouse gas emissions from the use of fossil fuels, mainly carbon dioxide (CO_2), are having a profound effect on our climate, presenting us with one of the most significant environmental and social challenges of the century. In its most recent Assessment Report last year, the Intergovernmental Panel on Climate Change, an independent scientific body, issued the loudest warning to date, calling the warming in the climate system "unequivocal" and calling for serious emission reductions if we are to avoid truly dangerous greenhouse gas concentrations. Failure to pursue significant reductions in greenhouse gas emissions very soon will make it much harder in the future both to stabilize atmospheric pollution concentrations and to avoid the worst impacts of climate change. Climate change is expected to and, indeed, already is having a profound effect on sources of drinking water. The American West, for example, is already becoming noticeable hotter and drier, as a recent compilation of studies by the Rocky Mountain Climate Organization (RMCO) and NRDC summarizes.[1]

A growing body of scientific research indicates that we face extreme dangers to human health, economic well-being, and the ecosystems on which we depend if global average temperatures are allowed to increase by more than 2 degrees Fahrenheit from today's levels. We have good prospects of staying below this temperature increase if atmospheric concentrations of CO_2 and other global warming gases are kept from exceeding 350 to 450 parts per million (ppm) CO_2-equivalent. Achieving this goal will require rapid reductions in existing emissions, including action to cut emissions by approximately 80% by mid-century. This goal is ambitious, but achievable. It can be done through an annual rate of emissions reductions that ramps up to about a 4% reduction per year. Fortunately, a wide variety of tools is available today to achieve those reductions.

While it is not a "silver bullet", one important tool is the geologic sequestration (GS) of CO_2 at properly selected and properly regulated sites. Our Environmental NGO Group does not necessarily have a common view concerning the magnitude of the long-term role of GS in combating climate change, but we are united in recognizing that a transition away from fossil fuels will take time and that GS is likely to be an important part of the near- to medium-term solution. Fortunately, capturing CO_2 and permanently sequestering it in certain types of well-selected and well-managed geologic formations is a technology that is ready to begin deployment today. While GS projects can be permitted today under the Safe Drinking Water Act's (SDWA) UIC program (in fact a number of projects have already been permitted under existing well classes), the rules that currently apply to such projects were not designed with

[1] "Hotter and Drier: The West's Changes Climate". Rocky Mountain Climate Organization (RMCO) and the Natural Resources Defense Council. Available at: http://www.nrdc.org/globalWarming/west/west.pdf

geologic sequestration in mind. Thus, the importance of this rulemaking is not that it is needed in order for GS projects to receive permits; rather, the rulemaking is important because it can assure that GS projects are regulated under rules that are specifically designed to require GS projects to be done safely and effectively without endangering underground sources of drinking water (USDWs) or, as discussed below, resulting in a risk of release to the atmosphere. For that reason, it is essential that EPA promulgate final rules for GS in a timely manner that are sufficient to protect USDWs.

It is also essential that the U.S. Environmental Protection Agency (EPA) take supplemental action, based on other (non-SDWA) authority, to provide additional assurance that injected CO_2 will not be released into the atmosphere in a way that adversely impacts the climate or otherwise endangers public health and welfare. Generally, the steps needed to protect USDWs are also needed in order to prevent emissions to the atmosphere. Supplemental steps citing additional authority should also guarantee that CO_2 injected into geologic formations stays out of the atmosphere. This should be done according to a permanence (performance) standard, which will certify CO_2 as 'geologically sequestered' for that purpose, in addition to protecting USDWs. These are needed, as none of the existing or proposed injection classes are adequate for the task of certifying CO_2 as permanently sequestered for the purposes of preventing atmospheric releases. In order to be fully protective of the environment, Congress will also need to pass comprehensive cap and trade legislation to control the emission of greenhouse gases from all anthropogenic sources. But the need for such legislation is not a basis for deferring the adoption of EPA rules to protect USDWs or to assure that injected CO_2 does not result in harmful releases to the atmosphere.

The Supreme Court recognized in *Massachusetts v. EPA*[2] that EPA has authority and, indeed an obligation, under the Clean Air Act to regulate emissions of greenhouse gases, including CO_2, that "cause or contribute to air pollution that may reasonably be anticipated to endanger public health or welfare."[3] Similarly, the D.C. Circuit's remand of the power plant new source performance standards ("NSPS") places EPA in the position to regulate CO_2 emissions from new and also existing sources within that industrial sector.[4] The Environmental Appeals Board EAB also recently has rejected the agency's arguments that it is not authorized to issue best available control technology (BACT) emissions limits for CO_2 in the context of a new source air permit decision for a large new coal-fired power plant, under the Clean Air Act's Prevention of Significant Deterioration (PSD) new source review authority.[5]

In comments on the Agency's recent advanced notice of proposed rulemaking on using the Clean Air Act to combat climate change, a coalition of environmental NGOs, including some members

[2] 127 S.Ct. 1438 (2007).
[3] *Id*. at 1460-61.
[4] Order, *NY, et al. v. EPA*, D.C. Cir. No. 06-1322 (Sept. 24, 2007). Once NSPS are set for an industry under section 111(b), 42 U.S.C. §7411(b), the Act requires EPA to set standards for states to regulate emissions from existing sources in that industry. 42 U.S.C. § 7411(d).
[5] *In re: Deseret Power Electric Coop.,* PSD App. No 07-03, Slip Op. (Nov. 13, 2008). The memorandum issued December 18, 2008 by Administrator Johnson entitled "EPA' Interpretation of Regulations that determine Pollutants Covered by Federal Prevention of Significant Deterioration (PSD) Permit Program" (Johnson PSD memo) is procedurally deficient, and, in any event, states explicitly on its face that it is not intended to supersede the EAB's decision in the *Deseret* case. Johnson memo at 2. Nor, indeed, can it lawfully do so.

