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Sequestering Carbon Dioxide Undersea in the Atlantic: Legal Problems and Solutions

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ABSTRACT

Reducing the amount of carbon dioxide in the atmosphere is vital to mitigate climate change. To date, reduction efforts have primarily focused on minimizing the production of carbon dioxide during electricity generation, transport, and other activities. Going forward, to the extent that carbon dioxide continues to be produced, it will need to be captured before release. The captured carbon dioxide can then be utilized in some fashion or injected into underground geological formations (e.g., depleted oil and gas reserves, deep saline aquifers, or basalt rock reservoirs) where it will hopefully remain permanently sequestered. This injection process is referred to as "carbon capture and storage" (CCS).

Significant research has been undertaken to identify possible carbon dioxide injection sites in the continental United States.

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There is also growing interest in the possibility of injecting carbon dioxide offshore into geological formations underlying the seabed. However, little is currently known about the legal regime for sub-seabed injection. This article outlines the key legal requirements for injecting carbon dioxide into the seabed off the northeast coast of the U.S.

The legal requirements for offshore carbon dioxide injection differ depending on the location of the injection operation. Injection operations undertaken in the Northeastern U.S., within three nautical miles of the coast (i.e., in "state waters"), are regulated under the Environmental Protection Agency's (EPA) Underground Injection Control Program. That Program does not, however, apply to operations in "federal waters," 3 to 200 nautical miles from shore, or on the "high seas" beyond those waters.

There is currently no regulatory regime specific to carbon dioxide injection in federal waters or on the high seas. However, injection operations in those areas may be regulated under general programs, such as the ocean dumping regime established in the Marine Protection, Research, and Sanctuaries Act (MPRSA). The MPRSA was enacted to fulfill the U.S.'s obligations under the London Convention, which aims to prevent pollution of the seas by waste and/or other materials. Consistent with the terms of the Convention, the MPRSA regulates the disposal of material at sea. The EPA has suggested that the MPRSA may apply to the injection of carbon dioxide into the seabed.

Assuming it applies to seabed injection, the MPRSA may operate as a barrier to offshore CCS. Under the MPRSA, any person transporting material from the U.S. for the purpose of dumping it at sea, whether in state waters, federal waters, or on the high seas, must obtain a permit from the EPA. Notably, the EPA cannot grant a permit when the material consists of industrial waste, which is defined as "solid, semi-solid, or liquid waste generated by a manufacturing or processing plant." The dumping of such waste is therefore effectively prohibited by the MPRSA.

Depending on whether carbon dioxide is considered an industrial waste, the MPRSA may operate either to ban its offshore injection or allow its injection with a permit from the EPA. Various other permits and authorizations may also be required depending on where and how injection occurs. The key requirements are outlined in this article.

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INTRODUCTION

The 2014 National Climate Assessment concluded that average temperatures in the U.S. have increased by up to 1.9° F since 1895 and may rise an additionaluy 4° F in coming decades.[1] This is primarily due to the emission of greenhouse gases which trap heat in the earth's atmosphere, causing surface temperatures to rise.[2] The most important greenhouse gas is carbon dioxide, which is emitted in larger quantities, and remains in the atmosphere longer, than other major heat-trapping gases.[3]

Carbon dioxide emissions primarily result from the burning of

1 U.S. GLOBAL CHANGE RESEARCH PROGRAM, CLIMATE CHANGE IMPACTS IN THE UNITED STATES 8 (2014), http://s3.amazonaws.com/nca2014/high/NCA3_Climate_Change_Impacts_in_the_United%20States_HighRes.pdf [https://perma.cc/NM9N-YBGL].
2 INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, CLIMATE CHANGE 2014: SYNTHESIS REPORT 4 (2014), http://www.ipcc.ch/pdf/assessment-report/ar5/syr/SYR_AR5_FINAL_full_wcover.pdf [https://perma.cc/U7Y4-DQ4L].
3 *Id.* at 5.

fossil fuels—coal, oil, and natural gas—in electricity generation and other applications.[4] Seeking to reduce emissions, many policymakers have called for the replacement of fossil fuels with lower-carbon alternatives. Although some progress has been made, a complete phase-out of fossil fuels would be difficult, at least in the short- to medium-term. Some researchers have therefore begun investigating other emission-reduction strategies. One such strategy involves capturing carbon dioxide at its source before it is released into the atmosphere. The captured carbon dioxide could then be used in some way or injected into underground geologic formations for the purposes of permanent storage ("carbon dioxide capture, utilization, and storage" or "CCUS").

Currently, in North America, only small amounts of carbon dioxide are captured prior to release. Almost all of this captured carbon dioxide is used for "enhanced oil recovery" (EOR), whereby it is injected into oil wells for the purpose of maintaining formation pressure (i.e., to replace oil and water that have been pumped out of the well). However, carbon dioxide could also be injected underground for the purpose of disposal (unrelated to EOR). This is known as carbon dioxide capture and storage (CCS). To date, most CCS research has focused on the possibility of injecting carbon dioxide into onshore geological formations, such as depleted oil and gas reservoirs and deep saline aquifers. However, there is growing interest in the possibility of injecting carbon dioxide offshore, into geological formations underlying the seabed.

From a public policy perspective, offshore CCS has a number of advantages over onshore alternatives. Most notably, locating injection sites offshore keeps them away from populated areas, reducing risks to public safety and the potential for public opposition.[5] However, offshore injection is not without difficulties. Offshore injection is likely to be costly, as it necessitates the building of complex drilling platforms and/or other structures at sea, as well as an extensive transportation

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4 *Id.*

5 For a discussion of this issue, *see* Daniel P. Schrag, *Storage of Carbon Dioxide in Offshore Sediments*, 325 SCIENCE 1658, 1659 (2009).

system to deliver carbon dioxide to the injection wells.[6] There are also significant associated regulatory risks, as there is currently no comprehensive legal framework for offshore carbon dioxide injection.[7] Most offshore injection operations are regulated under a patchwork of laws developed with other activities in mind and, as a result, are often poorly suited to CCS.

This article examines the regulatory framework for offshore CCS along the Northeastern U.S. coast. The Introduction and Part Regulatory Jurisdiction Over Offshore CCSI of the article provide a general overview of the regulatory regimes governing offshore CCS, under both U.S. and international law. The subsequent parts then explore the regimes in more detail and discuss their application to specific aspects of CCS. Part III focuses on injection well construction, outlining the regulatory requirements for installing offshore platforms and drilling wells. The regulatory regime governing the transport of carbon dioxide to the well site—by pipeline, road, rail, and/or ship—is examined in Part IV. Lastly, Part V discusses the regulation of carbon dioxide injection at the well site.

I. REGULATORY JURISDICTION OVER OFFSHORE CCS

The regulation of any future carbon dioxide injection project will depend on its location. Under international law, offshore areas are divided into several distinct zones, each with a different regulatory status. These various zones are discussed in this part.

A. International Legal Framework

Jurisdiction over offshore areas is determined under the principles of international law as set out in the 1982 United

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6 *Id.*

7 Regulations specific to carbon dioxide injection have been adopted by the Environmental Protection Agency (EPA) through its Underground Injection Control Program. Notably however, those regulations only apply to injection operations onshore or in state waters, i.e., within three nautical miles offshore. *See generally* 40 C.F.R. § 144.1(g).

Nations Convention on the Law of the Sea (UNCLOS).[8] Under UNCLOS, each country has jurisdiction over areas within 200 nautical miles (n.m.) of its shores, and further in certain circumstances (see Table 1 below). Areas more than 200 n.m. offshore are not subject to the jurisdiction of any country, but rather form part of the high seas, which are open to use by all countries in accordance with international law.[9]

Table 1: Offshore Zones Identified in UNCLOS

Area	Definition	Status
Offshore Waters		
Territorial Sea	The area extending 12 n.m. from the baseline (normally the low-water line along the coast).[10]	The territorial sea, its bed and subsoil, and the airspace above it form part of the sovereign territory of the coastal state.[11]
Exclusive Economic Zone (EEZ)	The area adjacent to and beyond the territorial sea which extends 200 n.m. from the baseline.[12]	Within the EEZ, the coastal state has: • sovereign rights to explore, exploit, conserve, and manage natural resources and undertake other activities for the economic exploitation of the zone; and • jurisdiction with regard to the establishment and use of artificial

8 United Nations Convention on the Law of the Sea, Dec. 10, 1982, 1833 U.N.T.S. 397 [hereinafter UNCLOS]. The U.S. has not ratified UNCLOS, but recognizes most of its provisions, including those discussed in this part, as forming part of customary international law.
9 *Id.* at art. 57.
10 *Id.* at art. 3.
11 *Id.* at art. 2.
12 *Id.* at art. 55, 57.

Area	Definition	Status
		islands, installations, and structures, marine scientific research, and marine protection.[13]
The High Seas	All areas not included in the Territorial Sea or EEZ.[14]	The high seas are open to use by all countries. No country has sovereign rights within the high seas.[15]
Offshore Land		

Continental Shelf	The submarine area extending beyond the territorial sea to the farthest of:
	• 200 n.m. from the baseline; or
	• the outer edge of the continental margin[16] up to:
	  o 60 n.m. from the foot of the continental shelf; or
	  o the point where sediment thickness is 1 percent of the distance thereto.[17]
		The coastal state has sovereign rights over the continental shelf for the purpose of exploring and exploiting its natural resources.[18]

13 *Id.* at art. 56.
14 *Id.* at art. 86.
15 *Id.* at art. 87.
16 The “continental margin” refers to the submerged prolongation of the land mass of the coastal state. *Id.* at art. 76(1).
17 The continental shelf shall not extend more than 100 n.m. from the 2,500 meter isobath or 350 n.m. from the baseline. *Id.* at art. 76(5).
18 *Id.* at art. 77.

B. U.S. Jurisdictional Areas

Consistent with UNCLOS, the U.S. has claimed jurisdiction over all waters up to 200 n.m. from its coast ("U.S. waters").[19] Jurisdiction is shared between the states, which have title to areas within three n.m. of shore (and further in certain circumstances), and the federal government, which has title to areas further offshore.

1. State Waters

In the U.S., each coastal state has regulatory authority over the waters adjacent to its land, known as "state waters." The Submerged Lands Act of 1953 (SLA) extended the boundaries of each coastal state to three n.m. from its coastline, except for Texas and the west coast of Florida, where the SLA extended state boundaries to nine n.m. from the coastline.[20] For the purposes of the SLA, a state's "coastline" is defined as "the line of ordinary low water along that portion of the coast which is in direct contact with the open sea and the line marking the seaward limit of inland waters."[21]

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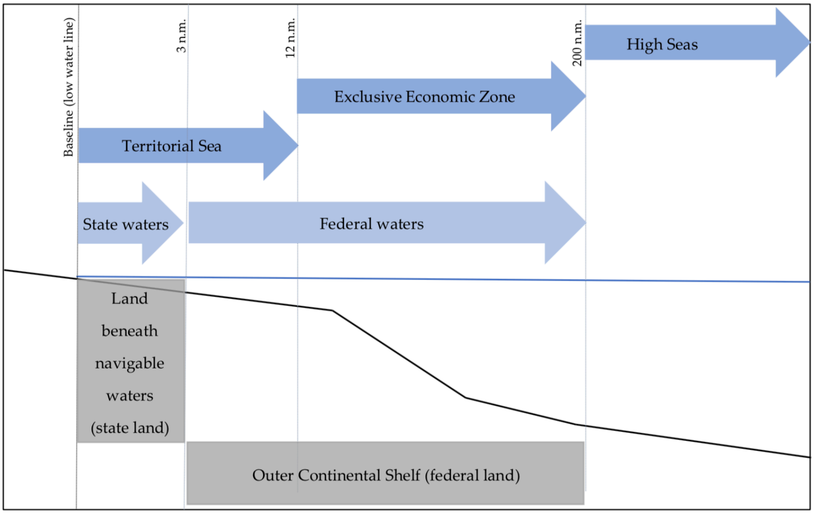
19 Proclamation No. 5030, 48 Fed. Reg. 10605 (Mar. 14, 1983).
20 43 U.S.C. § 1312 (2012) (providing that "[t]he seaward boundary of each original coastal State is approved and confirmed as a line three geographic miles distant from its coast line"); *see also id.* § 1301(b) (defining the term "boundaries" and providing that "in no event shall the term boundaries . . . be interpreted as extending from the coast line more than three geographical miles in the Atlantic Ocean or the Pacific Ocean, or more than three marine leagues into the Gulf of Mexico"). A "marine league" is equivalent to three n.m. Thus, in the Gulf of Mexico, the boundaries of Texas and Florida extend nine n.m. from the coastline. *See generally* U.S. v. Louisiana, 100 S.Ct. 1618 (1980), 420 U.S. 529 (1975), 394 U.S. 11 (1969), 389 U.S. 155 (1967), 363 U.S. 1 (1960), 339 U.S. 699 (1950) (holding that the boundaries of Louisiana, Mississippi, and Alabama extend three n.m. from their respective coastlines, while the boundaries of Texas and Florida extend three leagues (nine n.m.) from their coastlines).
21 43 U.S.C. § 1301(c).

Figure 1: Regulatory Jurisdiction Over Offshore Areas



The SLA confirms that each coastal state has title to, and ownership of, all lands beneath navigable waters within its boundaries.[22] All natural resources within those lands and waters, including minerals, marine animals, and plant life, are also owned by the state.[23] The federal government has relinquished all of its rights to, and interests in, the land and resources within state waters (though it retains regulatory jurisdiction).[24]

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22 *Id.* § 1311(a)(1). The term "lands beneath navigable waters" is defined to mean "(1) all lands within the boundaries of each [State] . . . which are covered by nontidal waters that were navigable under the laws of the United States at the time such State became a member of the Union, or acquired sovereignty over such lands and waters thereafter, up to the ordinary high water mark . . . (2) all lands permanently or periodically covered by tidal waters up to but not above the line of mean high tide and seaward to a line three geographic miles distant from the coast line of each such State . . . and (3) all filled in, made, or reclaimed lands which formerly were lands beneath navigable waters." *Id.* § 1301(a).

23 *Id.* § 1311(a)(1). The term "natural resources" is defined to include, without limitation, "oil, gas, and all other minerals, and fish, shrimp, oysters, clams, crabs, lobsters, sponges, kelp, and other marine animal and plant life but does not include water power, or the use of water for the production of power." *Id.* § 1301(e).

24 *Id.* § 1311(b).

2. Federal Waters

Along the Northeast coast, federal waters begin three n.m. from the coastline (as defined in the SLA)[25] and extend to the edge of the EEZ, located 200 n.m. from the baseline specified in UNCLOS.[26] The normal "baseline" used for measuring the EEZ is the low-water line along the coast.[27] In some instances, however, the baseline may be adjusted based on geological factors such as the nature of the coastline and/or the presence of reefs thereon.[28]

The federal government has title to offshore land, comprising the subsoil and seabed of the "outer continental shelf" (OCS). The federal Outer Continental Shelf Lands Act (OCSLA) defines the OCS as those "submerged lands lying seaward and outside of the area [subject to state jurisdiction] . . . and of which the subsoil and seabed appertain to the U.S."[29] As noted in I.B.1, state jurisdiction typically ends three n.m. from shore (except in Texas and on the west coast of Florida, where it ends nine n.m. from shore), at which point the OCS begins. The OCS extends to the seaward limit of U.S. jurisdiction, defined under international law as the farthest of:

- 200 n.m. from the baseline (normally the low-water line along the coast); or
- if the continental margin[30] exceeds 200 n.m., a line:
    - 60 n.m. from the foot of the continental shelf; or

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25 *Id.* §§ 1331(a), 1332(1) (providing that the U.S. has exclusive jurisdiction over the outer continental shelf, which lies seaward and outside the area of lands beneath navigable waters). *See also id.* §§ 1301(a), 1302 (defining the term "lands beneath navigable waters" to include all lands within the boundaries of the state and providing that state boundaries generally extend three n.m. from shore).
26 UNCLOS, *supra* note 8, at art. 57.
27 *Id.* at art. 5.
28 *Id.* at art. 6–11.
29 43 U.S.C. § 1331 (2012).
30 The "continental margin" comprises "the submerged prolongation of the land mass of the coastal state and consists of the seabed and subsoil of the [continental] shelf, the slope, and the rise." *See* UNCLOS, *supra* note 8, at art. 76.

- beyond the shelf foot where the sediment thickness is 1 percent of the distance thereto.[31]

The OCS cannot, however, extend more than 350 n.m. from the baseline or 100 n.m. from the 2,500 meter isobath (a line connecting the depth of 2,500 meters).[32]

C. Areas Beyond U.S. Jurisdiction

U.S. jurisdiction over offshore waters only extends to the outer edge of the EEZ, or 200 n.m. from the baseline. Waters lying seaward of the EEZ are considered part of the "high seas," over which no country has exclusive jurisdiction. The high seas are open to all countries[33]—whether coastal or land-locked—for use in accordance with international law.[34] This so-called "freedom of the high seas" includes: (a) freedom of navigation; (b) freedom of overflight; (c) freedom to lay submarine cables and pipelines; (d) freedom to construct artificial islands and other installations; (e) freedom of fishing; and (f) freedom of scientific research.[35] Countries must exercise these freedoms "with due regard for the interests of other[s]."[36]

II. Regulation of Offshore CCS

The location of any future offshore CCS project will have important implications for its regulation. This article focuses on the regulatory regime governing projects in U.S. federal waters or on the high seas. A general overview of that regime is provided in this part. The subsequent parts then discuss the application of that regime to specific aspects of offshore CCS.

