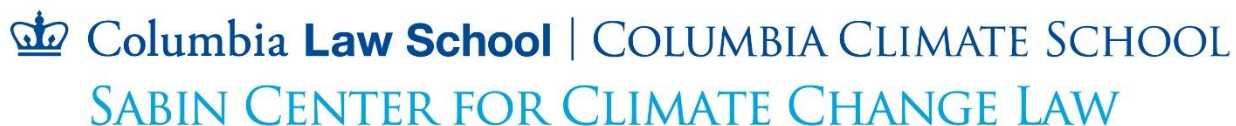

October 6, 2025

California Air Resources Board

VIA ELECTRONIC SUBMISSION

Re: Information Solicitation to Inform Implementation of Carbon Capture, Removal, Utilization, and Storage Program: Senate Bill 905

Columbia Law School's Sabin Center for Climate Change Law ("Sabin Center") respectfully submits these comments in response to the California Air Resource Board's ("CARB") solicitation for feedback to inform the implementation of Senate Bill ("SB") 905 (Caballero, Statutes of 2022).[1]

An academic think tank housed at Columbia Law School, the Sabin Center works to develop innovative legal tools to combat the climate crisis and advance climate justice. Through its initiative on "carbon management and negative emissions technologies," the Sabin Center analyzes existing legal frameworks for point-source carbon capture and storage ("CCS") and atmospheric carbon dioxide removal ("CDR") both domestically in the U.S. (at both the federal and state levels) and internationally.[2] We also recommended legal reforms to advance safe, responsible, and just CCS and CDR to help mitigate climate change.[3] In all of our work, we recognize that CCS and CDR are at best a complement to, and cannot substitute for, deep decarbonization of the global economy. We are encouraged to see this reflected in SB 905, which

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[1] Cal. S.B. 905 (2021–2022 Sess.), ch. 359 (Cal. 2022).

[2] *See e.g.,* MICHAEL B. GERRARD & TRACY HESTER, CLIMATE ENGINEERING AND THE LAW: REGULATION AND LIABILITY FOR SOLAR RADIATION MANAGEMENT AND CARBON DIOXIDE REMOVAL (2018); Romany M. Webb, Martin Lockman & Korey Silverman-Roati, *Removing Methane via Atmospheric Oxidation Enhancement: The Legal Framework*, SABIN CENTER FOR CLIMATE CHANGE LAW (2024), https://scholarship.law.columbia.edu/sabin_climate_change/229/; Romany M. Webb, *The Law of Enhanced Weathering for Carbon Dioxide Removal*, SABIN CENTER FOR CLIMATE CHANGE LAW (Sep. 2020), https://scholarship.law.columbia.edu/sabin_climate_change/46/.

[3] *See e.g.,* Ashwin Murthy, Korey Silverman-Roati & Romany M. Webb, *State Authority to Regulate Ocean Alkalinity Enhancement*, SABIN CENTER FOR CLIMATE CHANGE LAW (Dec. 2024), https://scholarship.law.columbia.edu/sabin_climate_change/237/; Korey Silverman-Roati & Romany M. Webb, *International Legal Guidelines for Marine Carbon Dioxide Removal Governance under the London Convention and London Protocol*, SABIN CENTER FOR CLIMATE CHANGE LAW (Aug. 2025), https://scholarship.law.columbia.edu/sabin_climate_change/255/.

notes the need to prioritize "[r]educing the emissions of greenhouse gases" and "[r]educing fossil fuel production." We urge CARB to keep this overarching objective in mind in developing its approach to implementing SB 905. Below, we offer more detailed responses to several of the questions posed by CARB. Our comments focus specifically on questions 1, 2, 3, 4, 6, 7, 18 and 27.

Questions 1 and 2: **Definition of terms used in SB 905**

Several of the terms used in SB 905 are ambiguous and require further definition to clarify their scope and avoid inadvertently excluding key CDR approaches. We make five key comments in this regard.