of our Environmental NGO Group, pointed out that for the U.S. to achieve its necessary climate goals, controlling CO_2 emissions from new and existing sources of CO_2 is required. That necessitates reductions from all sectors, including radical shifts to zero-emitting technologies and corrective action on existing sources. These reductions will require targeted measures and policies, which include air regulations that would set CO_2 emissions standards implicating the capture and sequestration of CO_2. Setting an NSPS or a BACT standard based on CO_2 capture technology necessarily creates a need for complementary requirements to assure that the captured CO_2 is effectively isolated from the atmosphere. At this time, such an outcome requires injecting CO_2 underground for permanent sequestration in either hydrocarbon reservoirs or deep saline formations. Such permanent sequestration clearly meets the definition of underground injection, regulated by the UIC program of the Safe Drinking Water Act ("SDWA").[6]

We therefore are pleased to submit these comments on EPA's proposed rules concerning "*Federal Requirements Under the Underground Injection Control (UIC) Program for Carbon Dioxide (CO_2) Geologic Sequestration (GS) Wells,* 73 Fed. Reg.43492 (July 28, 2008).

B. The Safe Drinking Water Act Authorizes EPA to Create a Preventive, Forward Looking, and Adaptive Program Specific to CO_2 GS Permitting

Under the SDWA, EPA's authority to protect USDWs is clearly defined, broadly scoped, and forward looking.[7] Section 1421 requires the Administrator to publish rules for state implemented underground injection programs that "prevent underground injection which endangers drinking water sources" as that phrase is further defined by the statute.[8] Such programs, at a minimum, must "prohibit any underground injection … which is not authorized by a permit,"[9] and such permit programs must require a showing to the satisfaction of the state that the underground injection will not endanger drinking water sources…."[10] Underground injection "endangers drinking water sources if such injection may result in the presence in underground water which

[6] 42 U.S.C. §300h, *et seq*. Geologic sequestration of CO_2 clearly meets the definition of underground injection found at 42 U.S.C. §300h(d)(1), "the subsurface emplacement of fluids by well injection." Carbon dioxide, whether injected in a supercritical state, or as a gas, meets the definition of a fluid included in the existing regulations under the SDWA: those rules state that a "fluid" is "any material or substance which flows or moves whether in a semisolid, liquid, sludge, gas or other form or state." 40 CFR § 144.3.

[7] While our Environmental NGO Group agrees that EPA's primary authority for the promulgation of this rule is found in the Safe Drinking Water Act, we also point out above that the Clean Air Act authorizes controls on CO_2 emissions that necessarily implicate and necessitate this UIC approach, and so also can be said to provide authority for Class VI rules. EPA must exercise its Clean Air Act authority to regulate CO_2 for the purposes of preventing its release to the atmosphere. Additionally, and more generally, EPA could also promulgate verification and accounting protocols for CO_2 GS, as needed, under those Clean Air Act rules. Such Clean Air Act rules may or may not prove adequate for purposes of any future legislatively created trading system. Clearly, however, the UIC rules should not be regarded as sufficient to authorize or certify carbon credits as part of such a system, as they do not provide sufficient proof that CO_2 will be permanently sequestered from the atmosphere, nor do they include additional details necessary for verifying and quantifying any atmospheric releases.

[8] 42 U.S.C. §§ 300h(a)(1), (b)(1).
[9] *Id*. § 300h(b)(1)(A).
[10] *Id*. § 300h(b)(1)(B).

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 system's not complying with any national primary drinking water regulation or may otherwise adversely affect the health of persons."[11] And "contaminant" is defined as "*any* physical, chemical, biological, or radiological substance or matter in water."[12] Underground injection furthermore is prohibited without a permit, and to receive a permit the applicant must demonstrate that endangerment "will not" occur.[13] This preventive, broadly scoped language demonstrates that Congress intended that all underground injection be regulated under the UIC program.[14]

The statute provides additional direction to EPA in developing its rules – the rules must "permit or provide for consideration of varying geologic, hydrological, or historical conditions, in different States and in different areas within a State,"[15] and they are not to "interfere with or impede" underground injections for the purposes of "the secondary or tertiary recovery of oil or natural gas, unless such requirements are essential to assure that underground sources of drinking water will not be endangered by such injection."[16] While EPA is not free to exempt a particular class of injection entirely from rulemaking, the Agency is authorized to tailor the UIC rules to the specific geologic conditions and also to particular injection activities. The statute clearly authorizes EPA to create a new class or classes of UIC wells for the purpose of CO_2 sequestration.

This precautionary, forward looking statutory purpose and structure authorizes EPA also to take an adaptive approach, both in rulemaking and in defining permit terms, specifically to direct states to be adaptive in monitoring, tracking, and updating permits, in order to reflect lessons learned from experience and from monitoring reports. The statute also authorizes EPA to take an adaptive approach to the rules themselves. Section 1421(a)(1) states that "any regulation [governing underground injection activities] may be amended from time to time."[17] Whereas, as is the case with EPA's proposed Class VI rules, regulations are established to govern a system on a scale of deployment that has not yet been demonstrated[18], the preventive and precautionary nature of the UIC statute demands a periodic review, assessment, and update of the rule. EPA should, in its final rule, declare its intention to undertake such a process. Moreover, our Environmental NGO Group recommends that EPA commit itself to issuing a Notice of Proposed Rulemaking by no later than an identified date, perhaps in 2020, which would formally initiate this process.

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[11] *Id*. § 300h(d)(2).
[12] 42 U.S.C. § 300f(6).
[13] 42 U.S.C. § 300h(b)(1)(A), (B).
[14] *See also NRDC v. EPA*, 824 F.2d 1258, 1271 (1st Cir. 1987), holding that Congress intended the phrase 'underground injection which endangers drinking water sources" should have the broadest applicability, and citing and quoting H.R. Rep. No. 1185, 93d Cong., 2d Sess., *reprinted in* 1974 U.S. Code Cong. & Admin. News at 6484.
[15] 42 U.S.C. § 300h(b)(3)(A).
[16] Id. § 300h(b)(2)(B).
[17] 42 U.S.C. § 300h(a)(1).
[18] Although the practice of injection/GS has been demonstrated at the individual project scale.

