

April 20, 2026

State Fire Marshal Daniel Berlant
Office of the State Fire Marshal
715 P St
Sacramento, CA 95814

Re: Water Quality Comments on the Draft Regulations for Carbon Dioxide Pipeline Safety Standards

Dear State Fire Marshal Berlant,

We, the undersigned organizations, submit these comments on the [draft regulations](#) implementing Senate Bill 614. These comments focus on threats to water quality and are meant to be a companion to the [comments](#) that some of our organizations previously submitted on the draft regulations. Our organizations represent communities, workers, and residents across California's Central Valley and beyond who would bear the direct impacts of carbon capture, utilization, and storage (CCUS) infrastructure development, including the construction and operation of high-pressure CO₂ pipelines.

We appreciate the State Fire Marshal's efforts to develop comprehensive safety standards and the opportunity to provide input on the draft regulations. Given the significant impacts that CO₂ pipelines can have on our communities, emergency regulations must be focused on protecting health and safety. Below we share our concerns about impacts to water if CO₂ pipelines were to leak and our recommendations for strengthening the regulations to address these concerns.

Threats to Water Quality from CO₂ Pipelines are a Major Concern

We are particularly concerned about threats to water quality in places where CO₂ pipelines might cross, or pass under, marshes, rivers, wetlands, shallow drinking water aquifers, estuaries or other bodies of water. It is well documented that when CO₂ mixes with water, carbonic acid is created.¹ And there is evidence discussed below that such acid can increase concentrations in water of harmful metals such as arsenic and lead. Any leaks of CO₂ from CO₂ pipelines would mix with fresh water or seawater outside the pipelines, creating carbonic acid which could threaten adjacent water supplies and the people, plants, and animals that depend on them. Below, we share findings from several studies of the risks that CO₂ intrusion would pose to water quality. This field of research is still emerging, particularly as it pertains to marine environments, but there is enough information to support the enactment of protective regulations.

EPA has expressed concern about the impact of acidity on both water quality and aquatic life. The agency explained that acidity of water is measured on a 14-point pH scale with 7 meaning neutral, numbers less than 7 signifying increasing acidity and numbers greater than 7 signifying that the water is increasingly basic,² or not acidic.³ Each whole number increase or decrease in the pH scale reflects a 10-fold change in

acidity. In other words, water with a pH of 6 is ten times more acidic than water with a pH of 7. “A change in pH can alter the concentrations and forms of toxic chemicals in water,” EPA wrote in 2021. “Metals such as aluminum, lead, mercury, copper, and arsenic are generally more soluble at a lower pH. Therefore, higher concentrations can be absorbed into the tissues of organisms, rendering these metals more toxic to aquatic life.” The EPA added that pH can have far-reaching impacts on aquatic life:

...pH also plays a key role in aquatic health by affecting biochemical processes and the metabolism of aquatic organisms. Generally, if water is too acidic or too basic, damage can occur to an organism’s gills, exoskeleton, fins, and other critical components. Of particular concern are pH sensitive macroinvertebrates (small organisms without a backbone), fish eggs (most fish eggs cannot hatch at a pH less than 5), and juvenile fish.... even though an organism itself may tolerate a more extreme pH, its food source may not.⁴

Experimental and modeling studies show that leakage of CO₂ into groundwater can increase acidity and create harmful levels of toxic metals in the water. Though these studies were conducted to examine the potential risks of storing CO₂ underground, they are also relevant to risks associated with pipelines that pass underneath water sources as the pipelines transmit CO₂ to storage sites. A 2016 paper published in the *International Journal of Greenhouse Gas Control* found that CO₂ infiltration can negatively impact water quality:

A major concern about [global carbon sequestration] is the possibility of CO₂ leakage into the atmosphere and into underground drinking water resources through conductive pathways. Observations at natural analog sites in New Mexico and Arizona have documented the upward intrusion of injected CO₂ and brackish brine into shallow drinking water aquifers through fault zones (citation omitted). Experimental and modeling studies, including both multi-phase flow and reactive transport simulation and reduced order models, have shown that CO₂ enrichment can reduce pH, increase total dissolved solids, and mobilize metals.⁵

A study published in the same journal in 2015, provided experimental evidence that when sediments from an aquifer were exposed to CO₂ in the presence of synthetic groundwater, “National drinking water regulations were exceeded” for several metals in the groundwater, including arsenic, lead, and mercury, “despite low levels of these contaminants found in the sediments.”⁶

All three of the metals identified as capable of leaching into an aquifer—a potential source of human drinking water—are harmful substances that can cause negative health impacts:

- *Arsenic*: The Department of Health and Human Services,⁷ EPA, and the International Agency for Research on Cancer have found that arsenic causes

cancer. In addition, arsenic can be deadly when ingested at high levels; exposure to lower levels can cause nausea and vomiting, decreased production of red and white blood cells, damage to blood vessels, and abnormal heart rhythm, and a feeling of “pins and needles” in hands and feet.⁸

- *Lead*: The Department of Health and Human Services’ Agency for Toxic Substances and Disease Registry reports that lead can affect almost every organ and system in the body, with particular harm to the nervous system. Long-term exposure can result in decreased learning, memory, and attention, and high levels of exposure can severely damage the brain and kidneys and can cause death.⁹
- Mercury, like lead, can affect the nervous system and the kidneys. Exposure can impair physical coordination, vision, learning and memory. High levels of exposure are associated with birth defects.¹⁰

In a paper published in *Environmental Science & Technology* in 2010, researchers reported similarly alarming releases of dangerous metals when sediment samples from aquifers were placed in water that was exposed to CO₂. The authors found that the CO₂-infused water contained increased acidity and metals including aluminum, cadmium, barium and uranium, at levels that approached or exceeded the U.S. EPA’s maximum contaminant levels (MCLs).¹¹ MCLs are the maximum level of a contaminant that EPA allows in water delivered by a public water system.¹² Any exceedances of MCLs would make water unsafe to drink, as cumulative exposures to substances at levels above the MCL can cause serious health effects in humans. For example:

- *Aluminum*: High levels in the body have been linked in some cases with Alzheimer’s disease and may cause brain and bone disease in children with kidney disease.¹³
- *Cadmium*: Drinking water with very high cadmium levels severely irritates the stomach, leading to vomiting and diarrhea, and sometimes death. Oral intake can lead to an accumulation of cadmium in the kidneys that can damage the kidneys. Long-term exposure to lower levels of cadmium can cause bones to become fragile and break easily.¹⁴
- *Barium*: Drinking very large amounts can cause changes in heart rhythm, paralysis, or even death. Eating or drinking somewhat smaller amounts for a short period may result in vomiting, abdominal cramps, diarrhea, difficulties in breathing, increased or decreased blood pressure, numbness around the face, and muscle weakness.¹⁵
- *Uranium*: Ingesting water-soluble uranium compounds can cause kidney damage. Although uranium is radioactive, neither the National Toxicology Program nor the EPA has classified natural uranium as a carcinogen.¹⁶

In addition to these studies showing negative impacts of CO₂ infusion on fresh water, other studies have shown that leaks of CO₂ in marine environments can negatively impact marine life. In a paper published in *The International Journal of Greenhouse Gas Control* in 2015, researchers reported on an experiment in which they injected more than four tons of CO₂ into the seabed approximately 860 feet off the coast of Scotland,

27 feet under the sea floor beneath 25-30 feet of water, for 37 days. The authors found that at low tide, the CO₂ in deeper sediment areas transferred to shallower sediment and spread over a wide area, reducing the sediment pH (increasing acidity) by 1.5 to 2 points. The baseline pH, apparently for both the sediment and overlying seawater, was 8. There was a continuous release of CO₂ to the overlying seawater, decreasing pH (increasing acidity) by 1.5 to 2.2 points but without a diffusion of the lower pH water to a wider area. At high tide, increased water pressure caused the CO₂ to transfer from the deeper to shallower sediment at a lower rate. The pH dropped in the shallow sediment by only about 0.5 points and, because there was a diminished release of CO₂ into the seawater, pH in the seawater dropped by only about 0.3 points. After the CO₂ injection ended, the sediment's pH gradually returned to background levels.¹⁷

In a second related paper published in *The International Journal of Greenhouse Gas Control* in 2015, a different team of researchers reported on the CO₂ released under the seabed off the coast of Scotland. They found that “[i]ncreased levels of dissolved inorganic carbon (DIC) were detected in the pore waters close to the sediment-sea water interface in sediments sampled closest to the subsurface injection point within 5 weeks of the start of the CO₂ release.” They found that pore waters with high concentrations of DIC had enhanced concentrations of metals including calcium, iron, and manganese, but that “the pore water metal concentrations did not exceed levels considered to be harmful to the environment.” They also observed that the chemical composition of the pore waters “rapidly returns to background levels within 2 weeks of the end of the CO₂ injection.”¹⁸

However, the researchers commented that they had significant environmental concerns about CO₂ leakage:

[n]evertheless, the overall increase in pore water metal concentrations... even at low CO₂ leakage rates... indicates that release of metals will occur and concentrations can be expected to be significantly higher at higher leakage rates and/or leakage duration. Moreover, if sites are contaminated by, for example, drill cuttings that can have order of magnitude higher metal contents than normal sediments [citation omitted], or they are located in polluted areas such as the proposed CO₂ storage site in Suances (N-Spain) estuary, then the potential for release of harmful levels of metals may be higher still.¹⁹

The authors also noted that “our data clearly demonstrate that the impact of CO₂ on the benthic ecosystem is not confined to sea floor features, such as pock marks and gas bubbles streams that are easily recognized using conventional monitoring tools.”²⁰

In a 2015 paper published in *The International Journal of Greenhouse Gas Control*, a third group of researchers studied the CO₂ leak off the coast of Scotland and found “a significant negative impact on the structure and diversity of the resident macrofauna community in the immediate vicinity of the leak,” as measured in core samples taken of the seabed. “This negative impact consisted of an overall reduction in species diversity,

abundance and biomass.” They also found that the negative impacts were limited to a small area around the site of the CO₂ release and that significant recovery of macrofauna was observed within 18 days after the leak stopped. The researchers concluded that even small leaks of CO₂ can cause harmful effects and, at the same time, the impacts in this study suggest that impacts may be limited if leaks are detected and stopped quickly. The researchers found that most of the impact of the CO₂ was in the sediment, “with little evidence of acidification in the overlying water.”²¹

The researchers noted that it could be difficult to differentiate impacts on species from CO₂ leaks and impacts on species caused by natural fluctuations or events like storms, especially if it is difficult to know when or where a CO₂ leakage has occurred. The authors suggest that one method to address this situation would be to conduct baseline measurements over the course of many years of species in an area slated for CO₂ storage. They acknowledge that such a study would be very expensive. They propose that “a possible alternative approach could be to identify some measures of community health that are not affected by seasonal cycles” that could be used to detect impacts from CO₂ leakage. They add that “the application of these indices and measures to CCS impact has yet to be tested.”²²

In summary, CO₂ releases into, or immediately beneath, water bodies would be expected to lower the pH and mobilize hazardous metals from sediments, threatening aquatic biota and water quality. Explosive releases of large volumes of CO₂ beneath relatively shallow water would be expected to quickly rise to the surface and be released to air.

Recommendations for Draft Regulations

Based on the science, we recommend several additions to the draft regulations including improved monitoring of pipelines for leaks where pipelines cross water, development of methods to detect environmental impacts due to leaks, and collection of data specific to the type of water body being crossed by a CO₂ pipeline before such a pipeline is installed. Recommended additions are listed below in red under each section heading.

§ 2174.1 Valves

(2) Valves shall not be placed further than 7 ½ miles apart on pipelines located in high population areas or other populated areas as defined by 49 CFR §195.450. **Valves shall be placed in a CO₂ pipeline just before the pipeline passes through or underneath a body of water and just after the pipeline passes through or underneath a body of water so that, in the event of a leak in that portion of the pipeline that passes through or underneath a body of water, the valves can be turned off to prevent the flow of CO₂ into that portion of the pipeline.**

§ 2175. Pressure testing and spike testing

“All carbon dioxide pipelines must be tested or internally inspected at least once every 5 years (60 months).” Testing on a more frequent basis shall be required in the event of newly developing geohazards, recent nearby seismic activity, or on the portion of a CO2 pipeline that passes through or underneath a water body.

§ 2177 Emergency planning zone inventory and map.

51015.06. (a) (1) An operator of a pipeline transporting carbon dioxide shall submit to the State Fire Marshal and the public agency that is the lead agency for the project that includes the pipeline for purposes of the California Environmental Quality Act (Division 13 (commencing with Section 21000) of the Public Resources Code) an emergency planning zone inventory and map that includes all of the following:

(A) A list of all sensitive receptors within the emergency planning zone that encompasses the pipeline. Sensitive receptors shall include all water bodies or wetlands through or under which the pipeline is expected to pass.

§ 2178. Emergency Preparedness

(a) Training. Pipeline operators must provide annual training services for State and local emergency services, and disaster agencies for training, exercises, and equipment related to carbon dioxide pipelines. Training shall be offered to all emergency responders and interested parties, including hospitals and residents, and other utilities, along the route of the pipeline within 5 miles of the centerline of the pipe. At a minimum training shall include:

- (1) How to identify a carbon dioxide release and consequences of a carbon dioxide release, including a release in or underneath a water body,
- (2) Communications procedures to inform of a carbon dioxide release, including alarms, sirens, text message alerts, and other means of alerting the public,
- (3) Procedures for relocating residents and others in the affected area, evacuation routes, and transportation for those impacted by a release to health care facilities,
- (4) Signs and symptoms of exposure to a carbon dioxide release.
- (5) Procedures for inspecting the affected areas prior to repopulation or any affected water body prior to reuse for at least the following: (i) Presence of CO2 or other hazardous substances that may impact the health of sensitive receptors

