COMMENT #10

Comments of the NW Energy Coalition (NWEC), Climate Solutions (CS), Washington Environmental Council (WEC) and Natural Resources Defense Council (NRDC) on:
First Draft language for WAC 173-218 Geologic Sequestration of Carbon Dioxide

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The NW Energy Coalition (NWEC), Climate Solutions (CS), and Natural Resources Defense Council (NRDC) appreciate the opportunity to offer these comments on the *First Draft language for WAC 173-218 Geologic Sequestration of Carbon Dioxide*.

We commend WA DOE for the leadership role it has taken in establishing a statewide greenhouse gas (GHG) emission performance standard (EPS), and developing standards that protect, preserve and enhance our air, land and water. We strongly support the DOE's efforts to design and implement the EPS, to protect Washington from the significant financial and reliability risks associated with investments in highly carbon-intensive generating technologies and to help meet Washington and the Governor's GHG reduction goals.

We believe that thorough regulation is necessary at this time because of the potential risks to human heath and safety. Injected CO2 and any impurities it may contain have the potential to endanger USDWs or adversely affect human health". Additionally, it is essential that commercial carbon sequestration projects in WA follow established best practices and not be experimental in nature, continuing to display an impeccable track record that has been set internationally, if the technology is to gain public trust and contribute meaningfully to mitigating greenhouse gas emissions at scale. We also believe detailed site characterization is necessary because of the large injection volumes involved at the commercial scale and because of Washington's unique and complex geology".

We applaud DOE for the first draft language for WAC 173-218. We believe the language is a solid first start in creating a framework that protects and preserves our air, land and water. It is a strong effort on a very complex and groundbreaking topic.

We have provided detailed comments on certain sections in the draft, following general comments on the document. We hope that DOE finds the following comments to be helpful when deciding on the final language. Again, we are grateful to have the opportunity to provide this feedback.

General Comments
Below are general comments that relate to the overarching language and concept in the draft

rules.

Containment systems
We believe that a "containment system" should be used in place of "target formation" where appropriate. The term "formation" in geology has a different meaning to what we are trying to get at in some parts of the regulation. Formations can be geographically very extensive and homogeneous. The objective of sequestration is to contain CO2, and some formation will be involved in the injection, but our focus should be on the set of geologic features that will accept AND contain the CO2 through features, layers and other characteristics. We therefore urge the consistent use of the term "containment system" throughout the entire rule where appropriate.

Monitoring
The proposed draft wisely proposes that a monitoring program be agreed on before injection starts. The same should apply for a Mitigation and Remediation Program (MRP). It is important to have a plan of what to do if problems arise. For an excellent discussion, see the latest CA CCS report with a dedicated chapter to mitigation: http://www.energy.ca.gov/2007publications/CEC-500-2007-100/CEC-500-2007-100-SD.PDF, which is attached.

Modeling and monitoring need to inform each other in a feedback cycle: data gathered should be used to refine the models, and modeling projections should be used to update the monitoring array/methods. This should be clearly stated in the regulations. Initial modeling results and assumptions should be submitted with the permit and inform area of review, monitoring scheme etc.

Injectivity
We support the use of stronger standards for injectivity. For example, the CEC addresses the following, effective thickness and permeability, production/flow rate, delivery rate connectivity by collecting conventional core analysis, well logs, production history, stem or leak-off tests, and pressure tests. We believe that the following analysis should be required specifically until new technologies are proposed by the department: detailed stratigraphic analysis, population of static geological models, core plug analysis, conventional stimulation, well pump tests/stem tests and hydrofracture analysis.

Others
There was no mention of a risk assessment in the draft. This needs to take place along with site characterization.

Section: WAC 173-218 Definitions
We suggest that the "Caprock" definition should say, "means the geologic layer that prevents the upward migration of injected carbon dioxide."

We believe the definition of "geologic sequestration of carbon dioxide" should be altered to include the following:

• Sequestration cannot exist without monitoring and verification, which should be reflected in the definition. It is essential to prove and quantify retention for use to prevent the build-up of carbon dioxide in the atmosphere.

• We believe the words "intended to limit" should be replaced with "prevent". The statement "intention to limit" could carry a very light burden of proof and is not specific

enough for the regulation needed here.

• The line, "defined length of time." Should be augmented to include permanence. For example, the following phrase should be added, "and according to defined 'permanence' standards".