C. The Proposed Rule Has Many Positive Features

Before offering comments on the proposal itself, we want to praise and lend our support to EPA for incorporating, or in some cases intending to incorporate, a number of features of the rule that we regard not solely as desirable, but essential. These include:

- specific requirements for a comprehensive characterization before deeming a sequestration site as appropriate for injection;
- monitoring requirements for tracking the behavior and location of CO_2 in the subsurface, validating its confinement, or detecting unwanted behavior early to allow for corrective action;
- the need to compile a monitoring plan, a site care and closure plan and a remedial response plan prior to obtaining a permit;
- the requirement to update and report on these plans, including the area of review adjustment process, as monitoring and operational data become available;
- a requirement for a continuous feedback loop between monitoring and modeling, whereby one updates the other in order to optimize operations and refine simulations; and
- a criterion for site closure that is not based on the mere passage of a set number of years, but on the finding that drinking water is not endangered and that the project meets the necessary performance standards (we note, however, that articulation of the performance standards that need to be met in order to make such a finding is one of the areas where the rule needs work).

These features are captured to differing extents by the proposed rule's language, and our suggested changes below serve to reinforce these features. Some of these features appropriately go beyond what is currently required under existing well classes in the UIC program. We regard them as necessary for the effective regulation of GS in the Class VI context, and strongly support them. We would therefore label our proposed changes as technical modifications, and not radical changes in the rule. Even though these strengthening changes are needed, we urge EPA to maintain the basic structure of the rule as proposed and thank the drafting working group for producing the proposed rule in a short timeframe.

D. General Comments

Timing of promulgation

The proposed rule is based on a risk management approach and is written in a way that should avoid unintended consequences to USDWs. It is important to bear in mind that CO_2 injection projects can already be permitted today. While this may be adequate to protect USDWs in certain cases, it is in the interests of the public (and the regulated industry) to have a new injection class, designed from the outset with the particular characteristics of GS in mind, as soon as possible. This is necessary in order provide certainty and adequately safeguard public health and the environment. If the final rule incorporates changes concerning the adaptive nature of the rule and permits, as our Environmental NGO Group suggests, the Agency, and its state counterparts, will be able to deal with such unintended consequences to USDWs through the rule's performance-

based provisions, review and a possible reissuance of permits if necessary, and by revising the rule text if appropriate.

We consider the Phase III Deployment Phase of the Department of Energy's (DOE) Regional Partnership Program to be very worthwhile, but we do not consider the completion of this program to be a prerequisite for either commercial implementation of CCS or for the promulgation of a sound and protective rule. The DOE's program has limited funds available through appropriations, and its demonstration projects will be of limited scale and duration. In addition, it focuses as much or more on the optimum way to apply existing technologies as it does on fundamental research or even demonstrations that particular technologies "work." Our scientific and practical understanding and experience in GS itself, as well as in related underground injection activities, is sufficient to construct and operate the first large-scale, commercial plants in the U.S., provided they are regulated adequately. In that respect, we do not consider the proposed rule premature, but a very timely and necessary development.

The rule itself, rather than individual permits, should assure that Class VI permits do not allow responsible parties to avoid CERCLA liability on grounds that a release constitutes a "federally permitted release"

EPA notes in the preamble to the proposed rule (73 Fed. Reg. 43504) that CERCLA exempts from liability certain "federally permitted releases, including releases in compliance with a UIC permit under the Safe Drinking Water Act." EPA further notes that "Class VI requirements and permits will need to be carefully structured to ensure that they do not 'authorize' inappropriate hazardous releases." Our Environmental NGO Group strongly urges EPA to go further and effectively prohibit Class VI permit conditions that would make the "federally permitted release" defense available should injected fluids or displaced formation fluids enter or endanger USDWs. We suggest that such a prohibition be added to Subpart E – Permit Conditions, or to any other section of the rule that EPA finds appropriate.

The rule should incorporate a "non-interference principle" to keep one sequestration project from interfering with the effectiveness of another

As EPA notes in the preamble (page 43506), "it is … possible that multiple owners or operators will be injecting CO_2 into formations that are hydraulically connected and thus the elevated pressure zones may intersect or interfere with each other." Our Environmental NGO Group agrees that this is a genuine possibility at this stage in GS implementation. Until comprehensive approaches to basin-scale management are developed, we urge the adoption of the following addition to §146.94:

> "(e) If an owner or operator obtains evidence that a pressure front associated with one geologic sequestration project intersects or threatens to intersect a pressure front associated with any other project, the owner or operator obtaining such evidence must notify the Director and the other owner or operator. If the Director determines that the pressure front associated with one project interferes or

threatens to interfere with the ability of a project that began operations at an earlier date to sequester the earlier project's total anticipated volume of the carbon dioxide stream as determined under §146.83(a), the Director may require the owner or operator of the project that began operations at a later date to modify operations as necessary to avoid such interference. "

Process for permit review by experts

We recommend that EPA consider establishing a process to collect input from experts to help inform EPA and states on evolving GS technology and appropriate policy and regulatory responses. Participants in the process should be independent, non-partisan, unbiased experts in the field, We recommend that the participants not be convened under the Federal Advisory Committee Act. Their opinions would be non-binding. Obtaining such input would help regulators improve their permitting decisions and would be complementary to the objectives of increased funding and resources for the UIC Program, outlined below.

Funding and resources for the UIC Program

Although not directly addressed in the EPA proposal, the need for adequate resources to implement the regulatory program for geologic sequestration at both the federal and state levels is a major consideration and one that EPA should be addressing both internally and in its discussions with Congress. The annual national budget for the UIC program (approximately $11 million) has remained static for many years, while UIC agencies have been asked to take on additional responsibilities. Furthermore, inflation of salaries and other expenses has eroded the buying power of the unchanging UIC budget. If state and regional agencies are asked to take on the additional workload of CO_2 injection, while ensuring careful scientific review as well as an efficient processing time, they will require additional trained staff and other resources.