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31 *Id.* at art. 76(1), 76(4).
32 *Id.* at art. 76(5).
33 *Id.* at art. 87.
34 *Id.*
35 *Id.*
36 *Id.*

A. Federal Regulation

There are few federal regulations dealing specifically with offshore CCS. Certain CCS projects are regulated by the EPA through its Underground Injection Control (UIC) Program, which was established under the Safe Drinking Water Act[37] to prevent the contamination of drinking water by material injected underground.[38] As part of the UIC Program, in December 2010, the EPA promulgated regulations with respect to the underground injection of carbon dioxide for geologic sequestration.[39] The regulations require wells used for carbon dioxide injection to be permitted[40] and establish standards for injection well siting, construction, operation, testing, and monitoring.[41] Notably, however, the regulations only apply to wells located onshore or within state waters.[42] Wells situated "beyond [a] state's territorial waters" are expressly exempt from regulation.[43]

No federal regulatory programs specifically address CCS outside state waters. CCS projects may, of course, be regulated under general programs developed with other activities in mind. The most relevant general program is established under the MPRSA,[44] which regulates the dumping of waste and other materials in the ocean. The term "materials" is defined broadly in the MPRSA to include "matter of any kind or description,"

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37 42 U.S.C. § 300f et seq (2012).
38 U.S. Envtl. Prot. Agency, *General Information About Injection Wells*, UNDERGROUND INJECTION CONTROL (UIC), https://www.epa.gov/uic/general-information-about-injection-wells [http://perma.cc/s7V2-PS4B] (last updated Sep 6, 2016).
39 Federal Requirements Under the Underground Injection Control Program for Carbon Dioxide Geologic Sequestration Wells, 75 Fed. Reg. 77230 (Dec. 10, 2010) (to be codified at 40 C.F.R. pts. 124, 144–147) [hereinafter UIC Program Rules].
40 40 C.F.R. §§ 144.11, 144.18 (2016).
41 *See generally* 40 C.F.R. §§ 146.81–95 (establishing standards for state UIC programs regulating Class VI wells used in the geologic sequestration of carbon dioxide).
42 40 C.F.R. § 144.1(g)(1).
43 *Id.* § 144.1(g)(2)(i).
44 33 U.S.C. §§ 1401–1421 (2012).

which would encompass carbon dioxide.[45] There is, however, some uncertainty as to whether the MPRSA applies to offshore CCS projects.

By its express terms, the MPRSA only applies to the dumping of materials into ocean waters, defined as "waters of the open seas lying seaward of the base line" (i.e., normally the low water line).[46] Based on this definition, it may be argued that CCS projects are not covered by the MPRSA, as the carbon dioxide is injected into the seabed, rather than the water column. A similar argument has been made with respect to the London Convention,[47] on which the MPRSA is based, though many commentators have disputed the validity of such argument in that context.[48] Some assert that, for the purposes of the London Convention, "what matters is not the final resting place of the material, but the location of the act of [dumping] itself," and whether it occurs at sea.[49] Others emphasize that "the purpose of the Convention was . . . to protect the sea," and, as such, it should be interpreted as applying to "activities in the sea-bed that have the potential to harm the sea."[50]

Some support for a broad interpretation of the MPRSA, as applying to activities in the seabed, is provided by the Act's definition of "dumping." Section 3(f) of the MPRSA defines "dumping" to mean:

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45 *Id.* § 1402(c).
46 *Id.* § 1402(b).
47 *See, e.g.,* MARK A. DE FIGUEIREDO, THE INTERNATIONAL LAW OF SUB-SEABED CARBON DIOXIDE STORAGE 18 (2005), https://sequestration.mit.edu/pdf/international_law_subsea_co2_storage.pdf [https://perma.cc/R399-MJBM].
48 *See generally* Yvette Carr, *The International Legal Issues Relating to the Facilitation of Sub-Seabed CO_2 Sequestration Projects in Australia*, 14 AUSTL. INT'L L.J. 137, 144–145 (2007) (concluding that sub-seabed carbon dioxide injection likely constitutes "dumping" for the purposes of the London Convention).
49 *Id.*
50 Ray Purdy & Richard Macrory, *Geological Carbon Sequestration: Critical Legal Issues* 19 (Tyndall Centre for Climate Change Research, Working Paper No. 45, 2004), https://www.researchgate.net/profile/Ray_Purdy/publication/268031244_Geological_Carbon_Sequestration_Critical_Legal_Issues/links/55cb201c08aeca747d6a08b3/Geological-Carbon-Sequestration-Critical-Legal-Issues.pdf [https://perma.cc/6YK6-9HA7].

> a disposition of material: Provided, That it does not mean a disposition of any effluent from any outfall structure to the extent that such disposition is regulated under the provisions of the Federal Water Pollution Control Act, as amended, under the provisions of section 407 of this title, or under the provisions of the Atomic Energy Act of 1954, as amended, nor does it mean a routine discharge of effluent incidental to the propulsion of, or operation of motor-driven equipment on, vessels: Provided, further, that it does not mean the construction of any fixed structure or artificial island nor the intentional placement of any device in ocean waters or *on or in the submerged lands beneath such waters*, for a purpose other than disposal, when such construction or such placement is otherwise regulated by Federal or State law or occurs pursuant to an authorized Federal or State program (emphasis added).[51]

The exclusion for construction or placement of structures or artificial islands "on or in the submerged lands beneath [ocean] waters" would be unnecessary if the MPRSA did not apply to seabed activities. Thus, it appears that seabed activities are subject to the MPRSA, unless covered by the exclusion. Disposal is specifically excepted from the exclusion.

Consistent with this view, the EPA has suggested that "sub-seabed CO_2 [carbon dioxide] injection . . . may, in certain circumstances, be defined as ocean dumping and subject to regulation under the MPRSA."[52] Such injection is unlikely to fall within the exclusion noted above, partly because carbon dioxide is arguably not a "structure" or "device"—as those terms imply manmade, artificial objects or systems—and also because the

51 33 U.S.C. § 1402(f) (2012).

52 UIC Program Rules, *supra* note 39, at 77236.

injection is for the purposes of disposal.[53] In this article, then, we assume that the MPRSA applies to the injection of carbon dioxide into the seabed.

B. International Law

The only international agreement dealing specifically with offshore CCS is the 1996 Protocol to the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matters ("London Protocol"). The London Protocol aims to prevent pollution of the seas[54] through "dumping," defined broadly to include the "storage of wastes or other matter in the seabed."[55] It requires contracting nations to "prohibit the dumping of any wastes or other matter with the exception of those listed in Annex I."[56] The list in Annex I includes "[c]arbon dioxide streams from carbon dioxide capture processes for sequestration."[57] The dumping of carbon dioxide for sequestration requires a permit.[58] Each contracting nation must adopt procedures for issuing permits that ensure, as far as practicable, that environmental disturbance and detriment are minimized and benefits are maximized.[59]

The U.S. signed the London Protocol, but has not ratified it. The U.S. has ratified the London Convention, under which the protocol was adopted. The London Convention regulates the

53 The Cambridge Dictionary defines "structure" to mean "something that has been made or built from parts" and "device" to mean "an object or machine that has been invented for a particular purpose."
54 The term "sea" is defined broadly to mean "all marine waters other than the internal waters of the States, as well as the seabed and the subsoil thereof." 1996 Protocol to the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matters, art. 1.7, Nov. 7, 1996, 26 U.S.T. 2403, 1046 U.N.T.S. 120 (as amended in 2006).
55 *Id.* at art. 1.4.1.3.
56 *Id.* at art. 4.1.1.
57 *Id.* at annex 1.1.8.
58 *Id.* at art. 4.1.2.
59 *Id.* at art. 4.1.2, annex 2.

dumping of waste and other material at sea.[60] While it does not expressly address the injection of carbon dioxide into the seabed, some commentators have argued that injection operations implicitly fall within its terms, constituting "dumping" for the purposes of the Convention.[61]

III. DRILLING CARBON DIOXIDE INJECTION WELLS

Before carbon dioxide can be injected offshore, one or more wells will need to be drilled into the seabed. Drilling will likely take place from offshore platforms, which may be fixed to the seabed or floating. The regulatory requirements for installing platforms and drilling wells are outlined in this part.

A. Drilling in Federal Waters

As noted in Subpart I.B.2 above, in the Northeastern U.S., federal waters extend 3 to 200 n.m. from the coast. The federal government has title to the land underlying those waters and, if the continental margin extends beyond 200 n.m., additional land up to 350 n.m. from the low water line or 100 n.m. from the 2,500 meter isobath (i.e., the OCS). Activities on the OCS are therefore subject to federal regulation. This part outlines federal permitting and other requirements for drilling offshore carbon dioxide injection wells on the OCS.

1. Leasing Land for Drilling

Persons wishing to drill on the OCS must obtain a lease from the Department of the Interior's (DOI) Bureau of Ocean Energy Management (BOEM).[62] BOEM's current authorizing statute—the OCSLA—restricts the circumstances in which it may lease

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60 Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, art. I, Dec. 29, 1972, 26 U.S.T. 2403, 1046 U.N.T.S. 120 (entered into force Aug. 30, 1975).
61 *See e.g.,* Purdy & Macrory, *supra* note 50, at 19; Carr, *supra* note 48, at 144.
62 ADAM VANN, CONG. RESEARCH SERV., R40175, WIND ENERGY: OFFSHORE PERMITTING 3 (2012) ("Use of federal and federally controlled lands, including the [outer continental shelf], requires some form of permission.").

land on the OCS. Under section 8(p)(1) of the OCSLA, BOEM may only grant leases for activities that:

> support exploration, development, production, or storage of oil or natural gas . . . ; support transportation of oil or natural gas, excluding shipping activities; produce or support production, transportation, or transmission of energy from sources other than oil and gas; or use, for energy-related purposes or for other authorized marine-related purposes, facilities currently or previously used for activities [relating to oil, gas, and other mineral development on the OCS].[63]

BOEM has asserted authority under section 8(p)(1)(C) of the OCSLA to grant leases for offshore injection of carbon dioxide "generated as a byproduct of . . . coal-fired power plants."[64] According to BOEM, injection of carbon dioxide from coal-fired power plants supports the production of energy from sources other than oil and gas, bringing it within paragraph (C). That paragraph would not apply to the injection of carbon dioxide from natural gas power plants or other non-energy industries. Injection of carbon dioxide from those sources could, in theory, fall within paragraph (D) if it is performed using existing facilities previously used in oil and gas drilling. To date, however, BOEM has not taken an official position on this issue.[65] In any event, there are no offshore oil and gas facilities in the Northeastern U.S.

a. Leases for New Drilling Operations

BOEM regulations outline the process it will follow when leasing land under section 8(p)(1)(C) of the OCSLA.[66] Notably,

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63 43 U.S.C. § 1337(p)(1) (2012).

64 Email from Melissa Batum, Senior Program Analyst, Bureau of Ocean Energy Mgmt., Dep't of the Interior, to Romany Webb (Feb. 21, 2017, 13:58 EST) (on file with author).

65 Email from Melissa Batum, Senior Program Analyst, Bureau of Ocean Energy Mgmt., Dep't of the Interior, to Romany Webb (Feb. 21, 2017, 13:58 EST) (on file with author).

66 30 C.F.R. §§ 585.100-1019 (2017).

the regulations currently only apply to leases for activities producing, or supporting the production of, energy from renewable sources.[67] BOEM is yet to adopt regulations with respect to activities supporting energy production from coal (e.g., CCS).

The OCSLA requires section 8(p)(1)(C) leases to be issued "on a competitive basis unless [BOEM] determines . . . that there is no competitive interest" in the lease area.[68] We anticipate that, in leasing land for activities supporting energy production from coal, BOEM will use a similar process as is currently used for activities supporting renewable energy production. Under its current renewable energy regulations, BOEM may propose areas for leasing on its own motion,[69] or accept requests from interested parties.[70] In both cases, prior to leasing, BOEM must publish a notice in the *Federal Register* seeking expressions of interest from third parties.[71] If it receives expressions of interest, BOEM must issue leases through a competitive auction;[72] otherwise, leases will be issued on a non-competitive basis.[73]

When issuing leases, BOEM must comply with various procedural requirements, including:

- BOEM must conduct an environmental review under the National Environmental Policy Act (NEPA).[74] NEPA requires

67 "Renewable energy" is defined to mean any resource other than oil and gas or minerals. *Id.* § 585.112. The term "minerals" includes "all minerals authorized by an Act of Congress to be produced from 'public lands.'" *Id.* § 580.1. This definition likely encompasses coal. While coal is not a "mineral" in the strict scientific sense of a naturally occurring inorganic substance, the term "mineral" can also be used more broadly to refer to any substance obtained by mining. It appears that the regulations use "mineral" in this broad sense as the term is defined to include "oil" and "gas," neither of which are inorganic. *Id.* Therefore, as coal is a substance obtained by mining and is authorized to be produced from public lands (i.e., under the Mineral Leasing Act), it is a mineral for the purposes of the regulations. It would not, therefore, fall within the regulatory definition of "renewable energy."

68 43 U.S.C. § 1337(p)(3) (2012).

69 30 C.F.R. § 585.210.

70 *Id.* § 585.230.

71 *Id.* §§ 585.210, 585.230.

72 *Id.* §§ 585.220, 585.231(c).

73 *Id.* §§ 585.212(a), 585.231(d).

74 42 U.S.C. §§ 4321–4370h (2012).

an environmental impact statement (EIS) to be prepared for any major federal action (one undertaken, authorized, or funded by a federal agency) that "significantly affect[s] the quality of the human environment."[75] The EIS must include an assessment of the likely effect of the action on natural, economic, social, and cultural resources.[76] Pursuant to NEPA, there is a process for release of the relevant documents to the public and there are opportunities for public input.

- BOEM must complete any required consultation under the Endangered Species Act (ESA).[77] Consultation is required under section 7 of the ESA where a federal agency undertakes, authorizes, or funds an action that may affect species listed as endangered[78] or threatened.[79] Where an action may affect endangered or threatened marine species, the federal agency must consult with the National Marine Fisheries Service (NMFS).[80]
- BOEM must consult with other federal agencies with an interest in leasing, as well as the governor of any state or the executive of any local government affected by the lease.[81] A state or local government is "affected" by a lease if:

75 *Id.* § 4332(2)(C).
76 *Id.*
77 30 C.F.R. § 585.203 (2014).
78 A species is considered "endangered" if it "is in danger of extinction throughout all or a significant portion of its range." *See* 16 U.S.C. § 1532(6) (2012).
79 A species is considered "threatened" if it "is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range." *Id.* §§ 1532(20)–1536(a)(2).
80 *Consulting with Federal Agencies (ESA Section 7)*, NAT'L OCEANIC AND ATMOSPHERIC ADMIN. FISHERIES (Oct. 22, 2017), http://www.nmfs.noaa.gov/pr/consultation/ [https://perma.cc/44RA-X7JX].
81 43 U.S.C. § 1337(p)(7) (2012) (requiring the BOEM to "provide for coordination and consultation with the Governor of any State or the executive of any local government that may be affected by a lease"); 30 C.F.R. § 585.203 (providing that, when awarding leases, the BOEM will consult with "relevant federal agencies" and "any affected State, the executive of any affected local government, and any affected Indian Tribe).

  - it is, or is proposed to be, used as a support base for activities permitted in the lease area; or
  - there is a reasonable probability of significant effects on land or water uses in its jurisdiction from activities permitted in the lease area.[82]
- If leasing will affect[83] land or water use or natural resources in state waters, BOEM must ensure, to the maximum extent practicable, consistency with any state management plan adopted under the Coastal Zone Management Act (CZMA).[84] BOEM must submit a consistency determination to the relevant state, describing the proposed activity, its expected effects, and how it is consistent with the CZMA management plan.[85] If the state objects to the determination, BOEM must work with it to address the objection.[86]

Using the information obtained through the various reviews and consultations, BOEM will evaluate the effect of leasing on the human, marine, and coastal environments.[87] It must develop measures to mitigate any adverse effects.[88]

b. Leases for Operations Using Existing Facilities

BOEM regulations provide for the issuance of rights of use and easement (RUEs) authorizing "alternative use" of existing

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82 30 C.F.R. § 585.112.
83 An activity "will affect" land or water use or natural resources if it has "any reasonably foreseeable effect on any coastal use or resource . . . Effects are not just environmental effects, but include effects on coastal uses. Effects include both direct effects which result from the activity and occur at the same time and place as the activity, and indirect (cumulative and secondary) effects which result from the activity and are later in time or farther removed in distance, but are still reasonably foreseeable." 15 C.F.R. § 930.11(g) (2014).
84 16 U.S.C. § 1456(c) (2012).
85 *Id.* § 1456(c)(1)(C); 15 C.F.R. § 930.39.
86 If resolution cannot be reached, BOEM may only proceed with leasing after serving the state with a notice, which clearly describes how leasing is consistent with the state management plan, to the maximum extent practicable. *See* 15 C.F.R. § 930.43.
87 30 C.F.R. § 585.211(b)(2).
88 *Id.* § 585.211 (b)(2).

facilities under section 8(p)(1)(D) of the OCSLA.[89] The regulations define "alternative use" to mean "the energy- or marine-related use of an existing OCS facility for activities not otherwise authorized by . . . law."[90] The terms "energy-related use" and "marine-related use" are not defined in the regulations. Nor are those terms defined in the OCSLA. The legislative history does not provide any indication of their scope.

Based on previous statements by BOEM, we consider that it is likely to interpret "energy-related use" broadly, to include offshore injection of carbon dioxide captured at power plants. As noted in Subpart III.A.1 above, BOEM has previously taken the view that such storage supports the production of energy, arguably making it "energy-related." Offshore injection of carbon dioxide from sources other than power plants (e.g., industrial facilities) would likely not be considered energy-related. It may, however, be considered marine-related.

The courts have not considered the meaning of "marine-related" as used in the OCSLA and associated regulations, but have considered its meaning in other contexts. The term has generally been construed broadly, to include activities taking place at sea and on-land enterprises supporting such activities.[91] Consistent with this view, offshore CCS is likely to be considered a marine-related activity, as it occurs at sea.

Interested persons may apply to BOEM for an RUE to make use of an existing facility on a portion of the OCS that has already been leased by BOEM.[92] If the person is not the lessee of

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89 *Id.* § 585.1000(a).

90 *Id.* § 585.112.

