# *NOTE*

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# Fire and Ice: Regulating Methane Hydrate as a Potential New Energy Source



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On March 12, 2013, Japan announced it had successfully extracted methane gas from solid methane hydrate—an icy compound formed when methane gas mixes with water under specific temperature and pressure conditions.[1] This achievement is thought to be the first instance of researchers extracting large quantities of methane gas from methane hydrate located directly below the seabed.[2] Current estimates place the amount of natural gas trapped in methane hydrate as many times that of "conventional" natural gas.[3] Given the abundance of methane hydrate in both permafrost and sediments beneath the seabed,[4] scientists have begun looking to the compound as a prospective new source of natural gas for energy production.[5] However, the regulatory scheme that would eventually govern extraction of natural gas from methane hydrate within the United States' 200-mile Exclusive Economic Zone (EEZ)[6] remains ambiguous, and such extraction raises serious questions about safety[7] and environmental damage.[8] This Note analyzes what methane hydrate is and how researchers and developers extract natural gas from the compound, examines the regulations that currently apply to research and development of natural gas from methane hydrates, looks at the ultimate implications for the environment if methane hydrate is ultimately exploited on a large scale as a source of natural gas, and finally, addresses additional regulations that may be needed

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1 Henry Fountain, *Unlocking the Potential of 'Flammable Ice,'* N.Y. TIMES, Sept. 16, 2013, http://www.nytimes.com/2013/09/17/science/earth/unlocking-the-potential-of-flammable-ice.html.

2 Hiroko Tabuchi, *An Energy Coup for Japan: 'Flammable Ice,'* N.Y. TIMES, Mar. 12, 2013, http://www.nytimes.com/2013/03/13/business/global/japan-says-it-is-first-to-tap-methane-hydrate-deposit.html.

3 Chuang Ji et al., *Natural Gas Production from Hydrate Decomposition by Depressurization*, 56 CHEMICAL ENGINEERING SCI. 5801, 5801 (2001).

4 *See* J.A. Majorowicz et al., *Study of the Natural Gas Hydrate "Trap Zone" and the Methane Hydrate Potential in the Sverdrup Basin, Canada*, 11 NAT. RESOURCES RES. 79, 80 (2002).

5 Tabuchi, *supra* note 2.

6 *See* 3 C.F.R. 22 (1983) (declaring the United States Exclusive Economic Zone to be a 200 nautical mile zone "contiguous to the territorial sea" where the U.S. maintains "sovereign rights for the purpose of exploring, exploiting, conserving and managing natural resources, both living and non-living, of the seabed and subsoil . . . .").

7 *See* Fountain, *supra* note 1.

8 Ben Lefebvre, *Critics Warn of Environmental Hazards of Extracting Methane Hydrate*, WALL ST. J., July 29, 2013, at B4.

to ensure the development of natural gas from hydrates is safe and not environmentally damaging.

## I
## WHAT IS METHANE HYDRATE?

Gas hydrates, including methane hydrate, are formed by both biological and non-biological processes.[9] Methane gas is produced biologically as a waste product of microorganisms as they consume biological material.[10] Methane gas can also be produced non-biologically through spontaneous decomposition of organic matter, which occurs to a significant degree only as the temperature of the organic material exceeds 100°C.[11] Given the relatively high temperatures at which organic matter decomposes non-biologically, non-biological formation of methane gas is slow and relatively uncommon.[12]

The methane hydrate itself forms in low-temperature and high-pressure environments, generally in permafrost or beneath the sea floor.[13] Under these conditions, methane bonds with water molecules to form an icy, crystalline structure.[14] Unlike ice, however, methane hydrates can remain stable at temperatures above 0°C[15] and ignite with a mere flick of a match.[16] While occasionally found at depths as shallow as 150 meters below the sea floor, methane hydrate is more commonly found more than 500 meters below the sea floor and can be up to 300-600 meters thick.[17] Just one cubic meter of methane hydrate has the potential to produce 170 cubic meters of methane

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9 George E. Claypool & Keith A. Kvenvolden, *Methane and Other Hydrocarbon Gases in Marine Sediment*, 11 ANN. REV. EARTH & PLANETARY SCI. 299, 301 (1983).

10 *Id.*

11 *Id.*

12 *Id.*

13 Yi Wang et al., *Experimental Investigation into Methane Hydrate Production During Three-Dimensional Thermal Stimulation with Five-Spot Well System*, 110 APPLIED ENERGY 90, 90 (2013).

14 *Id.*

15 A. Svandal & B. Kvamme, *Modeling the Dissociation of Carbon Dioxide and Methane Hydrate Using the Phase Field Theory*, 46 J. MATHEMATICAL CHEMISTRY 763, 763 (2009).