Significant additional resources will need to be made available to hire new permitting staff and field inspectors. Those new staff, along with existing UIC staff, must be trained in subjects that will enable them to make prudent permitting, management, and oversight decisions. EPA and states will need to be adequately prepared to review applications and make permitting decisions. Failure to provide sufficient resources will likely create permitting backlogs or result in sub-optimal permits being issued.

The Ground Water Protection Council (GWPC) estimated in 2004 that an annual funding increase to $56 million would be needed just to meet the needs of the existing UIC program at the state level even without the addition of GS project permitting.[19] GWPC has further estimated that EPA will need to provide funding at a level of $100 million annually to meet the needs for the full UIC program, including the regulation of geologic sequestration.

[19] GWPC, Class V Resource Needs Survey, Summary (September 2004).

Public Water Systems should receive notice of permit applications and have the opportunity to participate in the permitting process

EPA should adopt the existing requirements for public participation at 40 CFR Part 25 and 40 CFR Part 124 as suggested in the proposal. UIC Program Directors should also incorporate modern communication technologies (cable television, various internet tools) to increase the likelihood of effective public understanding and involvement. Engaging the public as soon as candidate locations are identified will also increase the effectiveness of the effort. Given the focus of the rule on preventing harm to USDWs, UIC Program Directors should work with primacy agencies and departments with responsibility for implementing other aspects of SDWA to identify and notify Public Water Systems (PWSs) with a potential interest in the project. PWSs are an important stakeholder in the projects and should be the focus of targeted outreach at every stage of the permitting process. PWS representatives should be invited to serve on any Advisory Groups or other bodies set up during the lifetime of the project. We suggest that in Guidance to accompany this rulemaking, EPA urge owners and operators to establish on-going relationships with potentially impacted PWSs.

Pressure limits

We believe that the pressure management provisions in §146.88(a) require modification. The members of our Environmental NGO Group have not reached agreement on the exact language for the suggested changes and are either submitting individual comments on this issue or are submitting comments jointly with other groups. We do agree, however, that injection pressure limits must be established after adequately considering the risks of both tensile failure and shear failure in the confining zone. We also agree that limits must be designed to avoid causing otherwise non-transmissive faults to become transmissive, in addition to addressing the more traditional concern of avoiding the initiation or propagation of fractures.

Site closure standards and framework for long-term stewardship

Our Environmental NGO Group did not come to a common set of recommendations on site closure and are either submitting individual comments on this issue or are submitting comments jointly with other groups. We do agree, however, that EPA's proposed closure standards in §146.93 need revision. In order to assure that site risks have diminished to the point that it is reasonable to discontinue or significantly reduce monitoring, it is essential that the rule require a demonstration of much more than merely 'plume stabilization' and that the nature of what must be demonstrated be precisely described. In addition, given the desired permanent nature of CO_2 sequestration in the subsurface and the importance to the public of ensuring long-term oversight of project sites, EPA should use its existing regulatory authorities to establish a framework for long-term stewardship and seek whatever additional authorities may be required for this purpose from Congress. This framework should include an entity with responsibility for monitoring and managing sites after closure has been authorized. The proposed rule authorizes operators to stop monitoring, but does not provide for the stewardship of sites following closure.. EPA must rectify this omission. It is important that the post-closure framework include financing provisions that are adequate to ensure proper site stewardship in the long-term.

E. Specific Amendments to the Proposed Rule

The rule should authorize Class VI permits for "up to" the operating life of a facility only if the rule is amended to require all aspects of project operations to be modified as appropriate over the course of the project

We support EPA's proposal in §144.36 to issue Class VI well permits for a period "up to" the operating life of the facility. Still, it is not appropriate to issue these permits for the full operating life of the facility without consideration how project performance is evolving. Revisions of the Area of Review, and the various plans outlined in the proposed rule are to be expected from time to time, and it is possible that some of the needed revisions might be so material so as to constitute ground for modification, revocation or reissuance of the permit.

Class VI is appropriately grouped with Class I Hazardous, Class II and Class III wells in the modification or revocation and reissuance provisions

We believe that EPA in §144.39 has appropriately listed Class VI alongside other injection classes for which a permit can be revoked and reissued for a specific cause (alterations to the facility, new information received and regulatory changes since the permit issued. This is necessary in order to ensure that Class VI regulations are adaptive, reflecting experience in GS as it is amassed. We do not support Class VI being listed alongside classes for which the permittee has control over whether reissue or modification would occur through requesting or agreeing to it.

The definition of "carbon dioxide stream" should not be restricted to CO_2 captured from industrial sources

The definition of "carbon dioxide stream" in §146.81(b) includes only carbon dioxide "that has been captured from an emission source (e.g., a power plant)." Over time, the vast majority of sequestered CO_2 is likely to be captured from such sources, but rules are also needed to govern the sequestration of naturally occurring CO_2 produced from geologic formations. We suggest that the definition be revised to read as follows:

> "Carbon dioxide stream means ~~that has been captured from an emission source (e.g., a power plant),~~ carbon dioxide plus incidental associated substances derived from the source ~~materials~~ of the CO_2 and/or the capture process, and any substances added to the stream to enable or improve the injection process. This subpart does not apply to any carbon dioxide stream that meets the definition of a hazardous waste under 40 CFR part 261."

Class VI applicants should be required to identify all known wells penetrating formations affected by increased pressure

In proposed §144.55(a) the rule would require Class I, II (other than existing), III or VI permit applicants to identify the location "of all known wells within the injection well's area of review which penetrate the injection zone" or, in the case of Class II wells operating over the fracture pressure of the injection formation, "all known wells within the area of review penetrating formations affected by the increase in pressure".