91 *See e.g.,* U.S. v. Transocean Deepwater Drilling Inc., 767 F.3d 485, 494 (5th Cir. 2014) (finding that an oil spill at sea was properly classified as a "marine-related" spill); Boudreaux v. American Workover Inc., 680 F.2d 1034 (5th Cir. 1982) (defining injuries occurring at sea as "marine-related" injuries); Stuart Sportfishing, Inc. v. Kehoe, 541 So. 2d 169 (Fla. Dist. Ct. App. 1989) (indicating that an on-shore business may be considered "marine-related" if it supports activities at sea by, for example, serving the needs of boat owners); Dravo Corp. v. Occupational Safety & Health Review Com., 613 F.2d 1227 (3d Cir. 1980) (finding that a product will be considered "marine-related" if it goes into a boat or barge used at sea).

92 30 C.F.R. § 585.1005.

the area or the owner of the facility, he must first reach an agreement with the lessee and/or owner as to his use thereof. The person must then file an application with BOEM.[93] On receiving the application, BOEM will publish a notice in the *Federal Register* to determine if there is competitive interest in making alternative use of the facilities.[94] If no interest is expressed, BOEM will issue the RUE on a non-competitive basis; otherwise, a competitive process will be used. BOEM will ask each competing applicant to submit a description of the use he proposes to make of the facilities.[95] BOEM will then evaluate each proposal to determine whether the use is compatible with existing activities at the facility.[96] Based on that evaluation BOEM will select one or more acceptable proposals and submit them to the lessee and owner for acceptance.[97] A RUE may be issued with respect to any accepted proposal.[98]

When issuing RUEs, BOEM must complete the procedural steps described in Subpart III.A.1.a above, including consultation with other government agencies. Based on the information obtained through consultation, BOEM will evaluate whether the activities to be permitted under the RUE can be conducted in a manner that:

- ensures safety and minimizes adverse effects to coastal and marine environments;
- does not inhibit or restrain orderly development of OCS mineral or energy resources;
- avoids serious harm or damages to, or waste of, any natural resource, life, or property;
- is otherwise consistent with section 8(p) of the OCSLA; and
- can be effectively regulated by BOEM.[99]

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93 *Id.* § 585.1005(b).
94 *Id.* § 585.1007(b).
95 *Id.* § 585.1007(c).
96 *Id.* § 585.1007(d).
97 *Id.* § 585.1007(f).
98 *Id.*
99 *Id.* § 585.1006(a).

Based on that evaluation, BOEM may authorize, authorize with modifications, or reject the proposed activity.[100]

2. Installing Drilling Platforms in the Lease Area

A BOEM-issued lease grants the lessee the right to occupy, and install and operate facilities on, a designated portion of the OCS.[101] However, that right is subject to the lessee obtaining any necessary approvals from other agencies.[102] Where the lessee wishes to install a drilling platform or other structure in the lease area that will be permanently or temporarily attached to the seabed, they must obtain a permit from the Army Corps of Engineers (ACE).[103]

Permit applications must be filed with the relevant district office of ACE.[104] Within fifteen days of receiving a permit application, ACE will issue a public notice, advising interested parties of the project for which a permit is sought and soliciting comments.[105] Based on the comments received and any responses from the applicant, ACE will decide whether or not the project should be permitted.[106] In making this decision, ACE will consider the impact of the project on the public interest, balancing its beneficial and detrimental effects.[107] As part of that balancing, ACE will consider all factors relevant to the project, including "conservation, economics, aesthetics, general environmental concerns . . . navigation, recreation . . . and, in general, the needs and welfare of the people."[108] ACE must complete any necessary reviews under NEPA and/or other

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100 *Id.* § 585.1006(b).
101 *Id.* § 585.200(a).
102 *Id.*
103 ACE regulations require a permit to be obtained prior to the construction of any "structures . . . in or affecting navigable waters of the United States," including "artificial islands, installations, and other devices on the seabed" of the OCS. 33 C.F.R. §§ 322.3(a)–(b) (2014).
104 *Id.* § 325.1.
105 *Id.* §§ 325.2(a)(2)–325.3.
106 *Id.* § 325.2(a)(3).
107 *Id.* § 320.4(a)(1).
108 *Id.*

federal legislation.[109] In undertaking the NEPA review, ACE must cooperate with BOEM and any other agency which has jurisdiction over, or special expertise with respect to, the project. A lead agency must be appointed to prepare an environmental assessment (EA) or EIS[110] for the project in cooperation with other involved agencies.[111]

In addition to being permitted by ACE, certain moveable drilling platforms must also be registered with the United States Coast Guard (USCG). Registration is required for any vessel that measures at least five net tons and is used in connection with offshore drilling.[112] The term "vessel" is defined broadly to mean "every description of watercraft or other artificial contrivance used, or capable of being used, as a means of transportation on water."[113] The definition includes mobile offshore drilling units[114] and ships involved in the setting, relocation, or recovery of the anchors or other mooring equipment of those units.[115]

USCG registration is evidenced by a Certificate of Inspection, which may be issued for any mobile offshore drilling unit that is

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109 For a discussion of NEPA, *see supra* Part IV.A.1.
110 40 C.F.R. § 1501.5(a) (2014) (providing that a "lead agency shall supervise the preparation of an environmental impact statement if more than one Federal agency either: (1) Proposes or is involved in the same action; or (2) Is involved in a group of actions directly related to each other because of their functional interdependence or geographical proximity"); *see also id.* § 1501.5(c) (providing that the lead agency shall be agreed between the involved agencies. "If there is disagreement among the agencies, the following factors . . . shall determine lead agency designation: (1) Magnitude of agency's involvement. (2) Project approval/disapproval authority. (3) Expertise concerning the action's environmental effects. (4) Duration of agency's involvement. (5) Sequence of agency's involvement").
111 *Id.* § 1501.6.
112 46 U.S.C. § 12102 (West, Westlaw through Pub. L. No. 115-68).
113 *Id.* § 115; 1 U.S.C. § 3 (2012).
114 46 C.F.R. § 107.111 (2016) (defining mobile offshore drilling units as vessels). USCG regulations provide for the registration of any mobile offshore drilling unit "capable of engaging in drilling operations . . . that is (1) seagoing and 300 or more gross tons and self-propelled by motor; (2) seagoing and 100 or more gross tons and non-self-propelled; or (3) more than 65 feet in length and propelled by steam." *Id.*
115 46 U.S.C. § 12111(d)(1) (defining such ships as "vessels").

wholly owned by an eligible[116] individual or entity in the U.S.[117] The owner or builder of a mobile offshore drilling unit may apply for a certificate prior to its construction by filing an application for inspection, together with design plans and related information, with the USCG.[118] The USCG will conduct inspections while the unit is being constructed and, if it finds that the unit meets safety and other requirements, issue a certificate of inspection that is valid for five years.[119] The certificate may be renewed for subsequent five year periods following another inspection by the USCG.[120]

3. Design of the Drilling Platform

Drilling platforms and other structures on the OCS must be designed and constructed in accordance with any requirements specified in the permit issued by ACE.[121] Additional requirements may also be imposed by other federal agencies in some circumstances. For example, if the structure will be a significant source of air pollution, it must comply with requirements established by the EPA under section 328 of the

116 The following are eligible owners: (1) an individual who is a citizen of the U.S., (2) an association, trust, joint venture, or other entity if all of its members are U.S. citizens and it is capable of holding title to a vessel under the laws of the U.S. or a state, (3) a partnership if each general partner is a U.S. citizen and the controlling interest in the partnership is owned by U.S. citizens; (4) a corporation if it is incorporated under the laws of the U.S. or a state, its chief executive officer and the chairman of its board of directors are U.S. citizens, and no more of its directors are non-citizens than the number necessary to constitute a quorum; (5) the U.S. government; and (6) the government of a state. *Id.* § 12103(b).

117 *Id.* § 12103(a).

118 46 C.F.R. § 107.211(a) (2016).

119 *Id.* §§ 107.211(b), (d). For a list of the requirements, *see id.* § 107.231.

120 *Id.* § 107.215.

121 33 C.F.R. § 325.4(a) (2014) (authorizing the Army Corps to impose conditions on permits when "necessary to satisfy legal requirements or to otherwise satisfy the public interest requirement"); *see also id.* § 325.4(d) (providing that, if the Army Corps has reason to believe that the permit holder may be prevented from completing work necessary to protect the public interest, it may require him/her to post a bond of sufficient amount to indemnify the government against any loss as a result of corrective action it may take).

Clean Air Act.[122] Those requirements may apply to structures installed in connection with the Northeast CCS projects that are equipped with air pollutant-emitting electric generating facilities.

Pursuant to the Clean Air Act, the EPA has adopted regulations governing the construction and operation of "OCS sources,"[123] defined as "any equipment, activity, or facility which:

(1) Emits or has the potential to emit any air pollutant;
(2) Is regulated or authorized under the [OCSLA]; and
(3) Is located on the OCS or in or on waters above the OCS."[124]

The regulations impose different requirements depending on the location of the OCS source. Generally, seaward sources located within twenty-five miles of the state waters boundary ("Near Shore OCS Sources") must comply with the air quality requirements of the corresponding onshore area (COA);[125] (i.e., typically the onshore area geographically closest to the source).[126] Sources located further offshore ("Seaward OCS Sources") are subject to federal air quality requirements.[127]

All OCS Sources are subject to New Source Review (NSR) under the Clean Air Act.[128] Pursuant to the NSR Program, OCS Sources must obtain a pre-construction permit if their emissions exceed certain thresholds. Permits for Near Shore OCS Sources are generally issued by the EPA in accordance with the rules applicable to sources in the COA.[129] Different permitting rules apply depending on local air quality in the COA and, in particular, on whether it has attained the National Ambient Air Quality Standards (NAAQS) for carbon monoxide, nitrogen oxides, sulfur oxides, lead, ozone, and particulate matter (collectively the "NAAQS Pollutants"). In summary:

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122 42 U.S.C. § 7627 (2012).
123 40 C.F.R. §§ 55.1–55.2 (2017).
124 *Id.* §§ 55.2–55.3(a). The EPA regulations do not apply to OCS Sources located in the Gulf of Mexico west of 87.5 degrees longitude. *Id.* § 55.3(a).
125 42 U.S.C. § 7627(a)(1); *see also* 40 C.F.R. § 55.3(b).
126 *40* C.F.R. § 55.2.
127 *Id.* § 55.3(c).
128 *Id.* §§ 55.13–55.14.
129 *Id.* §§ 55.11–55.14.

1. If the COA has attained the NAAQS, permitting occurs under the Prevention of Significant Deterioration (PSD) Program. Each state has its own PSD Program, which will apply to Near Shore OCS Sources off its coast. The state programs generally require a permit to be obtained by any source with annual emissions of 250 tons or more. The permit will require the source to apply the best available control technology that the permitting authority determines is achievable, taking into account energy, environmental, and economic impacts and other costs.[130]
2. If the COA has not attained the NAAQS, permitting will occur under the relevant state's non-attainment program. Generally, in each state, a permit must be obtained by any source emitting 100 tons or more of air pollution annually. Some states have lower permitting thresholds for certain pollutants and/or areas.[131] In all states, permitted sources must install pollution control technologies to meet the lowest achievable emissions rate,[132] and provide offsets for any increase in emissions.[133]

Only one class of pre-construction permit, issued under the PSD Program, is available for Seaward OCS Sources.[134] Permits are issued by EPA and must be obtained by any Seaward OCS Source emitting 250 tons or more of air pollution annually.[135]

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130 *Id.* § 52.21(b)(12).

131 *See, e.g.,* 7-1100-1125 DEL. ADMIN. CODE § 2.2.2 (2016) (providing that the permitting threshold for facilities emitting volatile organic compounds or nitrogen oxide is: (1) for areas in ozone attainment or marginal or moderate non-attainment—50 tons per year volatile organic compounds or 100 tons per year of nitrogen oxides; (2) for serious ozone non-attainment areas—50 tons per year of either volatile organic compounds or nitrogen oxides; (3) for severe ozone non-attainment areas—25 tons per year of either volatile organic compounds or nitrogen oxides; or (4) for extreme ozone non-attainment areas—10 tons per year of either volatile organic compounds or nitrogen oxides).

132 42 U.S.C. § 7501(3) (2012). The Lowest Achievable Emissions Rate or LAER is a technology-based standard reflecting the most stringent emissions limitation that can be achieved in practice. *See id.*

133 Offsets take the form of emissions reductions from existing facilities. Any emissions increase from the source must be balanced by equivalent or greater offsets. *See id.* § 7503(c).

134 40 C.F.R. § 55.13(d)(2); *see also id.* § 52.21(a)(2)(iii).

135 42 U.S.C. § 7479; *see also* 40 C.F.R. § 52.21.

Seaward OCS Sources emitting 100 tons of a NAAQS Pollutant or ten tons of a non-statutory hazardous air pollutant must also obtain an operating permit from EPA.[136] Operating permits are also required by certain Near Shore OCS Sources.[137]

Both Near Shore and Seaward OCS Sources must comply with emissions standards adopted under the Clean Air Act.[138] The minimum standards for sources with electric generating facilities are summarized in Table 2 below.

Table 2: Emissions Limits for Electric Generating Facilities

Facility Type	**Emissions Limit**		
	Particulate Matter	**Sulfur Dioxide**	**Nitrogen Oxides**
Steam generating unit[139] with capacity ≥ 2.9 megawatts (MW) but ≤ 29 MW.[140]	13 ng/J or 22 ng/J and 0.2 percent of the combustion concentration if coal, oil, and/or wood are used and unit capacity ≥ 8.7 MW.[141]	87 ng/J or 10 percent of the potential emissions rate if coal is used[142] or 215 ng/J if oil is used.[143]	N/A.

136 40 C.F.R. § 55.13(f)(2); *see also id.* § 71.3.
137 In the ten northeast states, operating permits are generally required for facilities emitting 100 tons of an air pollutant, or 10 tons of a hazardous air pollutant. Some states have lower thresholds for certain pollutants, most commonly nitrogen oxide and volatile organic compounds. *See, e.g.*, 7-1100-1130 DEL. ADMIN. CODE § 3.0 (1993); MD. CODE REGS. 26.11.03.01; 310 MASS. CODE REGS. § 7, Appendix C (2017); N.J. ADMIN. CODE § 7:27-22.2 (2015); N.Y. COMP. CODES R & REGS. tit. 6, §§ 201-2.1–201-6.1; VA. ADMIN. CODE § 5-80-50 (2001).
138 40 C.F.R. § 55.13(c).
139 EPA regulations define a "steam generating unit" as "a device that combusts any fuel and produces steam or heats water or heats any heat transfer medium." *Id.* § 60.41c.
140 *Id.* § 60.40c.
141 *Id.* § 60.43c(e).
142 *Id.* § 60.42c(a). Higher emissions limits apply to units that combust coal refuse in a fluidized bed combustion steam generating unit or use an emerging technology for the control of sulfur dioxide emissions. *See id.* § 60.42c(b).
143 *Id.* § 60.42c(d). This emissions limit will not apply if the unit uses oil containing ≤ 0.5 percent sulfur. *Id.*

Facility Type	Emissions Limit		
	Particulate Matter	Sulfur Dioxide	Nitrogen Oxides
Steam generating unit with capacity > 29 MW but ≤ 73 MW.[144]	13 ng/J if coal, oil, and/or wood are used.[145]	87 ng/J or 8 percent of the potential emission rate and 520 ng/J.[146]	86 ng/J if coal, oil, or gas are used.[147]
Steam generating unit with capacity > 73 MW.[148]	43 ng/J or 20 percent opacity.[149]	340 ng/J if liquid fossil fuels are used or 520 ng/J if solid fossil fuels are used.[150]	86 ng/J if gaseous fossil fuels are used, 129 ng/J if liquid fossil fuels are used, or 300 ng/J if solid fossil fuels[151] are used.[152]

4. Conduct of Drilling Activities

Drilling and other activities on the OCS must be undertaken in accordance with any conditions specified in the applicable

144 *Id.* §§ 60.40b–60.41b.
145 *Id.* § 60.43b(h)(1).
146 *Id.* § 60.42b(k)(1).
147 *Id.* § 60.44b(a). This emissions limit does not apply to certain units operating with a capacity factor of ten percent or less. *Id.* §§ 60.44b(j)–(k).
148 *Id.* § 60.40. Only fossil-fuel-fired and fossil fuel and wood residue-fired steam generating units are included within this category.
149 *Id.* § 60.42(a). These emissions limits do not apply to facilities that combust only natural gas or gaseous or liquid fuel (excluding residual oil) with potential sulfur dioxide rates of twenty-six ng/j. *Id.* §§ 60.42(d)–(e).
150 *Id.* § .43(a).
151 *Id.* §§ 60.44(a)(4)–(5). If the solid fossil fuel consists of lignite mined in North Dakota, South Dakota, or Montana and burned in a cyclone-fired unit, the emissions limit is 340 ng/J. For other types of lignite, the emissions limit is 260 ng/J. *Id.*
152 *Id.* § 60.44(a).

BOEM lease. BOEM may condition a lease to ensure that activities on the OCS are conducted safely and in a manner that provides for the:

- prevention of waste;
- protection of the environment;
- conservation of the natural resources of the OCS;
- protection of correlative rights in the OCS; and
- prevention of interference with reasonable uses of the ocean.[153]

The lessee must guarantee compliance with all conditions and provide a bond or other form of security sufficient to cover all of its obligations[154] under the lease.[155]

5. Well Design Requirements

There are currently no federal regulations governing the design of carbon dioxide injection wells on the OCS. Regulations have been adopted with respect to wells located onshore and in state waters as part of EPA's UIC Program.[156] Key requirements under that program include:

- *Well siting*: Wells used to store carbon dioxide must be sited in areas with a suitable geologic system. The system must comprise:
  - an injection zone(s) of sufficient areal extent, thickness, porosity, and permeability to receive all of the carbon dioxide proposed to be injected; and
  - a confining zone(s) free of transmissive faults or fractures and of sufficient areal extent and integrity to contain the injected carbon dioxide and allow injection at proposed

153 43 U.S.C. § 1337(p)(4) (2012); 30 C.F.R. §§ 585.201, 585.1006 (2016).