First, section 2 of SB 905 defines the term "carbon dioxide capture, removal, or sequestration project" to mean "a carbon dioxide capture project, a carbon dioxide removal project, or a sequestration project that seeks to provide for the long-term isolation of carbon dioxide from the atmosphere through storage in a geologic formation." It is unclear, from this definition, whether the requirement for "storage in a geologic formation" applies only to sequestration projects or also to CCS and CDR projects. Requiring geologic storage of carbon dioxide for all CDR projects would significantly limit the CDR approaches that could be supported via the Carbon Capture, Removal, Utilization, and Storage Program established through SB 905. Many CDR approaches achieve the long-term isolation of carbon dioxide from the atmospheric – as required by the definition of section 2 – but through means other than geologic storage. For example, in enhanced rock weathering, carbon dioxide is durably stored in the form of carbonate minerals on land or in the ocean.[4] Other parts of SB 905 suggest that the legislature did not intend to exclude this and other forms of durable CDR simply because they do not involve geologic storage of carbon dioxide. Most notably, section 2 of SB 905 defines "CDR technology" to include any activity that removes carbon dioxide from the atmosphere and puts it into long-term storage, without requiring that storage be in geologic formations. To remove any uncertainty, CARB should clarify that geologic storage is not required for all CDR projects.

Second, we recommend that CARB clarify the terms "long-term isolation" in the definition of "carbon dioxide capture, removal, or sequestration project," and "long-term storage" in the definition of "CDR technology" in section 2 of SB 905. The statute does not specify how long carbon dioxide must be isolated or stored for it to qualify as "long term" however, in other California legislations, a duration of at least 100 years has been required. For example, earlier this year the legislature enacted SB 643, which states that CDR projects must result in "storage of removed gases without leakage to the atmosphere that is sufficient long enough to ensure that the risk of leakage poses no material threat to public health, safety, the environment, or the

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[4] Intergovernmental Panel on Climate Change, Assessment Report 6 Working Group III: *CDR Factsheet*, https://www.ipcc.ch/report/ar6/wg3/downloads/outreach/IPCC_AR6_WGIII_Factsheet_CDR.pdf.

achievement of net zero greenhouse gas emissions in California, and shall not be less than 100 years."[5] Similarly, here, CARB should define "long-term" isolation and storage for the purposes of SB 905 as requiring carbon dioxide to remain out of the atmosphere for at least 100 years. Shorter duration isolation / storage does not adequately compensate for fossil fuel emissions, which remain in the atmosphere for centuries to millennia,[6] and thus allowing it would be inconsistent with California's net-zero goals which SB 905 intends to advance.

Third, the definition of "CDR technology" refers to approaches that "use technologies or engineered strategies to remove carbon dioxide from the atmosphere," but it is unclear what approaches this would include. Some CDR approaches do not use "technologies" as that term is commonly understood. For example, activities such as afforestation and reforestation and soil carbon do not ordinarily involve technologies or engineered strategies, but might in some cases (e.g., where drones are used for planting seedlings or biochar is used to enhance soil carbon). Other approaches might incorporate both engineered and non-engineered components. Enhanced weathering, for example, is based on natural rock weathering processes but uses technologies to enhance it. It is unclear whether and how these types of approaches fit within the definition of "CDR technology." CARB should seek to clarify this.

Fourth, adding definitions that distinguish between research and deployment may also be valuable, as a number of CDR approaches – both marine and terrestrial – are still nascent and require further research. The approach to regulating research may differ from regulating deployment, such as through requirements for open data policies or through differing scales of environmental permitting. Remaining scientific questions on the effectiveness of different CDR techniques may require field trials, including relatively large-scale or long-duration trials. As the goals of these field trials differ, i.e., they are focused on research goals rather than the generation of carbon credits or offsets, their regulation may also differ. The Sabin Center's model legislation on marine CDR includes definitions on "deployment" and "research projects" which may be instructive.[7] These definitions are distinguished on the amount of carbon dioxide the project proposes to remove.[8]

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[5] Cal. S.B. 643 (2025-2026 Sess.), ch. 8.5 (Cal. 2025).

[6] *See* e.g., Cyril Bruner, Zeke Hausfather & Reto Knutti, *Durability of carbon dioxide removal is critical for Paris climate goals*, COMMUNICATIONS EARTH & ENVIRONMENT (Nov. 11, 2024), https://www.nature.com/articles/s43247-024-01808-7.

[7] Romany M. Webb & Korey Silverman-Roati, *Developing Model Federal Legislation to Advance Safe and Responsible Ocean Carbon Dioxide Removal Research in the United States*, SABIN CENTER FOR CLIMATE CHANGE LAW (Mar. 2023), https://scholarship.law.columbia.edu/sabin_climate_change/199/ ("Deployment" is defined therein as "an activity or project that involves the use of an ocean carbon dioxide removal technique to remove a total of 100,000 metric tons or more of carbon dioxide from the atmosphere or such other amount as the [lead agency administrator] may specify in regulations adopted pursuant to section 3(b) of this Act."
"Research project" is defined as "an action or activity undertaken in U.S. ocean waters for the primary purpose of advancing scientific understanding of ocean carbon dioxide removal techniques. Research projects may involve the development, testing, evaluation, and demonstration of ocean carbon dioxide removal techniques. Research projects exclude deployment, as defined herein.").