Since injection in deep saline formations will result in an area of elevated pressure (above the original reservoir pressure) that will be larger than the CO_2 plume and could affect overlying or underlying formations, we believe that the latter requirement for Class II wells operating above the fracture pressure should also apply to Class VI wells. This would help prevent the unwanted migration of reservoir fluids from outside the injection zone through existing wells in the confining zone, as a result of the pressure increase. We therefore suggest that §144.55(a) be revised to read as follows:

> "*Coverage*. Applicants for Class I, II, (other than existing), or III, ~~or VI~~ injection well permits shall identify the location of all known wells within the injection well's area of review which penetrate the injection zone. In the case of Class II wells operating over the fracture pressure of the injection formation, applicants shall identify the location of all known wells within the area of review penetrating formations affected by the increase in pressure. Applicants for Class VI shall identify the location of all known wells within the area of review penetrating the injection zone and all known wells which penetrate formations affected by the increase in pressure and shall perform corrective action as specified in Sec. 146.84."

The rule should explicitly exclude from Class VI efforts to sequester CO_2 in basalts, coal seams, salt caverns and shales, which instead should be regulated under Class V Experimental

We believe that EPA has ample basis for adopting rules to regulate geologic sequestration in hydrocarbon reservoirs and in deep brine formations. For these types of geologic formations, there is a widespread technical consensus on how to assess and manage risks, what data is needed to characterize sites, how to select sites, how to conduct injection operations, how to model the behavior of CO_2 in the reservoir, and how to monitor project performance. There is no such consensus, however, regarding sequestration in basalts, coal seams, salt caverns and shales. The trapping mechanisms of CO_2 and/or the operational engineering involved in such operations is significantly different to those in deep saline formations and hydrocarbon reservoirs, and using identical regulatory language would be ill advised. In fact, it is not known at this time whether sequestration (or even injection in some cases) can even be done at scale in such formations – efforts in these formations are very much still in the experimental stage. There is no basis at this time for determining whether rules that are appropriate for wells in hydrocarbon reservoirs and deep saline formations are also appropriate for wells in these other formations. Until there is better understanding of whether and how sequestration can be safely accomplished in basalts, coal seams, salt caverns and shales, wells in these formations should be treated as experimental wells under Class V.

Projects designed to evaluate injection in coal seams, salt caverns and shales should be permitted under the UIC Class V provisions and subject to the March 2007 Guidance on "Using the Class V Experimental Technology Well Classification for Pilot GS Projects.[20] This Guidance clearly states that Class V is intended only for projects "…designed to evaluate the technical issues associated with CO_2 injection"[21]. The Director should review all Class V GS permit applications to insure that they meet the definition of Pilot Project in CFR 146.3: "… a technology which has not proven feasible under the conditions in which it is being tested." The purpose of such pilot projects should be to gather and share information which will lead to a clearer understanding of the feasibility of such projects on a commercial scale.

In order to implement our suggestion regarding these formations, we recommend revising sections 144.6(f), 144.80(f), 146.5(f) and the definition of sequestration in §146.81 accordingly. We suggest retaining the provision in proposed §144.15 that the construction, operation or maintenance of any non-experimental Class V geologic sequestration well is prohibited.

The rule should not prohibit in a blanket fashion GS sites located above the lowermost USDW, but should permit such sites only under certain conditions that are not applicable to sites below the lowermost USDW

We believe that GS sites located above lowermost USDWs may or may not present more types of risk than sites located below lowermost USDWs, but that in any event the *consequences* of leakage from sites above USDWs are likely to be more significant in the event that leakage occurs. At the same time, we recognize that there many potentially excellent sequestration sites above USDWs and that in some areas these may be the only sites available. We believe the rule should authorize GS sites above lowermost USDWs only if such sites meet requirements that go beyond what is mandatory for other sites. The following additional conditions would need to be satisfied:

- confirmation that there is a confining zone underlying the entire base of the injection zone;
- mandatory monitoring for changes in groundwater chemistry above the upper confining zone and below the lower confining zone; and
- prior to permit issuance, and as a condition of permit issuance, completion of regional hydrogeologic studies that are conducted with sufficient accuracy to simulate regional hydrologic flows and demonstrate that USDWs would not be endangered if injected or formation fluids were to move beyond either the higher or the lower confining zone.

Emergency and remedial response, including response to potential problems relating to geologic features, is a necessary complement to corrective action and should remain in the rule

[20] UICPG#83
[21] *Id.* at p. 1

While wells are the most likely conduits for fluid movement into USDWs, the definition of corrective action and the relevant provisions in §146.84 do not take into account the potential for geologic features, such as faults, spill points or fractures, to act as conduits for CO_2 or other fluid migration, and hence breach of confinement. Actions to mitigate or remediate a potential breach of confinement, or a situation which might eventually lead to a breach of confinement, should not be limited to corrective action on wells. We therefore strongly support EPA's inclusion of the Emergency and remedial response section. We propose two minor changes – change §146.94(b)(4) to read:

> "Implement the emergency and remedial response plan approved by the Director, and keep him apprized of the implementation."

and §146.94(d) to read:

> "The owner or operator must notify the Director and obtain his approval prior to conducting any well workover or other remediation measures not listed in the emergency and remedial response plan."

The definition of "confining zone" should not be limited to formations overlying the injection zone, and should focus on limiting movement through the confining zone rather than out the injection zone

The proposed definition of confining zone in §146.81(d) requires that the formation act as "a barrier" to fluid movement, which may be unnecessarily strict. The definition also fails to recognize that it is movement through and beyond the confining zone that needs to be limited. We suggest instead that the definition of "confining zone" read as follows:

> *"Confining zone* means a geologic formation, group of formations, or part of a formation ~~stratigraphically overlying the injection zone~~ that acts as a barrier to limit fluid movement beyond this formation, group of formations, or part of a formation."

The second sentence of the definition of 'geologic sequestration project" should be amended to refer more generally to formation fluids and be transferred to the definition of "area of review"

We suggest the following amendment to §146.81(d) in order to be more inclusive on the types of fluid that could be displaced:

> "[…] It includes the subsurface three-dimensional extent of the carbon dioxide plume, associated pressure front, and displaced ~~brine~~ formation fluids, as well as the surface area above that delineated region."

We also suggest that this second sentence of the definition of geologic sequestration project be transferred to the definition of area of review as recommended above. The language provided above reflects the change from "brine" to "formation fluids."