154 This includes the holder's decommissioning obligations. The holder of an RUE is responsible for all commissioning obligations that accrue following issue of, and pertain to the RUE. It is not, however, responsible for decommissioning obligations that accrue before issuance of the RUE or that accrue after issuance but are associated with continuing activities. *See* 30 C.F.R. § 585.1018.

155 43 U.S.C. § 1337(p)(6); 30 C.F.R. §§ 585.515, 585.516, 585.1012.

156 40 C.F.R. § 146.81.

maximum pressures and volumes without initiating or propagating fractures.[157]

- *Casing and cementing*: Wells must be cased using materials that have sufficient structural strength and are designed for the life of the project.[158] At least one long string casing, using a sufficient number of centralizers, must extend to the injection zone and be cemented by circulating cement to the surface in one or more stages.[159] The cement must be compatible with the carbon dioxide stream and formation fluids and of sufficient quality and quantity to maintain integrity over the life of the project.[160]
- *Tubing and packer*: Well tubing must be secured with a packer. Tubing and packer materials must be compatible with all fluids with which they are expected to come into contact.[161]
- *Testing*: Wells must be tested prior to use to ensure compliance with all applicable design requirements.

These requirements do not apply to wells in federal waters. Those wells may, however, be subject to similar requirements as a condition of the lease or of the RUE issued by BOEM for drilling.[162]

B. Drilling on the High Seas

As discussed in Part I.C above, U.S. jurisdiction generally only extends 200 n.m. from shore, with areas beyond that considered part of the high seas, which are open to all countries. The high seas have been described as "an international common space available for lawful uses by all [countries] and their citizens."[163] Use of the high seas is regulated under a patchwork of

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157 *Id.* § 146.83.
158 *Id.* § 146.86(b)(1).
159 *Id.* § 146.86(b)(3).
160 *Id.* § 146.86(b)(5).
161 *Id.* § 146.86(c).
162 As noted in Subpart IV.A.1 BOEM may impose terms and conditions on leases and RUEs to ensure drilling is conducted safely and in a manner that protects the environment. 43 U.S.C. § 1337(p)(4) (2012).
163 LOUIS B. SOHN ET AL., LAW OF THE SEA IN A NUT SHELL 13 (2nd ed. 2010).

international agreements, the most important of which is UNCLOS, which establishes the principal of "freedom of the high seas" described in Part I.C above.[164] UNCLOS declares the land underlying the high seas—i.e., the "Area" beyond the limits of national jurisdiction—to be "open to use . . . for peaceful purposes by all."[165] Activities in the Area must, however, "be carried out for the benefit of mankind as a whole."[166] The drilling of injection wells arguably meets this requirement, as CCS helps to mitigate climate change and thereby benefits mankind.

1. Installing Drilling Platforms on the High Seas

UNCLOS defines the principle of "freedom of the high seas" to include, among other things, freedom to construct artificial islands and other installations.[167] The term "installations" is not defined in UNCLOS, but is widely considered to encompass drilling platforms.[168]

UNCLOS does not establish any permitting or registration requirements for drilling platforms or other installations. It does, however, impose such requirements on "ships." The term "ship" is not defined in UNCLOS, but is used in other international agreements to refer to "a vessel of any type whatsoever operating in the marine environment," including a "fixed or floating platform."[169] On this basis a number of commentators have argued that platforms should be considered "ships" for the purposes of UNCLOS and subject to its

164 UNCLOS, *supra* note 8, at art. 87(1) (defining "freedom of the high seas" to include freedom of navigation, freedom of overflight, freedom to lay submarine cables and pipelines, freedom to construct artificial islands and other installations, freedom of fishing, and freedom of scientific research).

165 *Id.* art. 141 (declaring that "[t]he Area shall be open to use exclusive for peaceful purposes by all States"); *see also id.* art. 1(1)(1) (defining the "Area" as "the seabed and ocean floor and subsoil thereof beyond the limits of national jurisdiction").

166 *Id.* art. 140(1).

167 *Id.* art. 87(1)(d).

168 *See, e.g.*, Djamchid Momtaz, *The High Seas, in* HANDBOOK ON THE NEW LAW OF THE SEA 391 (René-Jean Duput & Daniel Vignes eds., 1991).

169 *See, e.g.*, International Convention for the Prevention of Pollution from Ships, art. 2(4).

registration requirements.[170] Consistent with that view, platforms used to drill oil and gas wells are generally registered in accordance with UNCLOS.[171] We recommend that platforms used to drill carbon dioxide injection wells also be registered.

UNCLOS requires all ships to be registered in one, but no more than one, country.[172] A ship can generally be registered in any country,[173] provided it complies with the country's registration rules.[174] Under U.S. rules, the owner of a ship wishing to register in the U.S. must apply to the USCG for a certificate, which evidences registration.[175] A certificate may be issued for any vessel that measures at least five net tons and is U.S. owned.[176] If the vessel is to be used in connection with offshore drilling, the certificate must be endorsed for "registry" (i.e., foreign trade) use.[177]

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170 George K. Walke & John E. Noyes, *Definitions for the Law of the Sea Convention – Part II*, 33 CAL. W. INT'L L.J. 191, 318–319 (2003); Brandon A. Carroll, *Drilling in the Deep: Jurisdiction over Oil Rigs Operating Outside of the Territorial Zone in Light of the Deepwater Horizon Spill*, SW. J. INT'L LAW 667, 676–677 (2012).

171 *See, e.g.*, Carroll, *supra* note 170, at 679 (discussing registration of the Deepwater Horizon drilling unit in the Republic of the Marshall Islands).

172 UNCLOS, *supra* note 8, at art. 92 (declaring that "ships shall sail under the flag of one State only").

173 There are some exceptions. Ships engaging in coastwise trade within the U.S., for example, must be registered in the U.S. *see* 46a U.S.C. § 883 (2012) (providing that "[n]o merchandise . . . shall be transported by water . . . between points in the United States . . . in any vessel other than a vessel built in and documented under the laws of the United States and owned by persons who are citizens of the United States").

174 UNCLOS, *supra* note 8, at art. 91(1) (stating that "[e]very State shall fix the conditions for the grant of its nationality to ships, for the registration of ships in its territory, and for the right to fly its flag").

175 46 U.S.C. § 12104 (2012).

176 *Id.* § 12103(a). The owner may be (1) an individual who is a citizen of the U.S., (2) an association, trust, joint venture, or other entity if all of its members are U.S. citizens and it is capable of holding title to a vessel under the laws of the U.S. or a state, (3) a partnership if each general partner is a U.S. citizen and the controlling interest in the partnership is owned by U.S. citizens; (4) a corporation if it is incorporated under the laws of the U.S. or a state, its chief executive officer and the chairman of its board of directors are U.S. citizens, and no more of its directors are non-citizens than the number necessary to constitute a quorum; (5) the U.S. government; and (6) the government of a state. *Id.* § 12103(b).

177 *Id.* § 12111.

IV. TRANSPORTING CARBON DIOXIDE TO THE WELL SITE

The carbon dioxide injected into offshore wells will likely be collected at power plants or other facilities and transported to the well site via pipeline, road, rail, and/or ship. While carbon dioxide can be transported as a gas, for economic and other reasons, transportation in liquid form is more common. This part discusses the regulatory framework for transporting liquid carbon dioxide from onshore collection points to injection wells located offshore.

A. Onshore Transportation

The safest and most efficient means of transporting carbon dioxide is via pipeline. Currently, however, there are no carbon dioxide pipelines in the Northeastern U.S. In the short-run, then, carbon dioxide will likely need to be transported by road or rail. This part identifies the permitting and other requirements for each mode of transport.

1. Pipeline Transportation

There are currently fifty carbon dioxide pipelines in the U.S., with a combined length of over 4,500 miles[178] and the capacity to transport 3.53 billion cubic feet (Bcf) of carbon dioxide per day, most of which is used in EOR.[179] The majority of carbon dioxide pipelines are, therefore, located in oil producing regions. The entire carbon dioxide pipeline system covers just twelve states, mostly in the South and Midwest.[180] There are currently no carbon dioxide pipelines in the Northeastern U.S.

As a practical matter, any person wishing to develop a new carbon dioxide pipeline, for example in the northeast, must

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178 MATTHEW WALLACE ET AL., A REVIEW OF THE CO2 PIPELINE INFRASTRUCTURE IN THE U.S. 1 (2015), https://energy.gov/sites/prod/files/2015/04/f22/QER%20Analysis%20-%20A%20Review%20of%20the%20CO2%20Pipeline%20Infrastructure%20in%20the%20U.S_0.pdf [https://perma.cc/4X76-CU7P].

179 *Id.*

180 *Id.* at 3.

obtain easements or other rights to cross private property. To facilitate the acquisition of such rights, federal and/or state statutes often grant pipeline developers eminent domain authority, which allows them to take title to private property subject to the payment of compensation and other requirements. Without such authority, developers may be unable to secure agreement from private property owners to use their land, or be forced to pay excessive compensation therefor. Recognizing this, several states have granted eminent domain authority to private entities for the development of carbon dioxide pipelines. Such authority has, for example, been granted in Texas and other states with a history of carbon dioxide use in EOR.[181] Notably however, the ten northeast states considered for this study have not granted eminent domain authority for carbon dioxide pipelines, making development there more difficult.

Even if developers can obtain easements or other rights to cross private property, expanding the carbon dioxide pipeline system to serve the northeast would take several years. It is, therefore, unlikely to be a viable option for the demonstration project. However, it may be of interest to developers of future commercial-scale projects. Project developers could construct new, or repurpose existing, pipelines to transport carbon dioxide.

a. Constructing New Pipelines

(1) Pipeline Siting

Developers are unlikely to be required to obtain federal approval to construct a new carbon dioxide pipeline. No federal agency currently regulates pipeline construction on private or state land. The Government Accountability Office has suggested

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181 *See, e.g.*, TEX. NAT. RESOURCE CODE ANN. § 111.019 (West 2017) (providing that "[c]ommon carriers have the right and power of eminent domain"); *see also id.* § 111.002(6) (defining the term "common carrier" to include a person who "owns, operates, or manages, wholly or partially, pipelines for the transportation of carbon dioxide . . . if such person files with the [Texas Railroad] Commission a written acceptance of the provisions of this chapter expressly agreeing that, in consideration of the rights acquired, it becomes a common carrier subject to the duties and obligations conferred or imposed by this chapter").

that construction may be regulated by the Surface Transportation Board (STB), which oversees pipelines transporting commodities other than water, oil, or gas.[182] However, jurisdiction over carbon dioxide pipelines was disclaimed by the STB's predecessor agency (the Interstate Commerce Commission) on the basis that carbon dioxide is a gas.[183] The Federal Energy Regulatory Commission (FERC), which regulates the interstate transportation of gas, has also disclaimed jurisdiction over carbon dioxide pipelines.[184] Indeed, to date, the only federal agency to have asserted authority over carbon dioxide pipelines is the DOI's Bureau of Land Management (BLM).[185] However, BLM's authority is limited to pipelines crossing federal land. Given the small amount of such land in the northeast, any new carbon dioxide pipeline there is likely to be constructed on private land, eliminating the need for BLM approval.

State regulation of carbon dioxide pipeline siting varies, with some states exercising little or no regulatory authority over such pipelines, while others have more comprehensive regulatory regimes. Regulation tends to be limited in states with little history of carbon dioxide use (e.g., for EOR). States in the northeast, including Virginia, Maryland, Delaware, New Jersey, New York, Connecticut, Rhode Island, Massachusetts, New Hampshire, and Maine (together the "ten northeast states"), generally do not require developers to obtain approval for new carbon dioxide pipelines.

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182 Government Accountability Office, Issues Associated with Pipeline Regulation by the Surface Transportation Board, RCED-98-99, Appendix 1 (1998).

183 Cortez Pipeline Co., (WL 20291) 7 FERC ¶ 61024 (1979) (concluding that the Natural Gas Act did not give FERC jurisdiction over an interstate pipeline transporting ninety-eight percent pure carbon dioxide); Southern Natural Gas Co., 115 FERC ¶ 62266 (2006) (affirming that facilities used to transport carbon dioxide are exempt from jurisdiction under the Natural Gas Act).

184 Cortez Pipeline Company, (WL 20291) 7 FERC ¶ 61024 (1979) (disclaiming jurisdiction over carbon dioxide pipelines, even where they transport small amounts of natural gas, under the Natural Gas Act); *see also* Southern Natural Gas Co., 115 FERC ¶ 62266 (2006).

185 BLM requires carbon dioxide pipelines crossing public lands to obtain a right-of-way under the Mineral Leasing Act of 1920, 30 U.S.C. § 181; Exxon Corp. v. Lujan, 970 F. 2d 757 (10th Cir. 1992).

In the absence of state and federal regulation, developers need only secure an easement or right-of-way from the relevant land owner and comply with any applicable local siting ordinances, such as zoning or land use plans. Some local government plans restrict pipeline construction in designated areas (e.g., near drinking water sources) and/or require a permit to be obtained therefor. This is common in New York, for example.[186] Before permitting a pipeline, local governments in New York must conduct an EA under the State Environmental Quality Review Act, which requires preparation of an environmental impact statement for any action with potentially significant adverse environmental impacts.[187] Similar environmental reviews must also be conducted by local governments in Massachusetts.[188]

In addition to complying with local siting ordinances, pipeline developers may also be subject to other requirements, e.g., under federal and/or state environmental law. The key requirements are summarized, in general terms, in Table 3 below.

Table 3: Environmental Approvals Required for Pipeline Projects

Jurisdiction	Permits Required
Federal	• If the pipeline will be constructed in navigable waters, a permit must be obtained from ACE under section 10 of the Rivers and Harbors Act.[189] • If pipeline construction will require the discharge of dredged or fill material into waters of the United States, a permit may be required from

186 Email from Amanda Mulhern, Pub. Aff. Officer, New York Dep't of Pub. Serv. to Romany Webb (Feb. 15, 2017, 09:29 EST) (on file with author).
187 N.Y. ENVTL. CONSERV. LAW §§ 8-0101–8-0117 (2006).
188 MASS. GEN. LAWS ch. 30, §§ 61–62H (2008).
189 33 U.S.C. § 403 (2012) (requiring a permit to be obtained from ACE prior to the construction of any "structure" in navigable waters of the U.S.). If construction may result in a discharge into navigable waters, before a permit can be issued by ACE, the applicant must obtain a certificate from the state in which the discharge originates or will originate, indicating that the discharge will comply with applicable provisions of the CWA. *See id.* § 1341(a).

Jurisdiction	Permits Required
	ACE (or an authorized state agency) under section 404 of the Clean Water Act (CWA).[190] • If pollutants other than dredged or fill material will be discharged during construction, a permit may be required from EPA (or an authorized state agency) under section 402 of the CWA.[191]
Connecticut	• If the pipeline will be constructed in an inland wetland or other water body, a license may be required from the state Department of Energy and Environmental Protection (CDEEP) or a local inland wetlands agency.[192] • If the pipeline will be constructed in a coastal wetland, a wetlands permit may be required from the CDEEP.[193]
Delaware	• If the pipeline will be constructed in or adjacent to state waters, a subaqueous lands permit may be required from the state Department of Natural Resources and Environmental Control (DDNREC).[194]

190 *Id.* § 1344 (authorizing the issuance of permits "for the discharge of dredged or fill material into the navigable waters"); *see also id.* § 1341(a).

191 *Id.* § 1342 (authorizing the issuance of permits "for the discharge of any pollutant, or combination of pollutants" to waters of the U.S.).

192 CONN. AGENCIES REGS. § 22a-39-4.1 (1974) (providing that a license must be obtained to undertake regulated activities affecting wetlands or water courses within the State of Connecticut); *see also id.* § 22a-39-2(12) (defining "regulated activity"); *see also id.* § 22a-39-2(18) (defining "water course"); *see also id.* § 22a-39-2(19) (defining "wetland").

193 CONN. GEN. STAT. § 22a-32 (1969) (providing that a permit is required to carry out any regulated activity within a wetland); s*ee also id.* § 22a-29 (defining "regulated activity").

194 7-7500-7504 DEL. ADMIN. CODE § 2.4.2 (2014) (providing that a permit is required to construct any structure on, in, under, or over public subaqueous lands"); *see also id.* § 3.0 (defining "subaqueous lands").

Jurisdiction	Permits Required
	• If the pipeline will be constructed in a wetland, a wetlands permit may be required from the DDNREC.[195]
Maine	• If the pipeline will be constructed in or adjacent to a freshwater wetland, river, stream, brook, or pond, a wetlands permit may be required from the state Department of Environmental Protection (DEP).[196] • If the pipeline and associated facilities will occupy more than twenty acres or result in the permanent clearing of more than three acres, a site law permit may be required from the state DEP.[197]
Maryland	• If the pipeline will be constructed in or through the Potomac River, a waterway construction permit may be required from the state Department of the Environment (MDE).[198] • If the pipeline will be constructed in a wetland, a

195 7-7500-7502 DEL. ADMIN. CODE § 6.1.1 (2014) (providing that a permit is required to undertake activities in wetlands"); *see also id.* § 5.0 (defining "wetlands").

196 ME. REV. STAT. tit. 38, § 480-C (2013) (providing that a permit is required to undertake activities involving "A. Dredging, bulldozing, removing or displacing soil, sand, vegetation or other materials; B. Draining or otherwise dewatering; C. Filling, including adding sand or other material to a sand dune; or D. Any construction, repair or alteration of any permanent structure" in "A. A coastal wetland, great pond, river, stream or brook or significant wildlife habitat contained within a freshwater wetland; or B. Freshwater wetlands consisting of or containing: (1) Under normal circumstances, at least 20,000 square feet of aquatic vegetation, emergent marsh vegetation or open water, except for artificial ponds or impoundments; or (2) Peatlands dominated by shrubs, sedges and sphagnum moss"); *see also id.* § 480-B (defining "coastal wetland," "great bond", "river, stream, or brook" and "freshwater wetland").

197 ME. REV. STAT. tit. 38, § 483-A (2016) (requiring a permit to be obtained for "any development of state or regional significance that may substantially affect the environment"); *see also id.* § 482 (defining "development of state or regional significance that may substantially affect the environment").