[8] *Id.*

Fifth, in Section 71460, the definition of "[g]eologic storage reservoir" includes "depleted oil and gas reservoirs and saline formations," but CARB could clarify that there are other formations suitable for carbon dioxide storage, such as basalt formations. Basalt rocks cause rapid mineralization of carbon dioxide, leading to minimal risk of carbon leakage as compared to other forms of geologic storage.[9]

Question 3: Marine CDR within CCS and CDR Project Categories

The list of project categories should explicitly include marine CDR which could fall under the ambit of SB 905. For example, direct ocean capture and storage, i.e., when carbon dioxide is captured from ocean waters and stored in geologic formations in the ocean or on land, would fall under the definition of "[c]arbon dioxide capture, removal, or sequestration project." The ocean absorbs over 25 percent of anthropogenic carbon dioxide emissions annually. This natural ability to draw down and store carbon dioxide makes the ocean a potentially massive contributor to global climate mitigation, providing CDR approaches that are potentially both scalable and long-term.[10] To avoid confusion, CARB should include marine CDR as a general project category.

Question 4: Need for Further Description of CCS and CDR Project Categories

CARB should clarify the distinctions between CDR and CCS techniques. The general project categories developed by CARB lump different approaches together, even where they involve fundamentally different activities, have different benefits and risks, and thus require different oversight and regulation. For example, CARB's information request lists a broad category that includes both "[c]arbon capture from large emitters and ambient air for 'permanent' sequestration through utilization," but these are fundamentally different processes. CCS aims to limit further additions of greenhouse gases to the atmosphere, and is often attached to large emitters such as fossil fuel plants.[11] CCS is a subset of CDR, which encompasses a broader set of approaches. CDR is used to remove legacy emissions that currently exist in the atmosphere, which CCS does not address.[12] Therefore, the two involve different approaches and goals, with differing applicable

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[9] Grant Charles Mwakipunda, *A review on carbon dioxide sequestration potentiality in basaltic rocks: Experiments, simulations, and pilot tests applications*, 242 GEOENERGY SCIENCE AND ENGINEERING (2024), https://www.sciencedirect.com/science/article/abs/pii/S2949891024006237 ("It has been found that basaltic rocks can store more than 95% of injected CO_2 as carbonate minerals through the mineral carbonation process within 2 years, as reported from two pilot tests with a minimum leakage risk than other storage geological options.").

[10] NATIONAL ACADEMIES OF SCIENCES, ENGINEERING AND MEDICINE, A RESEARCH STRATEGY FOR OCEAN-BASED CARBON DIOXIDE REMOVAL AND SEQUESTRATION 39-76 (2022), https://nap.nationalacademies.org/read/26278/chapter/2.

[11] Core Writing Team, *Climate Change 2023: Synthesis Report. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*, INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE 86 (2023), https://www.ipcc.ch/report/ar6/syr/downloads/report/IPCC_AR6_SYR_FullVolume.pdf.

[12] *Id.*

regulations. Further, the reference to "[n]ature-based solutions" is ambiguous, particularly given the uncertainty (noted above) regarding how "CDR technologies" is to be defined under SB 905.

Question 6: Separating Decommissioning and Accident Costs for Financial Instruments

SB 905 requires CARB to develop financial responsibility requirements that are "no less stringent than section 146.85 of Title 40 of the Code of Federal Regulations." Section 146.85 states that the financial instrument must be sufficient to cover both decommissioning costs (e.g., injection well plugging and site closure) and accident/risk costs (e.g., corrective action and emergency and remedial response).[13] Section 146.85 combines the two costs into a single financial instrument, but separating them into two distinct financial instruments may be more effective in preventing the public from bearing well abandonment costs if an owner defaults on their permit, and may generate incentivizes to reduce environmental risks.[14]

The oil and gas industry provides relevant context as to separating the two costs. Decommissioning costs for oil and gas wells are relatively definite, while accident costs are more uncertain and difficult to predict, as they are based on potential environmental harm that may or may not occur.[15] Due to the difficulties in assessing accident costs, a single combined financial instrument may not suffice for actual costs incurred. In the oil and gas context, accident costs have often exceeded projected values, leaving little to no money for decommissioning costs. Furthermore, aggregating the two liabilities allows companies to understate their obligations and the timelines on which they expect to incur them, as only a portion of the total potential liability is definite at the start of the project.[16] Companies can therefore produce vague balance sheets, which allows for the companies to underreport to investors and others outside the company.[17]