Moreover, we suggest that the present restriction of Class VI to formations below the lowermost USDW is more appropriately addressed elsewhere. Accordingly, we recommend that geologic sequestration project be defined as follows:

> "Geologic sequestration project means an injection well or wells used to emplace a carbon dioxide stream ~~beneath the lowermost formation containing a USDW~~ into an injection zone for geologic sequestration. ~~It includes the subsurface three-dimensional extent of the carbon dioxide plume, associated pressure front, and displaced brine, as well as the surface area above that delineated region.~~"

The term "pressure front" should be replaced with the more accurate term "area of elevated pressure" throughout the rule

The term "pressure front" in 146.81(d) is likely to be scientifically inaccurate as it implies a front, or discontinuity in pressure, whereas in reality there will be a continuous pressure gradient in the formation in most cases. We suggest globally replacing "pressure front" with "area of elevated pressure" throughout the rule.

Additional well identification methods that do not rely on the public record should be required in certain provisions

§146.82(b) requires a map to be submitted with the permit that shows wells within the area of review – only information of public record is required to be included on this map. §146.82(e) requires a tabulation of all wells within the area of review which penetrate the injection or confining zone(s), including information on the well's type, construction, date drilled, location, depth, record of plugging and/or completion and any additional information that the Director may require.

While we are comfortable with relying on information of public record in subsection (b), we believe that additional diligence is needed when it comes to wells that penetrate the injection or confining zone in subsection (e). Information of public record is often incomplete and/or inaccurate. There are numerous orphaned or abandoned wells that are not listed on the public record that could potentially affect the integrity of the confining zone. While generally it is possible to intercept these problems during operations, there are methods available today to identify wells not listed on the public record[22], which in many cases could identify potentially problematic wells in advance. A requirement to supplement public record information with field measurements should be included in the rule, and described with a term that is broader than "tabulation" in order to allow the Director to require other data formats as needed :

[22] NETL , for example, has developed an electromagnetic system that can be used for areal or ground-based identification of wells (casings).

§146.82(e): "A ~~tabulation~~ compilation of all wells within the area of review which penetrate the injection or confining zone(s). To supplement and/or verify information of public record, operators shall use reasonable methods to identify the presence wells within the area of review that penetrate the injection or confining zone(s). Such data must include a description […]"

Additionally, we believe that problematic wells may not be limited to the confining zone, as would be the case if confinement were to be breached, or if pressure effects caused by the injection caused fluid movement outside the defined confining zone. We recommend the following modification in §146.84(c)(2):

"Using methods approved by the Director, identify all penetrations, including active and abandoned wells and underground mines, in the area of review that may penetrate the confining zone or otherwise act as conduits for fluid movement inside or outside the confining zone".

The term "transmissive fault or fracture" should be clarified

The proposed rule in §146.83(a)(2) requires a confining zone(s) that is free of transmissive faults or fractures, while §146.81 defines this term as "A fault or fracture that has sufficient permeability and vertical extent to allow fluids to move between formations". We suggest the following modification to the definition in §146.81(d) in order to avoid unduly restricting movement that is merely between formations (compare our comments above on the definition of "confining zone"):

"Transmissive fault or fracture means a fault or fracture that has sufficient permeability and vertical extent to allow fluids to move ~~between formations~~ beyond a confining zone."

Secondary confining zone

§146.83 allows the Director to require additional confining zones, at his discretion. We do not believe that this will always be necessary – a good primary zone should be sufficient. Where additional hazards justify it, a secondary zone might be desirable. In all cases, we caution against relying on secondary confinement *in place of* establishing with a greater degree of certainty the suitability of the primary zone. Potential problems are best identified and anticipated early, and the focus should be on site characterization to show with confidence whether the confining zones are adequate. We suggest striking part (b) in §146.83 as it seems redundant. However, the Director must have the discretion to require a secondary confining zone if needed. We therefore recommend clarifying part (a)(2) to read explicitly:

"A confining zone, or zones, that ~~is~~ are free of transmissive faults or fractures and of sufficient areal extent and integrity to contain the injected carbon dioxide

stream and displaced formation fluids and allow injection at proposed maximum pressures and volumes without initiating or propagating fractures in the confining zone(s)"

The area of review provisions should be revised in several respects

Surprisingly, the definition of "area of review" (AOR) in §146.81(d) fails to mention that elevated pressure a critical aspect of what it means for an area to be "impacted" by injection activity. Our Environmental NGO Group recommends borrowing language from the proposed definition of "geologic sequestration project" and reworking the "area of review" definition.

An additional concern is that both §146.81 and §146.84(a) state that the AOR is "based on computational modeling". This could imply that the Area of Review could be based solely on computational modeling. Instead, the AOR should be based on computational modeling, monitoring and operational data (and kept updated until closure is approved). All references to computational modeling in relation to the Area of Review in this section, as well as in the definition of Area of Review in §146.81 should be amended as appropriate to read "based on computational modeling, as well as monitoring and other operational data." We urge that the definition be revised as follows:

> *"Area of review* means the area that may be impacted by the injection activity. The area of review is based on computational modeling, as well as monitoring and other operational data, that account for the physical and chemical properties of all phases of the injected carbon dioxide stream. It includes the subsurface three-dimensional extent, throughout the operating life of the facility, of the carbon dioxide stream plume, associated pressure front, and displaced formation fluids, as well as the overlying formations and surface area above that delineated region."

Even though proposed §146.84(f) requires "reevaluation" of the AOR at a "minimum" fixed frequency of ten years or "when operational and monitoring conditions warrant" (the "and" should be an "or"), §146.84 runs the risk that revisions will not be made on a timely basis. Default periods have a way of becoming the standard way of doing business. We recommend imposing a continual obligation on operators to assess *whether* the AOR should be revised, a requirement for an annual report stating whether circumstances during the preceding year warranted a revision, and a requirement that revisions be done when required by the Director as well as when the operator determines that conditions warrant. To accomplish this, it will be useful to break down the concept of "reevaluation" into two ideas – "assessment" of the need to revise the AOR and the actual process of "revision." There are several portions of §146.84 that will need to be changed in order to incorporate these suggestions. We believe that these suggestions will incentivize honest and truthful reporting of data and site performance while avoiding the excessive burden of "re-evaluating" or revising the Area of Review if such work is not needed. Moreover, a continuous obligation to assess whether revisions are needed, when coupled with the annual reporting requirement just suggested, will create a clear accountability trail for both operator and Director in case of disputes.