198 MD. CODE REGS. § 26.17.04.09 (2016) (providing that a permit is required to construct any pipeline "in, under, through, or over the bed or waters of the Potomac River).

Jurisdiction	**Permits Required**
	wetlands permit may be required from MDE.
Massachusetts	• If the pipeline will be constructed in an inland wetland or other water body, a waterways license may be required from the state Department of Environmental Protection (MDEP).[199] • If the pipeline will be constructed in a coastal wetland, approval may be required from the relevant local government.[200]
New Hampshire	• If the pipeline will be constructed in or adjacent to state waters, a wetlands permit may be required from the state Department of Environmental Services (NHDES).[201] • If the pipeline will be constructed within 250 feet of a protected lake, river, or stream, a shoreland impact permit may be required from the NHDES.[202]
New Jersey	• If the pipeline will be constructed in or adjacent to a state waterway, a flood hazard area permit may be required from the state Department of Environmental Protection (NJDEP).[203]

199 310 MASS. CODE REGS. § 9:05(1) (2017) (providing that a license is required to construct structures in, place fill in, remove fill from, or perform certain other activities in trust lands); s*ee also id.* § 9:04 (defining "trust lands").

200 *Id.* § 10.02 (providing that approval must be obtained for any activity proposed to be undertaken in coastal wetlands); *see also id.* § 10.27(2) (defining "coastal wetlands").

201 N.H. Rev. Stat. Ann. § 482-A:3 (2017) (providing that a permit must be obtained to "excavate, remove, fill, dredge, or construct any structure in or on any bank, flat, marsh, or swamp in and adjacent to any waters of the state"); *see also id.* § 482-A:4 (specifying the "waters and adjacent areas" to which the permitting requirement applies).

202 *Id.* § 483-B:5-b (providing that a permit must be obtained to undertake construction, excavation, or filling activities within the protected shoreland); *see also id.* § 483-B:4 (defining "protected shoreland").

203 N. J. ADMIN. CODE § 7:13-2.1(a) (2016) (providing that a permit must be obtained to undertake a regulated activity in a regulated area); *see also id.* § 7:13-1.2 (defining "regulated area"); *see also id.* § 7:13-2.2(a) (identifying regulated waters); *see also id.* § 7:13-2.3 (defining the "flood hazard area" and "riparian zone" of regulated waters); *see also id.* § 7:13-2.4 (defining "regulated activities").

Jurisdiction	Permits Required
	• If the pipeline will be constructed in a wetland, a wetlands permit may be required from NJDEP.[204] • If the pipeline will be constructed in tidelands, a tidelands license may be required from the NJDEP.[205]
New York	• If the pipeline will be constructed in the bed or banks of a designated stream, a protection of waters permit may be required from the state Department of Environmental Conservation (NYDEC).[206] • If the pipeline will be constructed in or adjacent to a freshwater wetland, a freshwater wetlands permit may be required from NYDEC.[207] • If the pipeline will be constructed in or adjacent to a tidal wetland, a tidal wetlands permit may be required from NYDEC.[208]
Rhode Island	• If the pipeline will be constructed in a wetland, a wetlands permit may be required from the Rhode Island Department of Environmental Management.[209]

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204 *Id.* § 7:7A-2.1(a) (providing that a permit must be obtained to engage in a regulated activity); *see also id.* § 7:7A-2.2(a) (identifying regulated activities; *see also id.* § 7:7A-1.4 (defining "freshwater wetland").

205 N.J.S.A. § 13:1B-13. (2009) (Tidelands include all lands currently and formerly flowed by the mean high tide of a natural waterway.).

206 NEW YORK COMP. CODES R. & REGS., tit. 6, § 608.2(a) (1994) (providing that a permit is required to change, modify, or disturb any protected stream, its bed or banks); *see also id.* § 608.1(a) (defining "bank"); *see also id.* § 608.1(b) (defining "bed"); *see also id.* § 608.1(aa) (defining "protected stream").

207 *Id.* § 663.3(e) (providing that a permit must be obtained to conduct activities on wetlands or adjacent areas); *see also id.* § 662.1(b) (defining "adjacent area"); *see also id.* § 662.1(k) (defining "freshwater wetlands").

208 *Id.* § 661.8 (providing that a permit is required to conduct a new regulated activity on any tidal wetland or any adjacent area); *see also id.* § 661.4(b) (defining "adjacent area"); *see also id.* § 661.4(ee) (defining "regulated activity"); *see also id.* § 661.4(hh) (defining "tidal wetlands").

209 Rules & Regulations Governing the Administration & Enforcement of the Freshwater Wetlands Act, § 5.01 (2007) (providing that a permit is required to undertake any project or activity which may alter a freshwater wetland); *see also id.* § 4.00 (defining "alter").

Jurisdiction	Permits Required
Virginia	• If the pipeline will be constructed in a wetland, a wetlands permit may be required from the relevant local government or the state Marine Resources Commission (MRC).[210] • If pipeline construction will disturb one acre or more of land, a storm water permit may be required from the state Department of Environmental Quality (VDEQ).[211]

Before any permit can be issued at the federal level, the permitting agency must undertake an environmental review under NEPA.[212] Some states, including Massachusetts and New York, have their own laws requiring environmental review of state- and/or locally-approved projects.[213] The federal and state reviews are generally coordinated, with the agencies involved often undertaking joint studies and preparing a joint EA or EIS, so as to reduce duplication and streamline the review process.[214] Some pipeline projects may be eligible for expedited review under the 2015 Fixing America's Surface Transportation (FAST)

210 VA. CODE ANN. § 28.2-1306 (1994) (making it unlawful for any person to conduct an activity which would require a permit under a wetlands zoning ordinance without such a permit); *see also id.* § 28.2-1302 (providing that a local government may adopt a wetlands zoning ordinance requiring a permit for any use of, or development in, a wetland subject to limited exceptions").

211 *Id.* § 62.1-44.15:34 (providing that a permit is required to conduct any land disturbing activities that disturb more than one acre of land (subject to limited exceptions)).

212 For a discussion of NEPA, *see supra* Subpart III.A.1.a.

213 New York state agencies must prepare, or cause to be prepared, an environmental impact statement for any action they permit which may have a significant effect on the environment under the State Environmental Quality Review Act before granting approval. *See* N.Y. ENVTL. CONSERV. LAW § 8-0109(2) (2006). Similarly, state agencies in Massachusetts must review the impact of actions on the natural environment under the Massachusetts Environmental Policy Act. *See* MASS. GEN. LAWS ch. 30, § 61 (2008).

214 40 C.F.R. § 1506.2(b) (2017) (requiring federal agencies to "cooperate with state and local agencies to the fullest extent possible to reduce duplication between NEPA and state and local requirements" including by undertaking joint planning processes, joint environmental research and studies, joint public hearings, and joint environmental assessments).

Act. The FAST Act applies to large pipeline and other infrastructure projects subject to NEPA that are likely to require a total investment of more than $200 million, or are of such "size and complexity" that they are "likely to benefit from enhanced oversight and coordination."[215] The determination of whether a project is likely to benefit from enhanced oversight and coordination is made by the Federal Permitting Improvement Steering Council,[216] which is established in the FAST Act and headed by an executive director appointed by the President.[217] The executive director must, in consultation with the council, "develop recommended performance schedules, including intermediate and final completion dates, for environmental reviews and authorizations most commonly required for each category" of covered projects.[218] Initial schedules were finalized in January 2017 and require federal agencies to complete environmental reviews of covered projects within 180 days after all information needed to complete the review is in the possession of the agency.[219]

(2) Pipeline Design

Carbon dioxide pipelines must be designed and constructed in accordance with applicable federal safety regulations. Current safety regulations, adopted by the Department of Transportation's (DOT's) Pipeline and Hazardous Materials Safety Administration (PHMSA), only apply to pipelines transporting carbon dioxide as a supercritical liquid[220] ("supercritical liquid pipelines").[221] The PHMSA is yet to adopt

215 42 U.S.C. § 4370m(6)(A) (2015).
216 *Id.* § 4370m(6)(A)(ii).
217 *Id.* §§ 4370m-1(a)–(b).
218 *Id.* § 4370m-1(c)(1)(C).
219 *See* Recommended Performance Schedules for Environmental Reviews and Authorizations for FAST-41 Covered Infrastructure Projects (2017), https://www.permits.performance.gov/sites/permits.performance.gov/files/docs/FPISC%20Performance%20Schedules-%20FINAL-%2001182017-final.pdf [https://perma.cc/T49E-5EZK].
220 This requires the carbon dioxide to be maintained at or above its critical temperature (i.e., 88°F) and pressure (i.e., 73 atmospheres).
221 49 U.S.C. § 60102(i)(1) (2013); *see* 49 C.F.R. §§ 195.0–195.12 (1972).

regulations with respect to pipelines transporting carbon dioxide as a subcritical liquid or gas. It is, however, expected to do so in the near future.[222]

Current PHMSA regulations establish various requirements for the construction of supercritical liquid pipelines. Most deal with technical aspects of pipeline design, such as:

- *Pipe materials*: All supercritical liquid pipelines must be made of steel capable of withstanding the internal pressures and external loads and pressures anticipated for the pipeline system.[223] The pipes must have an external coating designed to mitigate corrosion[224] and be equipped with a cathodic protection system.[225]
- *Valves*: Valves must be installed at various locations along supercritical liquid pipelines.[226] Each valve must be of sound engineering design[227] and made of materials that are compatible with carbon dioxide.[228] Valves subject to the

222 The 2011 Pipeline Safety, Regulatory Certainty, and Job Creation Act directed the DOT to "prescribe minimum safety standards for the transportation of carbon dioxide by pipeline in gaseous state." In February 2015, the PHMSA published a report recommending that the transport of gaseous carbon dioxide be subject to similar standards as are currently applied to transport of carbon dioxide as a subcritical liquid (i.e., under 49 C.F.R. Pt. 195). The report noted that "[s]ince the transportation of gases is subject to [49 C.F.R.] Part 192, an amendment to Part 192 would be needed to accommodate the regulation of the transportation of [carbon dioxide] CO_2 by pipelines in a gaseous state even if the requirements would be referenced within or very similar to those for supercritical liquid pipelines under Part 195. However, some of the regulations in Part 195 applicable to supercritical CO_2 would need to be modified to be applicable to the transport of gaseous CO_2." OFFICE OF PIPELINE SAFETY, PHMSA, BACKGROUND FOR REGULATING THE TRANSPORTATION OF CARBON DIOXIDE IN A GASEOUS STATE 2 (2015), http://www.eweboq.com/wp-content/uploads/2016/07/U_S_DOT_PHMSA_-_Report_-_Background_For_Regulating_the_Transportation_of_Carbon_Dioxide_in_a_Gaseous_State.pdf [https://perma.cc/ZP64-PJHN].

223 49 C.F.R. § 195.112(a) (1998).

224 *Id.* § 195.557, 195.559.

225 *Id.* § 195.563.

226 *See e.g. id.* § 195.260 (requiring valves to be installed on each side of water crossings that are more than 100 feet (thirty meters) wide and reservoirs holding water for human consumption).

227 *Id.* § 195.116(a).

228 *Id.* § 195.116(c).

internal pressure of the pipeline system must be compatible with the pipe or fittings to which they are attached.[229]

- *Fittings*: Fittings must be suitable for the intended service and at least as strong as the pipe.[230] There must not be any buckles, dents, cracks, gouges, or other defects in the fitting that might reduce its strength.[231]
- *Pumping equipment*: Each pump station must contain safety devices that prevent over-pressuring of pumping equipment and can automatically shut-off equipment in the event of an emergency. Adequate ventilation must be provided in pump station buildings to prevent the accumulation of hazardous vapors. Hazardous vapor warning devices and fire protection systems must be installed in buildings.

The PHMSA regulations also contain provisions governing the location of supercritical liquid pipelines. Under the regulations, pipeline rights-of-way must be selected to avoid areas containing private dwellings, industrial buildings, and places of public assembly, as far as practicable.[232] Pipelines generally cannot be located within fifty feet of a private dwelling, industrial building, or place of public assembly.[233] With some exceptions,[234] pipelines must be buried underground, such that the cover between the top of the pipe and ground level is at least thirty inches[235] or:

- if the pipeline is in an industrial, commercial, and residential area or drainage ditch at a public road or railway, thirty-six inches;[236]

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229 *Id.* § 195.116(b).
230 *Id.* § 195.118(c).
231 *Id.* § 195.118(b).
232 *Id.* § 195.210(a).
233 *Id.* § 195.210(b).
234 Pipeline components may be installed above ground in the following situations: (1) Overhead crossings of highways, railroads, or a body of water. (2) Spans over ditches and gullies. (3) Scraper traps or block valves. (4) Areas under the direct control of the operator. (5) In any area inaccessible to the public. *Id.* § 195.254(a).
235 Where rock excavation is required, only eighteen inches cover is required. Rock excavation is any excavation that requires blasting or removal by equivalent means. *See Id.* § 195.248(a).
236 Where rock excavation is required, only thirty inches of cover is required. *See id.*

- if the pipeline crosses an inland water body with a width of at least 100 feet from high water mark to high water mark, forty-eight inches.[237]

Pipelines located within fifty feet of a private dwelling, industrial building, or place of public assembly must have an additional twelve inches of cover.[238]

b. Repurposing Existing Pipelines

Given the high cost of constructing new carbon dioxide pipelines, project developers may seek to make use of existing lines, e.g., those used in transporting natural gas and/or other substances.[239] Whether this is permissible may ultimately depend on the terms of the existing pipeline easement. We understand that easements often include provisions restricting the substances that can be transported via the pipeline. Where this is the case, before the pipeline can be converted to transport another (unapproved) substance, a new easement would need to be negotiated.

Certain regulatory requirements must also be met prior to converting an existing gas and/or other pipeline to transport carbon dioxide. The key requirements are set out in regulations adopted by the PHMSA. Those regulations only apply where the converted pipeline will be used to transport carbon dioxide as a supercritical liquid.

Under the PHMSA regulations, any pipeline may be converted to transport supercritical liquid carbon dioxide, regardless of whether it meets the design requirements for new lines.[240] Thus, for example, the pipeline to be converted need not be made of steel. Generally, however, prior to converting a non-steel pipeline, the operator must notify the PHMSA, which may prevent conversion if use of the pipeline to transport carbon

237 *Id.* § 195.248.
238 *Id.* § 195.210(b).
239 We assume that pipelines designed to transport natural gas are technically suitable for transporting carbon dioxide (e.g., in terms of the materials used and pressures involved). This should be verified before any existing natural gas pipeline is used to transport carbon dioxide.
240 *See supra* Subpart. IV.A.1.a.

dioxide is found to be unduly hazardous.[241]

The PHMSA need not be notified where the pipeline to be converted is made of steel. Prior to pipeline conversion, the operator must:

- review the design, construction, operation, and maintenance history of the pipeline and, if sufficient historical records are not available, perform appropriate tests to confirm it is in satisfactory condition for safe operation;
- visually inspect the pipeline right-of-way, all aboveground segments of the pipeline, and appropriately selected underground segments and correct any unsafe defects or operating conditions; and
- pressure test the pipeline for at least four continuous hours at a pressure equal to 125 percent or more of the maximum operating pressure and, if the pipeline is not visually inspected for leaks during the test, an additional four continuous hours at a pressure equal to 110 percent or more of the maximum operating pressure.[242]

Additional regulatory requirements may apply to the conversion of pipelines previously used to transport natural gas. Prior to converting a natural gas pipeline crossing state boundaries (i.e., an interstate pipeline), the operator must obtain approval from FERC to stop transporting natural gas and abandon the line.[243] FERC may only approve pipeline abandonment if it finds that "the available supply of natural gas is depleted to the extent that the continuation of [transportation] service[s] is unwarranted, or that the present or future public convenience or necessity permit such abandonment."[244] In evaluating whether the public convenience or necessity permit abandonment, FERC applies a "presumption in favor of continued service"[245] and requires proof "that the public interest

241 49 C.F.R. § 195.8.
242 *Id.* § 195.5(a).
243 *See* 15 U.S.C. § 717f(b) (2017) (prohibiting any natural gas company from "abandon[ing] all or any portion of its facilities . . . without the permission and approval of" FERC).
244 *Id.*
245 Transcontinental Gas Pipe Line Corp. v. FPC, 488 F.2d 1325, 1330 (D.C. Cir. 1973).

will in no way be disserved" by cessation of service.[246] This must be assessed on a case-by-case basis considering "all relevant factors,"[247] including the availability of alternative transportation,[248] the extent to which the pipeline is underused,[249] the economic effects of pipeline abandonment,[250] the environmental impacts of abandonment,[251] and general public policy and safety considerations (e.g., the effect of abandonment on the nation's gas supply and retail prices).[252]

FERC does not have regulatory authority over natural gas pipelines located wholly within the boundaries of a single state (i.e., intrastate pipelines). Those pipelines are regulated by state public utility commissions or other energy agencies. While the state commissions or agencies oversee pipeline construction and operation, their approval is generally not required to abandon the line.[253]

2. Road and Rail Transportation

In areas lacking pipeline infrastructure, carbon dioxide may be transported by road or rail. For the purposes of road and rail transportation, carbon dioxide has been designated a hazardous material, pursuant to the Hazardous Materials Transportation Act (HMTA).[254] Regulations issued under the HMTA require

246 S. Nat. Gas Co., L.L.C., 139 FERC ¶ 61,237 (2012).
247 N. Nat. Gas Co. et al., 135 FERC ¶ 61,048 (2011).
248 *See e.g.* Transcontinental Gas Pipe Line Co., 134 FERC ¶ 61,238 (2011).
249 *See e.g.* Florida Gas Transmission Co., 129 FERC ¶ 61,135 (2009), *reh'g denied*, 131 FERC ¶ 61,119 (2010).
250 *See e.g. Transcontinental Gas Pipeline Corp*, 488 F.2d at 1330; Transcontinental Gas Pipe Line Corp., 110 FERC ¶ 61,337 (2005).
251 *See e.g.* El Paso Nat. Gas Co., 137 FERC ¶ 62,123 (2011).
252 *See e.g.* N. Nat. Gas Co. et al., 135 FERC ¶ 61,048 (2011); Nw. Pipeline GP, 139 FERC ¶ 62,147 (2012).
253 *See e.g.* 220 MASS CODE REGS. 107.00 (2004) (outlining rules for the abandonment of natural gas pipelines. The rules do not require advance notice to be given to, or approval to be obtained from, the state Department of Public Utilities); N.Y. COMP. CODES R. & REGS. tit. 16, § 255.727 (2017) (providing for pipeline abandonment without approval from the New York Department of Public Service).
254 49 U.S.C. § 5103(a) (2006) (requiring the Secretary of Transportation to "designate material . . . as hazardous when the Secretary determines that

persons transporting hazardous materials to be registered with the PHMSA.[255] The transporter must renew his/her/its registration annually, by submitting a registration statement to the PHMSA, along with a fee of $2,600.[256]

A registered operator may transport carbon dioxide in gaseous or liquid form.[257] The HMTA regulations outline various requirements for transportation including:

- *Packaging*: Liquid carbon dioxide may be transported in bulk by road cargo tanks or rail tank cars equipped with appropriate safety systems (e.g., pressure relief devices).[258] Carbon dioxide may also be transported, via road or rail, in high-pressure metal cylinders.[259]
- *Labeling*: Cylinders, cargo tanks, and tank cars used to transport carbon dioxide must be clearly marked.[260] Cylinders must have a green label stating "NON-FLAMMABLE GAS," unless they are permanently mounted in or on a vehicle that is placarded.[261]
- *Placarding*: Road vehicles and rail cars transporting carbon dioxide must display a green placard stating "NON-FLAMMABLE GAS" on each side and end.[262] There is an exception for road vehicles carrying less than 1001 pounds aggregate gross weight of carbon dioxide.[263]

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transporting the material in commerce in a particular amount and form may pose an unreasonable risk to health and safety or property"); *see also* 49 C.F.R. § 172.101 (2016) (designating "carbon dioxide" and "carbon dioxide, refrigerated liquid" as division 2.2 hazardous materials).