The CDR industry may face similar challenges, which may be addressed through separating the decommissioning and accident costs into separate financial instruments. Similar to oil and gas,

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[13] 40 C.F.R. §146.85(a)(2)(ii). *See also, Financial Responsibilities for Underground Injection Well Owners or Operators*, EPA (July 2, 2025), https://www.epa.gov/uic/financial-responsibilities-underground-injection-well-owners-or-operators ("Financial responsibility requirements protect: USDWs from endangerment [and] the public from bearing well abandonment costs if an owner defaults on the permit requirements").

[14] James Boyd, *Financial Assurance Rules and Natural Resource Damage Liability: A Working Marriage*, RESOURCES FOR THE FUTURE 6 (2001), https://media.rff.org/documents/RFF-DP-01-11.pdf (discussing the benefits of financial assurances, including on their positive impact on firms' decisionmaking).

[15] However, despite being somewhat uncertain as to their sufficiency, financial instruments for accident costs are nevertheless helpful in reducing environmental risks and in ensuring their cleanup. *Id.* ("financial responsibility ensures that the expected costs of environmental risks appear on a firm's balance sheets and in its business calculations. If new investments imply possible future environmental costs, financial responsibility increases the relevance of these costs to the firm's decisionmaking").

[16] Martin Lockman, Ashwin Murthy & Romany M. Webb, *Decommissioning Offshore Oil and Gas Infrastructure: Report of Proceedings, May 2, 2025 Offshore Decommissioning Workshop*, SABIN CENTER FOR CLIMATE CHANGE LAW 9 (2025), https://scholarship.law.columbia.edu/cgi/viewcontent.cgi?article=1251&context=sabin_climate_change.

[17] *Id.*

decommissioning costs for CDR projects are relatively definite and can be determined at the beginning of the project. Therefore, requiring a financial instrument solely for the decommissioning costs would ensure that those costs are guaranteed irrespective of other costs. A separate instrument would also allow for the decommissioning liabilities to be accurately reflected on a firm's balance sheets and in its business calculations at the beginning of the project. CARB should thus require separate financial instruments upfront for the decommissioning and accident costs.

CARB can also consider mandating third party assurances for large-scale CDR projects. Third party assurances would incentivize reducing environmental risks, as the assurance providers would have a strong incentive to monitor their clients' environmental safety, so as to prevent their capital from being consumed by future liabilities.[18]

Question 7: Fitness to Operate Standards as Transfer Restrictions

To account for scenarios such as ownership transfer and bankruptcy in the offshore oil and gas industry, the Biden Administration had proposed a "Fitness to Operate" standard, which was "intended to weed out [offshore oil and gas] companies unable to cover cleanup costs or guilty of safety and environmental infractions."[19] While the standard was never finalized, it aimed to establish "safety, environmental, and financial responsibilities" for companies to meet in order to operate in the U.S. Outer Continental Shelf.[20]

Similar standards could be implemented for the CDR industry, ensuring a level of protection against the aforementioned scenarios where companies are unable to cover cleanup costs or prevent safety and environmental infractions. The standard could be flexible, reflecting the growing nature of the CDR industry, and could include specifics on corporate structuring, revenue projections, history of environmental compliance and emergency management protocols.

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[18] *Supra* n.12 ("Firms with fewer resources often cannot self-insure and must therefore acquire rights to financial assets from third parties, such as banks and insurers. Third-party assurance providers are obviously concerned that their capital will be consumed by future liabilities. As a result, they have a strong incentive to monitor their clients' environmental safety. Capital providers can also base the cost of their capital (e.g., their premiums) on observable attributes of the firms to whom they provide capital. For example, more favorable capital costs can be offered to firms with meaningful risk management and safety programs. In the extreme, financial coverage may be denied altogether to firms that fail to demonstrate acceptable levels of safety. In these ways, the capital markets that arise to satisfy demand for financial responsibility generate incentives to reduce environmental risks.").

[19] *Report on the Federal Oil and Gas Leasing Program*, DEPT. OF INTERIOR (Nov. 2021), https://www.doi.gov/sites/doi.gov/files/report-on-the-federal-oil-and-gas-leasing-program-doi-eo-14008.pdf; Heather Richards, *Long Delayed Biden Rule could Shake Up Offshore Well Cleanups*, POLITICO E&E NEWS (Dec. 11, 2023), https://www.eenews.net/articles/long-delayed-biden-rule-could-shake-up-offshore-oil-well-cleanups/.