(c) In addition to any other information required as part of an application to approve construction of a carbon dioxide pipeline, the owner or operator of the pipeline shall

provide a risk analysis to the State Fire Marshal's Office, and State or local permitting agency. The State or local agency may consult with the State Fire Marshal's Office regarding the Risk Analysis prior to operation of the pipeline. The Risk Analysis shall include, at a minimum:

(1) Pipeline specific vapor dispersion and plume modeling that incorporates terrain, obstacles, buildings, time and spatial variations in wind that incorporate changes in direction and speed, ambient weather conditions, variations in the direction of a release, and concentrations and duration of carbon dioxide,

(2) Pipeline design specifications including diameter, thickness, shutoff valves,

(3) An owner or operator shall submit a redacted version of the risk analysis to the State Fire Marshal for posting to their website. Redactions shall be consistent with the Public Records Act or other applicable law. This information shall also be published to both the owner and operator's website and the State Fire Marshal's website. Complete versions of the risk analysis shall be provided to State and local emergency management agencies.

(4) Description of the likely effects on water quality and aquatic life in the particular water bodies through or under which the CO₂ pipeline is expected to pass if there were a leak in the portion of the CO₂ pipeline that passed through or under the water body. This description shall incorporate the information specified in subsection (h) and any other relevant information.

(g) Should a pipeline failure occur, that pipeline shall remain non-operational until an investigation is completed that determines the origin and cause of the failure. The State Fire Marshal, in consultation with appropriate State, Federal, and local agencies, shall determine if or when a pipeline may resume operations. In addition, should a portion of a pipeline that passes through or under a water body fail, the State Fire Marshal, in consultation with appropriate State, Federal, and local agencies shall determine if the water and, if applicable, the sediment, is free of contamination from at least the following analytes: aluminum, arsenic, barium, cadmium, calcium, iron, lead, manganese, mercury, pH, and uranium. If any of these substances, or other harmful substances, are found in the water at concentrations exceeding public health standards, the State Fire Marshal, in consultation with appropriate State, Federal, and local agencies shall immediately take action necessary to protect public health such as alerting relevant water providers or closing the water body to swimming. These protective actions shall continue until the appropriate agencies have determined that the concentrations are reduced to safe levels. Testing results shall be maintained by the Fire Marshal for public inspection.

(h) Prior to commencing operation of a carbon dioxide pipeline, the State Fire Marshal shall ensure that

- 1) There is water quality testing of any source of groundwater or drinking water through or under which the pipeline shall pass. The testing shall occur at least four times over the course of a year, once in each season: winter, spring, summer, and fall and shall test for water quality during representative conditions (e.g. drought and high flow). Testing shall establish the concentrations of at least the following analytes: aluminum, arsenic, barium, cadmium, calcium, iron, lead, manganese, mercury, pH, uranium. The results shall be maintained by the Fire Marshal and subject to public inspection.
- 2) There is testing of the sediments in any water body under which the pipeline shall pass. Testing shall occur at multiple points along the projected path of the pipeline including any points known to contain high concentrations of metals. The testing shall establish the concentrations of at least the following analytes: aluminum, arsenic, barium, cadmium, calcium, iron, lead, manganese, mercury, pH, uranium. The results shall be maintained by the Fire Marshal and subject to public inspection.
- 3) There is a description of the water bodies or wetlands through or under which the pipeline will pass including their type (e.g. ocean, lake, river) and type of water (salt water, brackish, fresh) as well as a list of the aquatic life found in these water bodies or wetlands and the aquatic life in the sediments of these water bodies or wetlands. The lists of the aquatic life in the water bodies and/or their sediments shall include any endangered and/or threatened species. These descriptions shall be maintained by the Fire Marshal and subject to public inspection.

Public health must be the focus of the regulations

The State Fire Marshal's regulations must be grounded in a public health framework that prioritizes protection of human life above all other considerations, including economic development, industry convenience, or technological aspirations for carbon capture deployment. By incorporating into the CO2 pipeline regulations information about the potential effect of CO2 leakage on water quality, the Fire Marshal can help ensure strong protection of public health and safety.

We appreciate your consideration of these comments and stand ready to provide additional technical input or community perspectives as you finalize these critical safety regulations.

Sincerely,

Science and Environmental Health Network

Food & Water Watch

SF Baykeeper

Restore the Delta

Interfaith Climate Action Network

Oil and Gas Action Network

Sierra Club California

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