255 *Id.* § 171.2; *see also id.* § 107.608.

256 *Id.* §§ 107.608(a), 107.612. Small businesses (defined as "a person that qualified as a small business under 13 C.F.R. Part 121") and not-for-profit organizations (defined as "an organization exempt from taxation under 26 U.S.C. § 501(a)) are only required to pay a fee of $275. *Id.* § 107.612.

257 *Id.* § 172.101.

258 *Id.* §§ 173.314–173.315; s*ee also id.* §§ 173.31–173.33.

259 The cylinder must be a pressure vessel built to Department of Transportation or UN standards. *Id.* § 173.301(a)(1); *see also id.* § 171.8 (defining "cylinder" to mean "a pressure vessel designed for pressures higher than 40 psia and having a circular cross section").

260 *Id.* §§ 172.301, 172.302, 172.328, 172.330.

261 *Id.* §§ 172.400, 172.400a, 172.415.

262 *Id.* §§ 172.504, 172.508, 172.514, 172.528.

263 *Id.* § 172.504(c).

- *Documentation*: Cylinders, cargo tanks, and tank cars cannot be transported by road or rail unless a shipping order, manifest, or other document has been prepared indicating that it contains carbon dioxide.[264]
- *Loading*: Cylinders containing carbon dioxide may be secured in an upright or horizontal position on the floor of a road vehicle or rail car or in racks, crates, or boxes.[265] A qualified person, trained in emergency response, must be present during loading and unloading.[266]

B. Offshore Transportation

As explained in Part IV.A above, carbon dioxide will likely be transported from the point of collection to a storage hub on the coast by road, rail, or in the longer-term pipeline. A separate offshore transportation system will then be needed to connect the storage hub to the well site. Offshore transportation may occur via pipeline or ship. The requirements for each are discussed in the following parts.

1. Pipeline Transportation

Offshore pipelines (i.e., those lying on or in the seabed) may be used to transport carbon dioxide to the well site. This part outlines the regulatory framework for pipeline development in state and federal waters and on the high seas.

a. Pipeline Construction in State Waters

(1) Pipeline Siting

Carbon dioxide pipelines in state waters must be permitted by ACE. As noted in Subpart IV.A.2 above, an ACE permit is required to construct any structure in the navigable waters of the U.S., including state waters "within a zone three [n.m.] from

264 *Id.* §§ 174.24, 177.817; *see also id.* § 172.200.
265 *Id.* §§ 174.201(a), 177.840(a).
266 *Id.* § 177.834(i).

the baseline."[267] The permit requirement applies to all devices, including pipelines, constructed on the ocean floor.[268]

In permitting offshore pipelines, ACE follows the same basic procedures as are used to permit drilling platforms and other structures, described in Subpart IV.A.2 above. Permit applications must be filed with the relevant district office of ACE.[269] On receiving an application, ACE will publish a notice, requesting comments from the public.[270] Based on the comments received and any responses from the applicant, ACE will decide whether or not a permit should be issued.[271] In making this decision, ACE evaluates the probable impacts of pipeline construction on the public interest, balancing its beneficial and detrimental effects.[272] As part of this balancing, ACE will consider the need for the pipeline, and its likely effect on other uses of the area.[273] In addition, if the pipeline is to be constructed in an area with recognized historic, cultural, scenic, conservation, recreational, or similar values, ACE must consider its likely effects on those values.[274]

Prior to permitting a pipeline, ACE must complete any necessary environmental and/or other reviews, for example under NEPA.[275] ACE must also work with the relevant coastal state(s) to ensure the pipeline project is consistent with any

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267 33 C.F.R. § 329.12(a) (2014) (providing that "[t]he navigable waters of the United States over which [ACE] regulatory jurisdiction extends include all ocean and coastal waters within a zone three geographic (nautical) miles seaward from the baseline"); *see also id.* § 322.3(a) (indicating that a permit is required "for structures and/or work in or affecting navigable waters of the United States . . . .").

268 *Id.* § 322.5(f) (requiring permits for the construction of "artificial islands, installations, and other devices on the seabed, to the seaward limit of the outer continental shelf . . . .").

269 *Id.* § 325.1(d)(1).

270 *Id.* §§ 325.2(a)(2), 325.3.

271 *Id.* §§ 325.2(a)(3)–(6).

272 *Id.* § 320.4(a)(1).

273 *Id.* § 320.4(a)(2).

274 *Id.* § 320.4(e).

275 *Id.* §§ 320.4(h), 325.2(a)(4). ACE's NEPA review will need to be coordinated with any reviews undertaken by other federal, state, and/or local agencies. For a discussion of this issue, *see* Part IV.A.1.a.

management plan(s) adopted under the CZMA.[276] The developer must provide ACE and the relevant state(s) with a consistency certification, indicating that the project complies with the management plan and will be undertaken in a manner consistent with that plan.[277] The state(s) must approve the certificate before the project can be permitted by ACE.[278]

Various other state approvals may also be required to construct carbon dioxide pipelines in state waters. Generally, as the land underlying state waters is publicly owned, a lease or similar authorization must be obtained prior to pipeline construction. One or more construction permits may also be required depending on the pipeline route. Key permits and other approvals required in the ten northeast states are summarized in Table 4 below.

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276 16 U.S.C. § 1456(c) (2006). Under the CZMA, all federally-approved actions that affect coastal uses or resources must be consistent with state management plans, to the maximum extent practicable. *See id.* § 1456(c)(3). This includes actions undertaken by non-federal agencies that require federal approval. Such actions are deemed to affect coastal uses or resources if they occur within state waters and the relevant state has listed the action in its management plan. *See* 15 C.F.R. § 930.53 (2012). Actions requiring ACE permits have been listed in the management plans adopted by Connecticut, Delaware, Massachusetts, New Jersey, New York, Rhode Island, and Virginia. *See* CONNECTICUT'S PROPOSED FEDERAL CONSISTENCY LIST (2010), http://www.ct.gov/deep/lib/deep/long_island_sound/federal_consistency_list_2010.pdf [https://perma.cc/UDY5-AZQR]; DELAWARE'S LISTED FEDERAL ACTIONS (2011) [https://perma.cc/ZQ55-3K5R]; MASSACHUSETTS COASTAL ZONE MANAGEMENT POLICY GUIDE (2011), http://www.mass.gov/eea/docs/czm/fcr-regs/czm-policy-guide-october2011.pdf [https://perma.cc/BK6N-J6SJ]; NEW JERSEY COASTAL MANAGEMENT PROGRAM FEDERAL CONSISTENCY LISTINGS (2008), http://www.nj.gov/dep/cmp/2008_fc_listing.pdf [https://perma.cc/82F9-2P7S]; NEW YORK STATE COASTAL MANAGEMENT PROGRAM (2006) [https://perma.cc/9E4C-GMQD]; RHODE ISLAND COASTAL ZONE MANAGEMENT PROGRAM (2015) [https://perma.cc/2PVH-V97Q]; FEDERAL CONSISTENCY INFORMATION PACKAGE OR VIRGINIA COASTAL ZONE MANAGEMENT PROGRAM (2011) [https://perma.cc/NWL8-D3JM].

277 15 C.F.R. § 930.57 (2002).

278 *Id.* §§ 930.62–930.64.

Table 4: State Approvals Required for Offshore Carbon Dioxide Pipelines

State	Required Approvals
Connecticut	• A certificate authorizing the use of submerged lands may be required from the CDEEP.[279] • If the pipeline will pass through a tidal wetland, a wetlands permit may be required from the CDEEP. [280]
Delaware	• A lease may be required from the DDNREC.[281] • If the pipeline will pass through a wetland, a wetlands permit may be required from the DDNREC.[282]
Maine	• A lease may be required from the state Bureau of Parks and Public Lands.[283] • If the pipeline will be constructed in or within seventy five feet of a coastal wetland, a wetlands permit may be required from the state DEP.[284]

279 CONN. GEN. STAT. § 22a-361 (2011) (providing that a certificate is required to erect any structure in the tidal, coastal, or navigable waters of the state).
280 *Id.* § 22a-32 (providing that a permit is required to carry out any regulated activity within a wetland); *see also id.* § 22a-29 (defining "regulated activity").
281 7-7500-7504 DEL. ADMIN. CODE § 2 (2017) (providing that a lease is required to lay a pipeline in, on, over, or under the beds of public subaqueous lands); *see also id.* § 1 (defining "subaqueous lands").
282 7-7500-7502 DEL. ADMIN. CODE § 6 (2017) (providing that a permit is required to undertake any "activity in wetlands"); *see also id.* § 5 (defining "activity").
283 ME. REV. STAT. tit. 1, §§ 1–2 (2016) (declaring the state's ownership of certain land and providing for the conveyance of that land to private entities).
284 ME. REV. STAT. tit. 38, § 480-C (2016) (providing that a permit is required to undertake activities involving "A. Dredging, bulldozing, removing or displacing soil, sand, vegetation or other materials; B. Draining or otherwise dewatering; C. Filling, including adding sand or other material to a sand dune; or D. Any construction, repair or alteration of any permanent structure" in a "costal wetland"); *see also id.* § 480-B (defining "coastal wetland").

State	Required Approvals
	• If the pipeline will be constructed in a coastal sand dune system, a sand dune permit may be required from the state DEP.[285]
Maryland	• A license may be required from the Maryland Board of Public Works.[286] • If pipeline construction will affect a wetland, a wetlands permit may be required from the MDE.
Massachusetts	• A license may be required from the MDEP.[287] • If the pipeline will pass through a coastal wetland, beach, dune, or bank, and construction will remove, fill, dredge, or otherwise alter that area, approval may be required from the relevant local government.[288]
New Hampshire	• A lease may be required from the NHDES.[289] • If the pipeline will pass through a sand dune, tidal wetland, or bog, a permit must be obtained from the NHDES.[290]

285 06-096-355 ME. CODE R. §§ 2(A), 4 (LexisNexis 2017) (indicating that permits must be obtained for activities in coastal sand dune systems); *see also* ME. REV. STAT. tit. 38, § 480-B(1) (Westlaw through 2017) (defining "coastal sand dune systems").

286 MD. CODE REGS. § 23.02.04.04(C) (2016) (providing that "[t]he construction [of] any . . . pipeline . . . over, on, in, or under [State] tidal wetlands or waters of the State requires a license.").

287 310 MASS. CODE REGS. §§ 9.03–9.05 (2017) (providing that a license is required for activities involving the "construction [or] placement . . . of any fill or structure[]" in all waterways in Massachusetts); s*ee also id.* § 9.02 (defining "structure").

288 *Id.* § 10.02 (providing that approval must be obtained for any activity proposed to be undertaken in coastal wetlands, coastal beaches, coastal dunes, and certain other areas which will remove, fill, dredge, or alter that wetland); *see also id.* § 10.27(2) (defining "coastal beach"); *see also id.* § 10.28(2) (defining "coastal dune"); *see also id.* § 10.30(2) (defining "coastal bank").

289 N.H. REV. STAT. ANN. § 4:40 (2017) (authorizing the conveyance of state-owned land).

290 *Id.* § 482-A:3 (providing that a permit must be obtained to "excavate, remove, fill, dredge, or construct any structures in or on any bank, flat, marsh, or swamp in and adjacent to any waters of the state"); *see also id.* § 482-A:4

State	Required Approvals
New Jersey	• A lease may be required from the New Jersey Tidelands Resource Council.[291] • A waterfront development permit may be required from the NJDEP.[292] • If the pipeline will pass through a designated coastal wetland, a coastal wetlands permit may be required from the NJDEP.[293] • If the pipeline will be constructed on a beach or dune, a CAFRA permit may be required from the NJDEP.[294]
New York	• A lease or easement may be required from the New York State Office of General Services.[295] • If the pipeline will pass through a tidal wetland, a tidal wetlands permit may be required from the NYDEC.[296] • If the pipeline will pass through a coastal erosion hazard area, a coastal erosion

(specifying the "waters and adjacent areas" to which the permitting requirement applies).

291 NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION, TIDELANDS (2017), http://www.nj.gov/dep/landuse/tl_main.html [https://perma.cc/C47Y-VA5S].

292 N.J. ADMIN. CODE § 7:7-2.4(d) (2017) (providing that a "permit shall be required for the construction . . . of any structure . . . in the waterfront area"); s*ee also id.* § 7:7-1.5 (defining "structure"); *see also id.* § 7:7-2.4 (defining "waterfront area").

293 *Id.* § 7:7-2.3(a) (providing that "[c]oastal wetlands permits are required for all activities in coastal wetlands . . . including, but not limited to[,] . . . the construction of any structure"); *see also* N.J. STAT. ANN. § 13:9A-2 (West 2017) (defining "coastal wetlands").

294 N.J. ADMIN CODE § 7:7-2.2 (2017) (providing that "a CAFRA permit shall be required for . . . any development located on a beach or dune"); *see also id.* § 7:7-1.5 (defining "development"); *see also id.* § 7:7-9.16(a) (defining "dune"); *see also id.* § 7:7-9.22(a) (defining "beach").

295 N.Y. PUB. LANDS LAW § 3(2) (2017) (authorizing the Office of General Services to lease state lands).

296 N.Y. COMP. CODES R. & REGS. tit. 6, § 661.8 (2017) (providing that a permit is required to conduct a regulated activity on any tidal wetland); s*ee also id.* § 661.4(hh) (defining "tidal wetlands"); *see also id.* § 661.4(ee) (defining "regulated activity").

State	Required Approvals
	management permit may be required from the relevant local government or the NYDEC.[297]
Rhode Island	• A lease or easement may be required from the Rhode Island Coastal Resources Management Council (RICRMC).[298] • A construction permit may be required from the RICRMC.[299]
Virginia	• A lease or easement may be required from the MRC.[300] • If the pipeline will pass through a wetland, a wetlands permit may be required from the relevant local government or the MRC.[301] • If the pipeline will pass through a coastal primary sand dune, a sand dune permit may be required from the relevant local government or the MRC.[302]

In addition to securing any necessary state environmental permits, the pipeline developer must also obtain any permits

297 *See id.* § 505.2(hh) (providing that any person proposing to undertake a regulated activity in an erosion hazard area must obtain a coastal erosion management permit) (defining "regulated activity"); *see also id.* § 505.2(o) (defining "erosion hazard area").

298 46 R.I. GEN. LAWS § 46-23-6(4)(iii) (2017) (authorizing the RICRMC to "[g]rant licenses, permits, and easements for the use of coastal resources which are held in trust by the state for all its citizens").

299 *Id.* § 46-23-6(4)(i) (authorizing the RICRMC to "[i]ssue . . . permits for any work in, above, or beneath the areas under its jurisdiction"); *see also* THE STATE OF RHODE ISLAND, COASTAL RESOURCES MANAGEMENT PROGRAM § 100.1 (2010) (providing that a council assent is required for "any alteration or activity that are proposed for (1) tidal waters within the territorial seas . . . (2) shoreline features; and (3) areas contiguous to shoreline features.).

300 VA. CODE ANN. § 28.2-1208 (2017) (authorizing the Marine Resources Commission to grant easements over or under or lease the beds of state waters).

301 *Id.* § 28.2-1306.

302 *Id.* § 28.2-1406 (making it unlawful for any person to conduct an activity which would require a permit under a coastal primary sand dune zoning ordinance without such a permit); *see also id.* § 28.2-1400(A) (defining "coastal primary sand dune").

required under federal environmental law. The key federal permits are discussed in Subpart 35IV.A.1 above.

(2) Pipeline Design

Carbon dioxide pipelines in state waters must be designed and constructed in accordance with safety regulations adopted by the PHMSA. The PHMSA regulations apply to pipelines transporting carbon dioxide [303] and certain other hazardous liquids[304] in state waters, except "where the pipeline is located upstream of the outlet flange of the following farthest downstream facility: [t]he facility where hydrocarbons or carbon dioxide are produced or the facility where produced hydrocarbons or carbon dioxide are first separated, dehydrated, or otherwise processed." [305] This exception was intended to capture pipelines associated with offshore production ("production lines"), which are regulated by the states, while leaving other transportation pipelines to be regulated by the PHMSA. [306] The PHMSA regulations have been applied to pipelines used to transport liquids between offshore production sites and onshore storage or other facilities.