[20] *Id.*

Question 18: Streamlining Administrative Proceedings through the Unified Permit Application

As set out in SB 905, the goal of the unified permit application is to avoid duplicative administrative proceedings and expedite the issuance of permits. One way to further this goal would be for CARB to implement pre-application processes, including pre-application consultations and meetings with the relevant permitting agencies.[21] Project applicants could then, early in the application process, ask questions and gain a better understanding of the information state agencies require to process permits. That should, in turn, help applicants submit complete applications on the first try, avoiding delays in the process. Further, to streamline the application review process, state agencies could identify primary points of contact, both for other agencies and for the project proponents.[22] CARB could also encourage agencies to execute MOUs or other agreements to clarify their respective roles in the permitting process and provide for greater cooperation to the extent permitted by law.[23] Finally, CARB could recommend timelines for project reviews and authorizations, to provide certainty for the applicants and fellow agencies as to expected durations for each stage of the permitting process.[24]

In addition to the unified permit application, CARB should establish an office dedicated to guiding project applicants through the permitting process. This could build on the example of Washington State, where a number of aquatic resource use permits can be obtained through a single application form known as the Joint Aquatic Resources Permit Application ("JARPA") form.[25] The JARPA form could provide an instructive parallel to the proposed unified permit application process in SB 905. To assist project applicants in navigating the JARPA form and other permit requirements, Washington State established the Governor's Office for Regulatory Innovation and Assistance.[26] The Office provides free services through its website, as well as texts, emails and phone calls, with the goal of assisting people and businesses meet regulatory requirements.[27] The website provides guidelines on how to apply for relevant permits, including providing the relevant forms.[28]

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[21] Romany M. Webb & Korey Silverman-Roati, *Executive Actions to Ensure Safe and Responsible Ocean Carbon Dioxide Removal Research in the United States*, SABIN CENTER FOR CLIMATE CHANGE LAW 7 (Apr. 2024), https://scholarship.law.columbia.edu/cgi/viewcontent.cgi?article=1212&context=sabin_climate_change.
[22] *Id.*
[23] *Id.*
[24] *Id.*
[25] *Work in Navigable Waters,* GOVERNOR'S OFFICE FOR REGULATORY INNOVATION AND ASSISTANCE, https://www.oria.wa.gov/site/alias__oria/mid__12357/403/handbook-entry?ItemID=36 [https://perma.cc/G7FH-86PF].
[26] GOVERNOR'S OFFICE FOR REGULATORY INNOVATION AND ASSISTANCE, https://www.oria.wa.gov/site/alias__oria/368/Home.aspx.
[27] *Id.*
[28] *See e.g.*, *Joint Aquatic Resources Permit Application Form*, GOVERNOR'S OFFICE FOR REGULATORY INNOVATION AND ASSISTANCE, https://www.oria.wa.gov/site/alias__oria/4220/jarpa-form.aspx.

State aquaculture permitting, which often requires complex permitting approvals from multiple agencies, may provide another instructive parallel. Alaska[29] and California[30] provide detailed guides on aquaculture permitting. CARB could prepare a similarly detailed guide for CDR permitting, indicating the permitting process in a flowchart, with expected timelines and highlighting relevant agencies.

Question 27: EPA Database on Class VI Wells

EPA manages a database of Class VI projects which, among other things, provides information on the projects currently under review, the final permit decisions and details on specific projects.[31] CARB could emulate a similar format for reporting on project deployment.

[29] A. Bishop et al., *Alaska Aquaculture Permitting Guide*, ALASKA SEA GRANT 8 (2021), http://akaquaculturepermitting.org/.
[30] *Guide to Leasing, Permitting, and Authorizing Commercial Aquaculture Operations off the California Coast*, NOAA (2025), https://www.fisheries.noaa.gov/s3//2025-06/guide-commercial-aquaculture-operations-california-coast.pdf.
[31] *Underground Injection Control (UIC) Class VI Permit Tracker,* EPA, https://awsedap.epa.gov/public/single/?appid=8c074297-7f9e-4217-82f0-fb05f54f28e7&sheet=51312158-636f-48d5-8fe6-a21703ca33a9&theme=horizon&bookmark=6218ffed-bb6e-42e4-a4f1-52d87e036a1b&opt=ctxmenu