• The following definition for permanence should be included: "Permanent sequestration' means sequestration in a defined geologic containment system where site characterization, operational protocols and the use of established and proven monitoring and verification methods create a high degree of certainty that over 99% of the CO2 injected will remain sequestered for at least one thousand years."

Section: Permit Application
We believe that the first lines should read:

The application for a discharge permit authorizing the injection of carbon dioxide for geologic sequestration shall include information supporting the demonstration required by WAC 173-200-050(3)(b)(vi) and all of the following:

(1) A current surface site map showing the boundaries of the geologic sequestration target formation, the location and well number of all proposed CO2 injection wells, including any subsurface observation wells and the location of all other wells including cathodic protection boreholes and the location of all pertinent surface facilities within the boundary of the project;

(2)*(c) A geologic and hydrogeologic evaluation of the geologic sequestration target formation, including an evaluation of all existing information on all geologic strata overlying the geologic sequestration target formation including the immediate caprock containment characteristics and all designated subsurface monitoring zones. A trapping mechanism should be free of major non-sealing faults.* The *evaluation shall include any available geophysical data and assessments of any regional tectonic activity, local seismicity and regional or local faults, and a comprehensive description of local and regional structural or stratigraphic features, including any voids and conduits. The evaluation shall focus on the proposed CO2 containment system and provide a description of mechanisms of geologic confinement, including but not limited to the geophysical, geochemical and hydrogeological characteristics of the containment system with regard to their ability to prevent migration of CO2 beyond that proposed system. The evaluation shall also identify any productive oil and natural gas zones occurring stratigraphically above, below, or within the geologic sequestration target formation and all water-bearing horizons known in the immediate vicinity of the geologic sequestration target formation. The evaluation should include an analysis of CO2 pressure build up possibilities. This would take into effect reservoir transmissibility, injection rate, during of CO2 injection, total injection volume, boundary conditions, pressure volume temperature, injection depth, and relative permeability effects of CO2 injection into a brine filled reservoir. The evaluation shall include a method to identify unrecorded wells that may be present within the project boundary. The evaluation shall include exhibits and plan view maps showing the following:*

We believe that Project boundary/Area of Review needs to be defined for this section. The target formation may be hundreds of miles long/wide. We recommend using "project boundary" instead or "formation" and define it accordingly as stated above in our general comments.

2(c)(ix) Structural and stratigraphic cross-sections that describe the geologic conditions at the reservoir
A licensed geologist or engineer shall conduct the geologic and hydrogeologic evaluation required under this paragraph. Existing geologic, geophysical, geochemical, hydrogeological or engineering data available on the proposed project area may be incorporated into the evaluation provided their source and chronology is identified and the effects of any subsequent modifications due to natural (seismic or other) or human-induced (hydraulic fracturing, drilling or other) events are analyzed;

2(e) The proposed calculated maximum volume and aerial extent for the proposed containment system using a method approved by the department to and filed with the department;

(3) The projected temporal evolution and extent of the CO2 determined through proven and established modeling tools that utilize all available geologic and reservoir engineering information, and the projected response and storage capacity of the geologic sequestration target formation. The assumptions used in the model shall be clearly presented;

(4) Last line: *These emergency response procedures should be updated as deemed necessary by the Department throughout the operational life of the permitted storage facilities.*

(7) A leak detection and monitoring plan for all wells and surface facilities, where [define leak here] the.. The approved leak detection and monitoring plan shall address:
(a) Identification of any breach of the containment system by the CO2;
(b) Identification of potential release to the atmosphere;
(c) Identification of potential degradation of all groundwater resources; and
(d) Identification of potential migration of CO2 into any overlying oil and natural gas reservoirs.

Again, it is imperative that "containment system" be clearly defined during site characterization and any CO2 outside it be a trigger for action. Mitigation and remediation should be triggered when the CO2 is in a place that compromises the containment. Both the atmosphere and groundwater are way too late in the stage to be sufficient, and overlying oil&gas reservoirs again will not always be relevant.

(8) A geologic sequestration target formation leak detection and monitoring plan utilizing subsurface observation wells to monitor any movement of the CO2 volume outside of the permitted geologic sequestration target formation. This must include the collection of baseline information of CO2 background concentrations in groundwater, surface soils, and within the geologic sequestration target formation. The approved subsurface leak detection and monitoring plan shall comprise proven and established monitoring methods for the specific geology of the formation, and be dictated by the site characteristics as documented by materials submitted in support of the application with regard to CO2 containment and address:
(a) Identification of any breach of the containment system by the CO2;

Also included in section (8) should be the following language:

(8+) A risk assessment that describes and quantifies features, events and processes that might result in undesirable impacts to human health and environment;

(8++) A mitigation and remediation plan (MRP), to be approved by the Department before injection begins, that identifies trigger thresholds and corrective actions to be taken if the CO2 breaches the containment system, contaminates groundwater or is released to the atmosphere.