Pipelines serving offshore carbon dioxide injection wells are unlikely to fall within the production line exception. Such pipelines are not associated with carbon dioxide production, but rather used in transportation between on- and offshore facilities. The pipelines would, therefore, be subject to regulation by the PHMSA. The PHMSA applies the same safety regulations to both onshore and offshore pipelines. The regulations, described in Subpart IV.B.1.a above, include requirements with respect to the design of pipelines and associated equipment (e.g., valves, fittings, and pumps). Notably, however, the requirements only

303 The PHMSA regulations only apply to pipelines transporting carbon dioxide as a supercritical liquid. 49 C.F.R. § 195.2 (2017) 2017 WL 49 CFR § 195.2.
304 The regulations apply to petroleum, petroleum products, anhydrous ammonia, and ethanol. *See* 49 C.F.R. § 195.2.
305 *Id.* § 195.1(b)(5).
306 PHMSA, *Fact Sheet: Offshore Pipelines*, https://primis.phmsa.dot.gov/comm/FactSheets/FSOffshorePipelines.htm [https://perma.cc/495A-YN43] (last updated Dec. 1, 2011).

apply to pipelines transporting carbon dioxide as a supercritical liquid. No requirements have been adopted with respect to pipelines transporting gaseous or subcritical liquid carbon dioxide.

b. Pipeline Construction in Federal Waters

(1) Pipeline Siting

Like carbon dioxide pipelines in state waters, those in federal waters must be authorized by ACE.[307] Authorization must also be obtained from the DOI's BOEM or Bureau of Safety and Environmental Enforcement (BSEE). BOEM may authorize "on-lease pipelines" that are to be installed by an existing lease holder within the area covered by of his/her/its drilling lease. Each lease confers on the holder "the right to one or more project easements without further competition for the purpose of installing . . . pipelines and appurtenances on the OCS as necessary for the full enjoyment of the lease."[308] Easement applications must be included as part of the Construction and Operations Plan[309] or General Action Plan,[310] which the lease holder is required to submit to BOEM before undertaking any activity in the lease area.[311] The plan must describe all facilities to be constructed in connection with the lease, including any pipelines, and include information regarding pipe design, installation, testing, maintenance, and repair.[312]

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307 33 C.F.R. § 322.3(b) (2014) (indicating that permits "are required for the construction of artificial islands, installations, and other devices on the seabed, to the seaward limit of the outer continental shelf").
308 30 C.F.R. § 585.200(b) (2017). Despite the broad language used in the provision, BOEM staff reported that the provision is only applied where a pipeline is situated "on lease." In all other circumstances, pipelines must be authorized by BSEE, through a right-of-way. Personal communication with Melissa Batum, Sen. Prog. Analyst, Bureau of Ocean Energy Management, Department of the Interior (Jun. 6, 2017).
309 A construction and operations plan must be submitted before activities are undertaken pursuant to a commercial lease. *See id.* § 585.600(b).
310 A general action plan must be submitted before activities are undertaken pursuant to a limited lease, ROW grant, or RUE grant. *See id.* § 585.600(c).
311 *Id.* § 585.200(b)(1).
312 *Id.* §§ 585.620(a), 585.640(a), 585.626(b), 585.640(c).

Off-lease pipelines—i.e., those located in areas not covered by the drilling lease—will require a stand-alone authorization from BSEE. The OCSLA confers broad authority on BSEE to issue rights-of-way (ROWs) through the OCS "for pipeline purposes . . . under such regulations and upon such conditions as may be prescribed."[313] BSEE regulations establish a framework for issuing ROWs for pipelines transporting oil, gas, sulfur, or produced water.[314] Currently, however, the regulations do not provide for the issuance of rights-of-way for carbon dioxide pipelines.

(2) Pipeline Design

The DOI is authorized, under the OCSLA, to regulate the design and construction of pipelines on the OCS for the purpose of "assuring environmental protection by utilization of the best available and safest technologies."[315] Regulations with respect to pipeline construction on the OCS may also be adopted by the DOT.[316] To avoid duplication of effort, the DOI and DOT have entered into a memorandum of understanding (MOU), dividing responsibility for pipeline regulation.[317] The MOU puts "production pipelines under DOI responsibility and . . . transportation pipelines under DOT responsibility."[318] As noted in Subpart IV.B.1.a above, pipelines serving offshore carbon dioxide injection wells are unlikely to be considered production lines, but rather transportation lines. The pipelines would, therefore, fall within the regulatory responsibility of the

313 43 U.S.C. § 1334(e) (2012).
314 30 C.F.R. § 250.105 (defining "pipeline" to mean piping and associated equipment installed to transport oil, gas, sulphur, and produced water).
315 43 U.S.C. § 1334(e); *see also* 30 C.F.R. § 250.1000-08.
316 *See* 49 C.F.R. § 195.0-12.
317 BUREAU OF SAFETY AND ENVT'L ENF'T, MEMORANDUM OF UNDERSTANDING BETWEEN THE DEP'T OF TRANSP. AND THE DEP'T OF THE INTERIOR REGARDING OUTER CONTINENTAL SHELF PIPELINES (Dec. 10, 1996), https://www.bsee.gov/sites/bsee.gov/files/memos/standards/003-1997-mou.pdf [https://perma.cc/JR69-2CWM].
318 DEP'T OF INTERIOR, MINERALS MGMT. SERV. MANUAL, PROGRAM SERIES, PART 640 RULES & OPERATIONS, CHP. 3 INCIDENT INVESTIGATION & INFO. MGMT. (2003).

DOT's PHMSA. The PHMSA imposes the same regulations on OCS pipelines as are imposed on pipelines located onshore and in state waters.[319]

c. Pipeline Construction on the High Seas

Whereas domestic law applies to pipeline construction in U.S. waters, construction on the high seas is regulated under the principles of international law. The key principles are set out in UNCLOS, which authorizes the installation of "submarine . . . pipelines on the bed of the high seas."[320] Under UNCLOS, when installing a submarine pipeline, the owner must pay due regard to any existing pipeline or cable on the seabed and notify the owner of such pipeline or crossing in the event of any crossing.[321] Beyond this, however, UNCLOS does not impose any other requirements for pipeline installation.

(1) Ship Transportation

Due to the cost and complexity of developing offshore pipelines, during the demonstration project, carbon dioxide is likely to be transported to the well site by ship. Tank vessels could be used to transport carbon dioxide in bulk. Carbon dioxide could also be transported in non-bulk containers (e.g., cylinders) by other vessels. In both cases the vessel would be loaded at a port in the U.S. and travel through the U.S. and possibly international waters before reaching the well site.

2. Transporting Carbon Dioxide in U.S. Waters

Vessels transporting carbon dioxide in state and federal waters are subject to regulation by the U.S. The U.S. applies different regulatory frameworks to vessels engaged in bulk and

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319 For a discussion of the regulations, *see supra* Parts I and II.
320 UNCLOS, *supra* note 8, at 112(1).
321 *Id.* at 79(5), 112(2). For a discussion of this issue, *see* Mišo Mudrić, *Rights of States Regarding Underwater Cables and Pipelines*, 29 AUSTL. RESOURCES & ENERGY L.J. 235, 252 (2010).

non-bulk transportation.

Bulk transportation vessels are regulated by the USCG under its Safety Standards for Self-Propelled Vessels Carrying Bulk Liquefied Gases ("Safety Standards").[322] Under the Safety Standards, liquefied carbon dioxide may only be transported in bulk through U.S. waters if the transporter holds a certificate issued by the USGS, which has been endorsed for the carriage of carbon dioxide.[323] To be certified by the USCG, the vessel must meet various design and other requirements, including:

- *Cargo tank design*: Vessels may be equipped with integral,[324] membrane,[325] semi-membrane,[326] or independent[327] cargo tanks. Each tank must be made of steel, unless it is intended to operate at very low temperatures, in which case aluminum must be used.[328] Aluminum tanks must be enclosed by the vessel's hull or a separate steel structure.[329]
- *Piping systems*: Each cargo tank must be equipped with a piping system. Only that system may be used to load and unload the tank.[330] Loading and unloading must be supervised by a qualified person who has experience with the vessel and its cargo system and has received training in the hazards associated with the cargo and special procedures for its handling.[331]

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322 46 C.F.R. §§ 154.3, 154.5 (2016). The standards apply to "each self-propelled vessel that has on board bulk liquefied gases as cargo." *Id.* § 54.5. For the purposes of the standards, the term "liquefied gases" is defined to mean "a cargo having a vapor pressure of 172 kPa (25 psia) or more at 37.8°C (100°F)." *Id.* § 154.7. Liquefied carbon dioxide falls within that category. *See generally* GreenFacts, *How can CO_2 be transported once it is captured?*, CO_2 CAPTURE AND STORAGE, http://www.greenfacts.org/en/co2-capture-storage/l-3/4-transport-carbon-dioxide.htm (indicating that carbon dioxide can be transported in bulk by marine tankers at 700 kPa pressure).

323 *Id.* §§ 154.1801, 154.1802; *see also id.* §§ 154.9–154.24.

324 *Id.* §§ 154.418–154.421.

325 *Id.* §§ 154.425–154.432.

326 *Id.* §§ 154.435–154.436.

327 *Id.* §§ 154.437–154.453.

328 *Id.* §§ 154.610–154.620.

329 *Id.*

330 *Id.* § 154.1834.

331 *Id.* §§ 154.1831(a)(2)–(4); *see also* 33 C.F.R. § 155.710.

- *Safety devices*: Each cargo tank must be equipped with a pressure gauge that monitors the vapor space[332] and have one or more pressure relief devices.[333] The vessel must have a high pressure alarm that activates before any cargo tank exceeds the maximum pressure and triggers operation of the pressure relief device.[334]
- *Warning signs*: A vessel transporting liquid carbon dioxide must display a warning sign while at any dock or port.[335] The vessel must carry documentation specifying the amount of carbon dioxide on board and the cargo tank(s) in which it is stowed.[336] It must also carry a cargo information card containing general information about carbon dioxide.[337]

The above requirements only apply to ships transporting liquid carbon dioxide in bulk.[338] Ships engaged in non-bulk transportation are subject to different requirements, established through regulations adopted by the PHMSA under the HMTA.[339] The HMTA regulations do not apply to small vessels of fifteen gross tons or less ("small operators").[340]

Under the HMTA regulations, persons engaged in non-bulk transportation of carbon dioxide by ship, except small operators, must register annually with the PHMSA.[341] The registration process is the same as that for persons transporting carbon dioxide by road or rail.[342] Like road and rail operators, a registered ship can transport liquid carbon dioxide in metal cylinders that are clearly marked, and have a green "NON-

332 46 C.F.R. § 154.1335(a) (2016).
333 *Id.* § 154.801.
334 *Id.* § 145.1335(b).
335 *Id.* § 145.1830.
336 *Id.* § 154.1820.
337 A cargo information card must include the following information about the cargo: name, appearance, odor, safe handling procedures, procedures to follow in the event of spills, leaks, or uncontrolled release, procedures to be followed if a person is exposed to the cargo, and firefighting procedures. *Id.* § 154.1814.
338 *Id.* § 154.5.
339 49 C.F.R. § 171.1 et seq.
340 *Id.* § 176.5(b)(3).
341 *Id.* § 171.2(d); *see also id.* § 107.608.
342 *See supra* Subpart IV.A.2.

HAZARDOUS GAS" label.[343] The cylinders may be stored on the ship's weather deck or in a hold or compartment below it (except on certain passenger vessels,[344] which may only store cylinders below deck).[345] While the cylinders are on board, the ship must carry a dangerous cargo manifest, including details of their content, design, and location.[346] Other documentation, similar to that required for road and rail transport, is also required where carbon dioxide cylinders are transported by ship.[347]

a. Transportation on the High Seas

When outside U.S. waters, on the high seas, vessels transporting carbon dioxide are subject only to regulation by the country in which they are registered. Vessels registered in the U.S. must comply with the USCG's Safety Standards if transporting carbon dioxide in bulk[348] or the PHMSA's HMTA regulations if engaged in non-bulk transportation of carbon dioxide.[349]

b. Storage During Transportation

Carbon dioxide may need to be stored on a temporary basis during transportation to the injection site. The development of new storage facilities will be subject to local zoning and other ordinances. Developers must, for example, ensure that their facilities are located in an appropriately zoned area and comply

343 49 C.F.R. § 176.1 (2016); s*ee also id.* §§ 172.301, 172.302, 172.328, 172.330, 172.400, 172.400(a), 172.415.
344 The exception applies to passenger vessels carrying more than 25 passengers or one passenger per three meters of overall vessel length (whichever is larger). *See id.* § 176.101(k)(2); *id.* § 176.101, Tbl.176.101.
345 *Id.* § 176.63; *see also id.* §§ 176.101(k)(1)–(2); *id.* Tbl.176.101.
346 *Id.* § 176.30. The dangerous cargo manifest must specify the name, official number, nationality of the vessel, shipping name, identification number, hazard classification of each hazardous material on board, the number and description of packages containing hazardous materials, and the stowage location of the packages.
347 *Id.* § 176.24.
348 46 C.F.R. § 154.1 (2016); *see supra* Subpart IV.B.2.a.
349 49 C.F.R. § 176.1; *see supra* Subpart IV.B.2.b.

with any rules for development in the zone (e.g., setbacks, land coverage, building heights, etc.). A building permit may need to be obtained from the relevant local government. Depending on the location of the facility, various state and federal environmental permits may also be needed, as shown in Table 3 and Table 4 above.

Once operational storage facilities may be subject to reporting requirements under the Emergency Planning and Community Right-to-Know Act (EPCRA),[350] depending on their size. The EPCRA applies to certain facilities handling large amounts of hazardous chemicals. For the purposes of the EPCRA, the term "hazardous chemical" is defined to include an element, compound, or mixture of elements, classified as a physical hazard or health hazard.[351] Physical hazard chemicals include gases under pressure—i.e., gases maintained at a pressure of twenty-nine pounds per square inch or more—such as high-pressure liquefied gases which have a critical temperature between -58°F and 149°F.[352] This would include carbon dioxide.

Under the EPCRA, facilities handling 10,000 pounds (five tons) or more of carbon dioxide at any one time are subject to two reporting requirements, namely:

- *One-off Reporting*: The facility owner/operator must file a report within three months of becoming subject to the EPCRA. The report must consist of a list of each hazardous chemical(s) present at the facility at or above the threshold level or a safety data sheet (SDS) for each such chemical.[353] The SDS must include:
    - information about the chemical (e.g., its name, physical and chemical properties, and stability and reactivity data);
    - details of the physical, health, and environmental hazards posed by the chemical;

350 42 U.S.C. § 11001 (2012).

351 40 C.F.R. § 370.2 (2017); *see also* 29 C.F.R. §§ 1910.1200(c), 1910.1450 (2016).

352 *Id.* 29 C.F.R. § 1910.1200(c), Appendix B.

353 40 C.F.R. § 370.30(a).

- guidelines for safe handling, storage, and disposal of the chemical; and
- recommendations for dealing with chemical releases (e.g., first aid measures, fire-fighting techniques, and spill responses procedures).[354]

- *Inventory Reporting*: The facility owner/operator must file annual reports, by March 1 of each year, on any hazardous chemical that was present at the facility at or above the threshold level during the previous calendar year.[355] The report must specify:
  - the maximum, and average daily, amount of the chemical present at the facility;
  - the maximum number of days that the chemical was present at the facility; and
  - the general location of the chemical within the facility.[356]

The one-off and inventory reports must be filed with the State Emergency Response Commission for the state in which the facility is located (or, if there is no Commission, the state's Governor), as well as the relevant Local Emergency Planning Committee and local fire department.[357]

V. INJECTING CARBON DIOXIDE AT THE WELL SITE

Following delivery to the well site, carbon dioxide is injected into the seabed. This part outlines the regulatory framework governing carbon dioxide injection and post-injection well closure and monitoring.

A. Requirements for Carbon Dioxide Injection

Carbon dioxide injection operations in federal waters and

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354 *See* Occupational Safety and Health Administration, *Hazard Communication Standard: Safety Data Sheets*, https://www.osha.gov/Publications/OSHA3514.html [https://perma.cc/5Y9J-D5P4].
355 42 U.S.C. § 11022; 40 C.F.R. § 370.40.
356 40 C.F.R. § 370.41.
357 *Id.* §§ 370.32, 370.44.

on the high seas may be regulated by EPA pursuant to the MPRSA.[358] In general and with some exceptions, the MPRSA prohibits any person dumping materials into ocean waters unless permitted by EPA.[359] Notably however, EPA cannot permit the dumping of industrial waste, defined as "any solid, semi-solid, or liquid waste generated by a manufacturing or processing plant."[360] Whether this definition encompasses carbon dioxide is somewhat unclear and may ultimately depend on the source thereof.

The MPRSA does not define what constitutes a "manufacturing" or "processing" plant. In general parlance, a "manufacturing plant" is a facility where objects are produced by hand or machinery,[361] while a "processing plant" is a facility where raw materials are prepared for use.[362] Relying on these definitions, a number of commentators have argued that power plants are not manufacturing or processing plants for the purposes of the MPRSA.[363] Power plants are, however, often treated as manufacturing facilities under local zoning ordinances and other laws. EPA could take the view that power plants "manufacture" electricity, making the carbon dioxide they emit industrial waste. In any event, carbon dioxide emitted by industrial facilities (e.g., steel manufacturing plants) would

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358 33 U.S.C. § 1401 (2012).
359 *Id.* § 1412.
360 *Id.* § 1414(b).
361 The Collins Dictionary defines "manufacturing plant" to mean "a factory where goods are manufactured." *See* Collins, *Definition of 'manufacturing plant'*, https://www.collinsdictionary.com/us/dictionary/english/manufacturing-plant [https://perma.cc/ACQ2-MG4N]. The term "manufacture" is defined to mean "the making of goods or articles by hand or, esp., machinery." *See* Collins, *Definition of 'manufacture'*, https://www.collinsdictionary.com/us/dictionary/english/manufacture [https://perma.cc/365L-PRUZ].
362 The Collins Dictionary defines "processing plant" as "a factory where raw materials are treated or prepared by a special method, esp. one where food is treated in order to preserve it." *See* Collins, *Definition of 'processing plant'*, https://www.collinsdictionary.com/us/dictionary/english/processing-plant [https://perma.cc/9TQ5-LAJ3].
363 Ann Brewster Weeks, *Subseabed Carbon Dioxide Sequestration as a Climate Mitigation Option for the Eastern United States: A Preliminary Assessment of Technology and Law*, 12 OCEAN & COASTAL L.J. 245, 263 (2006).

almost certainly be considered industrial waste.