The rule should require updating when warranted of all of the proposed "plans" and should require an annual report that summarizes whether not updates have been warranted, and whether or not updates have been undertaken

We applaud EPA for proposing to require the creation, use, and updating of various "plans" during the operating life of a facility. By creating such an iterative process, and basing it on monitoring and other operational data that become available through time, EPA can assure that facilities are managed in a way that adapts to changing circumstances. This approach also has the potential to enable what the Preamble calls an "ongoing dialogue" between operators and regulators, especially if the rule is enhanced by the annual reporting requirement suggested below for inclusion in §146.91.

Perhaps inadvertently, the proposed rule does not explicitly require updating of several of the required plans. In most but not all cases, there is a rather ambiguous requirement to "maintain" a given plan. Explicit requirements to make updates as warranted appear to be missing from provisions relating to:

- the testing and monitoring plan required by §146.90 (the ambiguous word "maintain" is used and there appears to be no requirement that estimated plugging costs be kept current);
- the plugging plan required by §146.92 (again the ambiguous word "maintain" is used);
- the post-injection site care and site closure plan required by §146.93 (not only is the word "maintain" used, but the ambiguity inherent in this term is revealed by the instruction in §146.93(a)(3) to consider amendments to this plan "upon cessation of injection" – §146.93 might be read to mean that operators could "maintain" this particular plan simply by considering the need for amendment on one occasion over the life of the facility); and
- the emergency and remedial response plan required by §146.94 (there is no requirement here that the plan be updated as warranted – there is not even a requirement that the plan be "maintained."

An additional annual reporting requirement will enhance the ability of both Director and operators to keep track of which plans require updating and whether or not plans that ought to be updated have in fact been revised. Such a shared understanding is essential if there is to be the "ongoing dialogue" between regulators and operators that EPA anticipates. Our Environmental NGO Group considered supporting the inclusion of an annual report as described in the preamble at 73 Fed. Reg. 43518, but concluded that the benefits of that particular report would be outweighed by the burden. The annual report we are suggesting here, however, would be much simpler. We believe that EPA should require a report, signed by the appropriate company official, that:

- lists all of the required plans;

- confirms for each plan that the company has reviewed all monitoring and operational data since the previous annual report that is relevant to a decision on whether to update the plan;
- states with regard to each plan whether an update was determined to be warranted; and
- for those plans where the operator did decide that an update was appropriate, a statement that the update has or has not been completed and a summary of the modifications that have been made.

The rule should further provide that the Director has authority to require submission of copies of updated plans and/or further information regarding the reasons why updates of particular plans have or have not been done.

Cementing requirements for casings

§146.86(b)(3) requires the long string casing to be cemented by circulating cement to surface in one or more stages. It has come to our attention that may be hard to accomplish in some cases, such as very deep wells. We have also been alerted to disadvantages of this approach with regard to the weight of the cement column and its relation to well integrity. We urge EPA to fully consider the advantages and disadvantages of this approach. At a minimum however, the long string casing should be cemented to at least above the confining layer (caprock).

Cement bond logs and other outdated methods are not sufficient for establishing cement quality and integrity

Some of the techniques listed in §146.87(a)(2)(ii) and §146.87(a)(3)(ii), such as cement bond and variable density logs are no longer state-of-the-art, and do not reveal the nature or shape of any voids in the cement – instead they represents an average estimate of void space. To verify the integrity of cement behind casings, including the location of any channels, contamination or missing cement, the Director should require "a cement map that incorporates data from a cement bond log, a variable density display, and an ultrasonic image, unless an alternative evaluation based on equivalent or better technologies has been approved in writing".

Monitoring

In §146.90 the proposed rule outlines requirements for testing and monitoring. We strongly support the inclusion of such provisions. Monitoring is central to verifying and adapting the operational parameters of a GS project, while the concept of GS cannot be simply based on the premise of confinement without verification. We also support the provisions calling for a testing and monitoring plan, although we have suggested above that the requirements for updating this plan be strengthened. The collection of baseline data and information prior to the commencement of operations is also necessary for a number of monitoring techniques to produce useful results, and should be preserved.

The proposed rule outlines several different types of monitoring requirements: (a) analysis of the CO_2 stream; (b) continuous monitoring of injection pressure, rate and volume as well as other quantities; (c) corrosion monitoring for the well materials; (d) groundwater and geochemistry monitoring above the confining zone; (e) mechanical integrity testing; (f) pressure fall-off tests; (g) CO_2 plume and pressure front tracking; and (h) surface air monitoring.

We do not wish to comment on (c). We consider subpart (i), enabling the Director to require additional forms of monitoring, as well as subpart (j), calling for a quality assurance and surveillance plan, entirely appropriate. We consider (a), (b), (d), (e), and (f) and (g) to be essential elements of a sound monitoring system.

In particular, monitoring above the caprock, sometimes informally referred to as "above-zone monitoring, and covered in (d), is a tested monitoring method[23], and one that can be key to verifying the integrity and lateral extent of the caprock (or confining zone). We support its inclusion, but also recognize that it might not be necessary to employ this method every time. We would only consider its omission acceptable only if another method capable of testing and verifying the integrity of the confining zone is being used. Subpart (d) would also cover groundwater monitoring near the surface, at a long distance from the caprock. It is our understanding that researchers from the Lawrence Livermore National Laboratory are already confident in the merits of this approach and its accuracy in detecting small amounts of CO_2. We therefore recommend the following minor changes to §146.90(d):

> "Periodic monitoring of the ground water quality and geophysical, geochemical or other changes above the confining zone(s) that may be a result of carbon dioxide or other induced fluid movement through the confining zone or additional identified zones; provided however that the Director may instead require the inclusion of other methods that test and/or verify the integrity of the confining zone(s) with similar accuracy and to the same or larger areal extent.
> (1) […]"

We also strongly support monitoring to track the CO_2 plume. There is no unique method for doing this, and we do not believe that 4D-seismic techniques are appropriate or effective in all geologic settings, or that they should be made mandatory. However, tracking the extent of the CO_2 plume is generally possible and must be part of a comprehensive and credible monitoring plan and a GS project. Appropriate limits of accuracy will be needed, as neither tracking individual CO_2 molecules, nor to the nearest inch are feasible or desirable. However, the monitoring resolution must be such so as to enable confinement to be established, to give regulators confidence that the CO_2 and displaced fluids are not near potential leakage pathways, and to warn in advance of any remedial action that might be needed.