The following language should be added to section 11:

(11+) A performance bond for **the geologic formation** to department in an amount established by the department. The amount of the bond shall be sufficient to provide financial assurance to the department to cover the necessary mitigation and remediation of CO2 breaching the containment zone and/or any related effects on human health or environment;

Section: Geologic Sequestration Well Standards
The following language should be considered for addition to this section.

(1) Casing materials and cement must be designed, tested and maintained to withstand the reactive fluids and expected conditions encountered during the lifetime of the geologic sequestration projects

Section (7)(b) requires cement evaluation. We believe that new generation techniques should be required, given that cement bond logs are thirty years old and only represent an average measurement that could very well miss leakage pathways. For example, the use of ultrasound instead of sonic waves would be more appropriate. It may be the best to require BACT for this section. Below is language that would reflect this:

"Unless an alternative evaluation is approved by the department, the integrity of cement behind casings, including the location of any channels, contamination or missing cement, shall be verified by a cement map which incorporates data from a cement bond log, a variable density display, and an ultrasonic image."

Section: Permit Terms and Conditions
The following changes should be considered for this section.

1(a)(i)Hold carbon dioxide in the geologic sequestration containment system "permanently" as defined...
(ii) The caprock(s) above the geologic sequestration target formation in conjunction with other trapping mechanisms has/have the appropriate characteristics to provide...

(b) A monitoring program comprising proven and established methods for the specific geology of the formation has been developed that is likely to identify breaching of the containment system by the CO2, ground water quality degradation in shallower aquifers prior to degradation of any potable aquifer and leaks to the atmosphere. The detection ...

(c) Design and construction standards of all facility structures and wells are sufficient to prevent migration of carbon dioxide or non-potable water outside the containment system and/or into shallower aquifers that will degrade water quality in the shallower aquifers or impact beneficial uses, and/or the atmosphere.

(4) If the operator identifies migration of the CO2 outside the defined containment system

and/or water quality degradation in shallower aquifers or leaks to the surface, including those around wells or within well casing, the operator must:

(c) Obtain approval of a new definition of the containment system and its relevant dimensions by the Department or stop injecting immediately;

(d) Implement a mitigation and remediation plan to arrest, reverse and remediate environmental impacts. The mitigation and remediation plan shall be developed in consultation with the department.

(5) Monitoring for Geologic Sequestration projects shall include but not be limited to:

5(e) Quantities sufficient to deduce the spatial distribution of the CO2 in the subsurface.

6(e) Updated modeling and monitoring results that project and/or establish the spatial distribution of CO2 in the subsurface.

7(a) Updated monitoring results that establish the spatial distribution of CO2 in the subsurface.

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7(b) Updated modeling results that project the spatial distribution of CO2 in the subsurface based on the latest monitored data, as well as a discussion of history matching and an assessment of the model's accuracy to date.

Section: Closure
The following language should be considered for addition to this section.

If carbon dioxide injections stop for a period of 90 days or more, the operator shall begin implementing the approved closure plan. The department may extend this 90 day period, in writing, upon the request of the operator, if the operator demonstrates genuine technical or other reasons for the interruption and the feasibility of resuming carbon dioxide injection within one year without a significant risk of a similar interruption.

Section: Post Closure Activities
The following language should be considered for addition to this section.

The operator is obligated to renew and be covered under permit and pay all appropriate permit fees throughout the post closure period. The operator shall continue all required monitoring and reporting throughout the closure and post closure period. The post closure period shall continue until modeling and monitoring demonstrate that conditions in the geologic sequestration target formation have stabilized so that there is little or no risk of future environmental impacts and that there is high confidence in the containment system and the related trapping mechanisms.

Section: Mitigation and remediation plan
The following language should be considered for addition to this section and title.

Must be submitted before injection and identify risks, thresholds and actions. See AB1925 report chapter from California Energy Commission: http://www.energy.ca.gov/2007publications/CEC-500-2007-100/CEC-500-2007-100-SD.PDF, which is attached to these comments.