Assuming carbon dioxide generated by power plants is not considered industrial waste, it may be injected into the seabed with a permit from EPA. A permit is required whenever:

- carbon dioxide is transported from within the U.S., regardless of whether injection will occur in state or federal waters or on the high seas;[364] and
- carbon dioxide is transported from outside the U.S., if:
    - transportation occurs on a vessel registered in the U.S.; or
    - injection will occur within twelve nautical miles of the U.S. coast.[365]

Permit applications must be filed with the relevant EPA Regional Office.[366] On receiving an application, EPA must issue a public notice.[367] In response to that notice, any person may request a public hearing on the application.[368] Based on the views expressed at the public hearing (if any) and the information in the original application, EPA may issue or refuse to issue a permit. A permit may only be issued if EPA determines that injection "will not unreasonably degrade or endanger human health, welfare, or amenities, or the marine environment, ecological systems, or economic potentialities."[369]

1. Carbon Dioxide Purity

There are currently no specific regulatory requirements, under either U.S. or international law, with respect to the purity of carbon dioxide streams. U.S. and international law do not, for example, require that a certain percentage of the stream be carbon dioxide. There are more general requirements in the

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364 33 U.S.C. § 1411(a)(1) (2012) (prohibiting any person transporting from the U.S. material for the purpose of dumping it into ocean waters); *see also id.* § 1402(b) (defining "ocean waters" to mean "those waters of the open seas lying seaward of the base line from which the territorial sea is measured").

365 33 U.S.C. § 1411; 40 C.F.R. § 220.1(a) (2016).

366 40 C.F.R. §§ 220.4(b), 221.1.

367 *Id.* § 222.3.

368 *Id.* § 222.4; *see also id.* §§ 222.5–222.7 (outlining the hearing procedures).

369 33 U.S.C. § 1412(a).

London Protocol which, as discussed in Part IV.B above, provides for the permitting of seabed injection of carbon dioxide streams.[370] Under the Protocol, a permit may only be granted if the stream "consist[s] overwhelmingly of carbon dioxide."[371] The stream "may contain incidental associated substances derived from the source material and the capture and sequestration process," but must not have any "wastes or other matter" added for the purpose of disposing of those wastes or other matter.[372]

While the London Protocol requirements have not been incorporated into U.S. law, they should, in our view, be complied with as a matter of best practice. Additional legal requirements will apply to injection operations permitted under the MPRSA. Regulations adopted pursuant to that Act prevent permitted operators from injecting materials containing:

- any amount of:
  - high-level radioactive waste;
  - substances produced or used for radiological, chemical, or biological warfare; or
  - persistent inert synthetic or natural substances which may float or remain in suspension in the ocean and thereby interfere with its use;[373]
- more than "trace amounts" (i.e., defined as amounts that "will not cause significant undesirable effects")[374]of:
  - organohalogen compounds;
  - mercury and mercury compounds;
  - cadmium and cadmium compounds;
  - any type of oil including, but not limited to, petroleum; or
  - known or suspected carcinogens, mutagens, or teratogens;[375] or

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370 London Protocol, art. 4.1; *id.* Annex 2.

371 *Id.* Annex 2(4).

372 *Id.*

373 40 C.F.R. § 227.5.

374 *Id.* § 227.6(b) (providing that the "constituents will be considered to be present as trace contaminants only when they are present in materials otherwise acceptable for ocean dumping in such forms and amounts . . . that dumping of the materials will not cause significant undesirable effects, including the possibility of danger associated with their bioaccumulation in marine organisms").

- benzene, toluene, xylene, carbon disulfide, or other substances that are immiscible with or slightly soluble in seawater in concentrations exceeding their solubility limits.[376]

To the extent that these substances are found in a carbon dioxide stream, they will need to be entirely or substantially removed before offshore injection.

1. Conduct of Injection Operations

Injection operations in federal waters or on the high seas that are permitted under the MPRSA must be conducted in accordance with any terms and conditions specified in the permit.[377] All permits must specify the times at which injection shall occur.[378] Permits may also include other requirements for injection that EPA determines to be necessary or appropriate.[379] EPA's UIC Program provides an indication of the requirements which may be imposed.[380] Specifically, the Program establishes rules for injection operations onshore and in state waters.[381] Key requirements in the rules include:

- *Injection Pressure*: The injection pressure must not exceed ninety percent of the fracture pressure of the geologic formation(s) (i.e., the pressure above which fluid injection will cause the formation to crack).[382]
- *Well Monitoring*: Continuous recording devices must be used to monitor key parameters, including the injection pressure and the rate, volume and/or mass, and temperature of the carbon dioxide stream.[383]

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375 *Id.* § 227.6(a).
376 *Id.* § 227.7(a).
377 As noted in Part V.A above, offshore injection operations must be permitted under the MPRSA if: (1) the carbon dioxide injected was transported from a location within the U.S.; or (2) the carbon dioxide was transported from another location by an entity registered in the U.S. or will be injected within twelve n.m. of the U.S. coast.
378 40 C.F.R. § 223.1(a)(7).
379 *Id.* § 223.1(a)(10).
380 For a discussion of the program, *see supra* Part III.A.
381 *See* 40 C.F.R. § 145.1.
382 *Id.* § 146.88(a).
383 *Id.* § 146.88(e)(1).

- *Well Shut-off*: The operator must use automatic shut-off systems that are capable of sealing the well when operating parameters (e.g., injection rate or pressure) diverge from permitted ranges.[384]

The UIC Program rules do not apply to injection operations in federal waters or on the high seas.[385] Such operations could, however, be required to comply with the same or similar rules as a condition of their MPRSA permit.

B. Reporting on Injection

Complete records must be maintained with respect to all MPRSA permitted injection operations in federal waters and/or on the high seas. The records must include details of the material injected, such as its physical and chemical characteristics, as well as the time(s) and location(s) of injection.[386] This and any other information required to be collected under the permit must be reported every six months to EPA.[387]

1. Additional Requirements for Operations in Federal Waters

Injection operations undertaken in federal waters are subject to additional reporting requirements under EPA's Greenhouse Gas Reporting Program (GHGRP).[388] The GHGRP applies to facilities located on the OCS that, among other things, inject a carbon dioxide stream underground for long-term containment in geologic formations ("carbon sequestration facilities").[389] Notably, however, there is an exemption for facilities engaged in a research and development project,[390] defined as:

> a project for the purpose of investigating
> practices, monitoring techniques, or injection

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384 *Id.* § 146.88(e)(3).
385 *Id.* § 144.1(g)(2).
386 *Id.* §§ 224.1(a)–(b).
387 *Id.* §§ 224.1(c), 224.2 (2012).
388 *See id.* § 98.1.
389 *Id.* §§ 98.2(a), 98.440(a).
390 *Id.* § 98.440(d).

> verification, or engaging in other applied research, that will enable safe and effective long-term containment of a [carbon dioxide] stream in subsurface geologic formations, including research and short duration [carbon dioxide] injection tests conducted as a precursor to long-term storage.[391]

Unless covered by this exemption, each carbon sequestration facility must file annual reports with EPA specifying the quantity of carbon dioxide:

- received during the year and the source[392] of each receipt; [393]
- injected into the subsurface during the year;[394]
- emitted as a result of movement of the injected carbon dioxide to the surface;[395]
- emitted as a result of equipment leaks and venting;[396] and
- sequestered during the year and cumulatively over the life of the facility.[397]

2. Additional Requirements for Operations on the High Seas

Injection operations on the high seas are not subject to the requirements of the GHGRP. There are no other reporting requirements for such operations, except those established through the MPRSA and associated regulations.

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391 *Id.* § 98.449.
392 Sources must be reported according to the following categories: carbon dioxide production well, electric generating unit, ethanol plant, pulp and paper mill, natural gas processing, gasification operations, other anthropogenic source, discontinued enhanced oil and gas recovery project, and unknown. *Id.* § 98.446(d).
393 *Id.* § 98.442(a), 98.446(d).
394 *Id.* § 98.442(b).
395 *Id.* § 98.442(d); *see also id.* § 98.449.
396 *Id.* §§ 98.442(e)–(f).
397 *Id.* §§ 98.442(g)–(h); *see also id.* §§ 98.446(e)–(f).

C. Post-Injection Site Closure and Monitoring

1. Operations in Federal Waters

Monitoring requirements for certain carbon dioxide injection operations have been established by EPA through its GHGRP. The monitoring requirements apply to injection wells on the OCS, except those associated with a research and development project (as defined above).[398] The well owner or operator must monitor the area expected to contain the carbon dioxide, plus a half mile buffer zone (the "monitoring area"), until the plume has stabilized.[399] The monitoring area must be identified in a plan developed by the well owner or operator.[400] The plan must also:

- specify potential pathways through which injected carbon dioxide may move to the surface;
- assess the likelihood, magnitude, and timing of movement through those pathways; and
- outline a strategy for detecting and quantifying any such movement.[401]

The plan must be submitted to EPA within 180 days of approval of injection operations.[402]

As well as developing a monitoring plan, the owner or operator of a well in federal waters must also prepare annual monitoring reports, and submit them to EPA as part of the GHGRP.[403] Each report must contain:

- a narrative history of the monitoring efforts conducted over the previous year;
- a narrative history of any monitoring anomalies that were detected in the year and how they were investigated and resolved; and
- a description of any leakage resulting from the movement of carbon dioxide to the surface.[404]

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398 *Id.* § 98.440.
399 *Id.* § 98.449.
400 *Id.* § 98.448(a)(1).
401 *Id.* §§ 98.448(a)(2)–(3).
402 *Id.* § 98.448(b)(2).
403 *Id.* § 98.446(f)(12).
404 *Id.*

2. Operations on the High Seas

No monitoring or reporting requirements have been established with respect to carbon dioxide injection operations on the high seas. EPA could, however, impose such requirements as a condition of any permit issued for injection operations under the MPRSA.[405] The requirements could be based on those imposed on operations in federal waters under EPA's GHGRP. Alternatively, they could be developed with regard to the requirements for wells in state waters established through EPA's UIC Program. Under the UIC Program, the owner or operator of a well in state waters must monitor the site for at least fifty years following the completion of injection operations to show the position of the underground carbon dioxide plume[406] and pressure front,[407] and to demonstrate that underground sources of drinking water are not being endangered.[408]

D. Controlling Leaks from Carbon Dioxide Injection Wells

In the event that carbon dioxide is found to be leaking from an injection well, the operator will likely be required to take remedial action. Such requirements may be imposed as a condition of any permit issued for wells in federal waters or on the high seas (e.g., under the MPRSA).[409] EPA adopts a similar approach when permitting wells onshore and in state waters under the UIC Program. The owner or operator of such a well is required to submit, with its permit application, an emergency

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405 *Id.* § 223.1(a)(9) (stating that each permit "shall include . . . [s]uch monitoring relevant to the assessment of the impact of permitted dumping activities on the marine environment as [EPA] determine[s] to be necessary or appropriate").

406 The term "carbon dioxide plume" refers to "the extent underground, in three dimensions, of an injected carbon dioxide stream." *Id.* § 146.81(d).

407 The "pressure front" of a carbon dioxide plume refers to "the zone of elevated pressure that is created by the injection of carbon dioxide into the subsurface" where "there is a pressure differential sufficient to cause the movement of" fluids into an underground source of drinking water. *Id.*

408 *Id.* § 146.93(b).

409 *Id.* § 223.1(a)(10) (indicating that a permit may include any terms and conditions that EPA determines to be necessary or appropriate).

and remedial response plan detailing the actions it will take to address the movement of carbon dioxide during injection or post-injection monitoring.[410] EPA may require implementation of that plan as a condition of the permit.[411] The permit holder must maintain sufficient insurance, bonds, and/or other financial instruments to cover the cost of remedial action.[412]

E. Decommissioning Offshore Installations

Following the completion of injection operations and associated activities, the operator must decommission offshore platforms and other installations on the OCS. Regulations adopted by BOEM under the OCSLA require persons leasing land on the OCS to:

> within 2 years following termination of a lease or grant . . .
> Remove or decommission all facilities, projects, cables, pipelines, and obstructions;
> Clear the seafloor of all obstructions created by activities on [the] lease, including [the] project easement, or grant, as required by the BOEM.413

All facilities must be removed to a depth of fifteen feet below the mud-line unless otherwise authorized by BOEM.[414] If facilities are not removed as required, BOEM may take enforcement action against the lessee,[415] and recover removal costs from the lessee.[416] BOEM may also retain any bond or other financial security provided by the lessee to guarantee performance of its obligations under the lease.[417]

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410 *Id.* § 146.94(a).
411 *Id.* § 146.93(b).
412 *Id.* §§ 146.82(a)(1)–(2).
413 30 C.F.R. § 585.902(a) (2012).
414 *Id.* § 585.910(a).
415 *Id.* § 585.913(c) (providing that, if a lessee fails to comply with its decommissioning obligations, "BOEM may take enforcement action").
416 *Id.* § 585.913(b) (providing that, if a lessee fails to comply with its decommissioning obligations, it shall "remain liable for removal or disposal costs").
417 *Id.* § 585.913(a) (providing that, if a lessee fails to comply with its decommissioning obligations "BOEM may call for the forfeiture of [its] bond or

In certain circumstances, BOEM may authorize a lessee to leave facilities in place for use in other activities permitted under federal law.[418] In determining whether to grant such authorization, BOEM must consider:

- potential impacts to the marine environment;
- competing uses of the OCS;
- impacts on marine safety and national defense;
- maintenance of adequate financial assurance; and
- other factors it considers relevant.[419]

If the request is granted, the lessee will remain liable for decommissioning the facility following the activities unless BOEM determines that another person has assumed that responsibility and secured adequate financial assurances.[420]

The above decommissioning requirements only apply to facilities on the OCS. There are no similar requirements for facilities on the high seas.[421]

CONCLUSION

CCS can play an important role in reducing carbon dioxide emissions and thereby help to mitigate climate change. During CCS, carbon dioxide that would ordinarily be emitted by power plants and/or other facilities is captured and injected into underground geological formations, where it remains permanently sequestered. To date, CCS research has largely focused on sequestering carbon onshore, e.g. in depleted oil and

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other financial assurance"). For a discussion of the bonding requirements, *see supra* Part III.A.4.

418 *Id.* § 585.909(a).

419 *Id.* § 585.909(b).

420 *Id.* § 585.909(c).

421 International law requires the decommissioning of facilities on the EEZ, but does establish any similar requirements for facilities on the high seas. *See* UNCLOS, *supra* note 8, at 60(3) (providing "[a]ny installations or structures [on the EEZ] which are abandoned or disused shall be removed to ensure safety of navigation, taking into account any generally accepted international standards established in this regard by the competent international organization. Such removal shall also have due regard to fishing, the protection of the marine environment and the rights and duties of other states"). UNCLOS does not require the decommissioning of structures on the high seas.

gas reservoirs. However, there is growing interest in offshore sequestration.

The regulation of any future offshore sequestration project will depend on its location. Under international law, each country's regulatory authority is typically limited to the water and submerged land within 200 n.m. of its coast; areas beyond that are part of the high seas, over which no country has exclusive jurisdiction. In the U.S., authority over the 200 n.m. zone is shared between the coastal states, which regulate areas within three n.m. of their shores (or, in Texas and the west coast of Florida, nine n.m.) (i.e., state waters) and the federal government, which regulates areas further offshore (i.e., federal waters).

There is currently no comprehensive regulatory framework, under either U.S. or international law, specific to CCS in federal waters or on the high seas. CCS projects in those areas may, however, be regulated under general programs developed with other activities in mind. The most important of these is established under the MPRSA and requires persons transporting material from the U.S. or on a U.S. vessel for the purpose of dumping it at sea (i.e., whether in federal waters or on the high seas) to obtain a permit from EPA. For the purposes of the MPRSA, "material" is defined broadly to mean "matter of any kind or description," as is "dumping," which means any "disposition of material" at sea. The MPRSA would therefore appear to encompass the injection of carbon dioxide into the seabed.

In addition to obtaining a permit from EPA under the MPRSA, persons injecting carbon dioxide into the seabed may require various other approvals. Those approvals will differ depending on the location of injection as shown in the table below.

Injection Operations in Federal Waters	**Injection Operations on the High Seas**
The operator must: • obtain a lease or easement from BOEM before drilling an injection well;	Lease/easement not required for drilling. Permit not required to install drilling platforms. We

Injection Operations in Federal Waters	Injection Operations on the High Seas
• obtain a permit from ACE before installing a drilling platform that is attached to the seabed; • if the drilling platform is moveable, register the platform with the USCG; and • if the platform will be equipped with facilities that contribute significantly to air pollution, obtain a permit from EPA or a state authority. When granting leases or other authorizations for offshore injection, federal agencies must conduct an environmental review under NEPA.	recommend that platforms be registered with the USCG or an equivalent body in another country.

Additional requirements may apply to the transport of carbon dioxide to the injection site. Where carbon dioxide is transported onshore via road or rail, the transporter must be registered with the DOT. Registration is also required for offshore transport via ship, with the DOT registering ships involved in non-bulk transportation, and the USCG registering bulk transportation ships. On and offshore pipelines may require various federal, state, and local government approvals depending on the route thereof. Such approvals may also be required for facilities storing carbon dioxide during transport.