The "position of the pressure front" is not something that is as straightforward to establish as the extent of the CO_2 plume. As we have commented above, there is no distinct "front", or discontinuity, but rather a gradient in pressure that dissipates with distance away from the injection zone. Estimating the total injection footprint therefore will require appropriate

[23] Used successfully at the Frio pilot project, and already being considered for other projects.

thresholds to be defined in order to estimate the area of elevated pressure. Additionally, methods such as seismic surveys do not work in the same way for compressed brine as they do for CO_2-rich brine. Tracking the extent of the CO_2 plume is generally possible and must be part of a comprehensive and credible monitoring plan and a GS project. The extent of the area of elevated pressure will likely be estimated with a combination of measurements, inferences and modeling, but it is presently essential to have monitoring wells penetrating the confining zone to do this. Where the CO_2 plume itself is concerned, rather than the area of elevated pressure, the role of measurements (including indirect measurements such as seismic surveys) will and should be far greater than that of modeling.

Finally, surface air monitoring techniques will not always be necessary for GS projects. As with other monitoring methods, they may work well in particular settings but not in others (for example where distinguishing from natural variability or from baseline data is hard). Current scientific thinking also dictates that the CO_2 plume and confinement are best monitored near the injection zone or right above the caprock. This implies far greater depths, and a much larger distance between CO_2 and displaced fluids from USDWs. The Director should have the discretion to require such techniques, but we do not believe that they should be made mandatory for all permits nor should the rule be limited to listing specific techniques (which might be superseded or have preferable alternatives).

To capture the points made above and resolve current inaccuracies or limitations in the proposed language, we recommend the following additional changes in §146.90(g):

> "(1) Testing and monitoring to ~~track~~ establish the extent of the carbon dioxide plume ~~and the position of the pressure front~~ within defined thresholds, with the assistance of modeling tools where appropriate and through direct measurements or indirect, geophysical or other techniques ~~by either monitoring for pressure changes in the first formation overlying the confining zone or using indirect, geophysical techniques (e.g., seismic, electrical, gravity, or electromagnetic surveys and/or down-hole carbon dioxide detection tools)~~;
> (2) Testing and monitoring to establish the extent of the area of elevated pressure through direct measurements and the assistance of modeling tools."

and in §146.90(h):

> "At the Director's discretion, surface ~~air~~ monitoring methods ~~and/or soil gas monitoring~~ to detect movement of carbon dioxide that could signal endangerment of a USDW.
> (1) The testing and monitoring plan must be based on potential vulnerabilities within the area of review;
> (2) The monitoring frequency and spatial distribution of surface ~~air~~ monitoring ~~and/or soil gas monitoring~~ must reflect baseline data and the monitoring plan must include how the proposed monitoring will yield useful information on the area of review delineation and/or compliance with standards under 40 CFR 144.12"

Seismicity

Naturally occurring seismicity has been cited as an area of concern for geologic sequestration of CO_2. We do believe that seismicity merits diligent treatment both in the regulations and in project operation, but we see no need for a blanket ban of sequestration in seismically active areas. Although some sites – especially ones near major active faults – would not be advisable for injection, there are plenty of other sites in seismically active areas that would make excellent candidates for safe and effective sequestration. Moreover, tools to measure, predict and design against the effects of seismic activity are available.

Nature has proven its ability to retain fluids trapped in the subsurface in seismically active areas in many instances over hundreds of millions of years, even in highly tectonically active regions of the country such as California. The potential for slippage for faults to create leakage pathways to USDWs or the surface can be managed and effectively minimized through careful siting and operational design using well-established tools and methods. The regulations should ensure that suitable sites are selected, while high risk areas, such as those near major, non-sealing faults or those that demonstrate frequent activity, are rejected. The most likely potential CO_2 leakage paths would be injection wells, and not faults. However, these can be designed to prevent leakage and to be resilient to earthquakes.

We regard a ban on sequestration in seismically active areas unwarranted. We do however believe that additional diligence is required in site characterization and selection in such areas. The requirement in §146.82(c)(3) should be modified as follows:

> "Information on seismic history including the presence and depth of seismic sources and an assessment of ~~that~~ whether such seismicity would ~~not~~ interfere with containment;"

In addition, language should be added to the minimum criteria for siting in §146.83, clarifying that if induced or natural seismicity poses unacceptable risks, a permit will not be granted. In order properly to assess the risk of significant induced seismicity in light of permitted operating conditions, the rule may need to require applicants to submit information beyond what is currently required in proposed §146.82. The effects of any seismic events during project operation should also be taken into account when updating, or considering whether to update, the Area of Review and Corrective Action Plan, the Testing and Monitoring Plans, and the Emergency and Remedial Response Plans, as well as any other plans as necessary.

F. Conclusion

Our Environmental NGO Group appreciates the opportunity to provide comments to EPA on this most important rulemaking effort. A final rule will represent a significant step forward in combating global climate change, and the time is more than ripe for the U.S. to take such steps. When EPA issues its final rule, we feel it must be both technically sound and adaptive to reflect learning from experience with GS projects in as seamless a manner as is possible. We very much look forward to continuing to work with the Agency on this rule, as well as other efforts under

the Agency's existing authority to address the significant problem of climate change in the near term.

Respectfully submitted,

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