16 Katia Moskvitch, *Buried Treasure*, SCI. AM., Aug. 2013, at 40–43.

17 Ayhan Demirbas, *Methane Hydrates as Potential Energy Resource: Part 1–Importance, Resource and Recovery Facilities*, 51 ENERGY CONVERSION & MGMT. 1547, 1554 (2010).

gas.[18] Overall, the amount of methane hydrate worldwide is estimated to be between $10^{15}$ and $10^{18}$ cubic meters.[19] To give this figure perspective, some researchers believe one-thousandth of the amount of methane hydrate worldwide “would suffice to cover current annual global energy needs.”[20] Given the vast quantities of methane hydrate available, scientists have considered methane hydrate as a future source of plentiful energy.[21]

While research continues to locate additional deposits of methane hydrate below the sea floor, known deposits of methane have been located worldwide—about 70 sites thus far have been identified as containing, or potentially containing, methane hydrate.[22] These include sites off the shores of the United States, Canada, Japan, and Southeastern Europe.[23] In the United States specifically, methane hydrate has been located on the eastern and western outer continental shelves, in the Gulf of Mexico, and on the Alaskan outer continental shelf.[24] Off the coasts of North and South Carolina alone, the United States Geological Survey estimates up to 1,300 trillion cubic feet ($10^{13}$ cubic meters) may be present in ocean sediments. If these estimates are correct, exploitation of these methane hydrates could represent a 700% increase in U.S. natural gas deposits.[25] Such a deposit would provide a 70-year supply of natural gas for the United States at current consumption rates.[26]

## II
## HOW IS METHANE HYDRATE USED TO OBTAIN NATURAL GAS?

The Committee to Review the Activities Authorized under the Methane Hydrate Research and Development Act believes that “[g]iven sufficient in-place reserves, there are no obvious technical or engineering roadblocks to prevent commercial production of gas from hydrate in the future. However, there are some technical and

18 Nam-Jin Kim et al., *Formation Enhancement of Methane Hydrate for Natural Gas Transport and Storage*, 35 ENERGY 2717, 2717 (2010).

19 Wang et al., *supra* note 13, at 90.

20 NARESH KUMAR THAKUR & SANJEEV RAJPUT, EXPLORATION OF GAS HYDRATES: GEOPHYSICAL TECHNIQUES 68 (2011).

21 *See id.* at 49.

22 *Id.* at 66.

23 Demirbas, *supra* note 17, at 1556–57.

24 *Id.* at 1554.

25 *Id.*

26 *Id.*

engineering challenges that have to be solved before commercial production can begin."[27] So far, researchers have devised a variety of methods to break apart methane hydrates into water molecules and methane, thereby creating natural gas. As explained above, methane hydrate remains stable at low temperatures and high pressures. To break apart the molecules, then, one can simply increase the temperature and/or decrease the pressure enough to cause the hydrate to decompose into gas and water.[28] Other researchers have proposed the injection of an "inhibitor," which displaces the methane gas in the hydrate so the gas can be utilized.[29] Another method is to simply mine the solid methane hydrate from ocean floor sediments.[30] Currently, the most cost-effective method of extracting natural gas from hydrate appears to be depressurization of the hydrate.[31]

To obtain methane gas through depressurization, a well is drilled into the methane hydrate deposit.[32] When pressure in the bore well is decreased, water moves towards the well, thereby creating an area of lower pressure that expands throughout the deposit.[33] When the pressure is lowered, the methane hydrate dissociates into methane and water, allowing the methane gas to be captured.[34] Once the gas and water are removed from the well, further depressurization of the deposit occurs, continuing the process.[35] While the technology to perform this method of methane gas production from hydrate currently exists, it is far more expensive than conventional natural gas development technology—thus adding to the overall costs of potential methane hydrate development.[36] Furthermore, "[a]ny future development would need to use techniques that minimize the release

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27 COMMITTEE TO REVIEW THE ACTIVITIES AUTHORIZED UNDER THE METHANE HYDRATE RESEARCH AND DEVELOPMENT ACT OF 2000, CHARTING THE FUTURE OF METHANE HYDRATE RESEARCH IN THE UNITED STATES 58 (2004).

28 Goodarz Ahmadi et al., *Production of Natural Gas from Methane Hydrate by a Constant Downhole Pressure Well*, 48 ENERGY CONVERSION & MGMT. 2053, 2055 (2007).

29 COUNCIL OF CANADIAN ACADEMIES, ENERGY FROM GAS HYDRATES: ASSESSING THE OPPORTUNITIES AND CHALLENGES FOR CANADA 87 (2008).

30 *Id.* at 83.

31 *Id.* at 88.

32 NAT'L ENERGY TECH. LAB., U.S. DEP'T OF ENERGY, ENERGY RESOURCE POTENTIAL OF METHANE HYDRATE 12 (2011).

33 *Id.*

34 *Id.*

35 *Id.*

36 *Id.*

of methane to the atmosphere, and development activities in both arctic and marine settings would need to be carried out in ways that maximize protection of these environments."[37]

## III
## HOW IS METHANE HYDRATE MINING CURRENTLY REGULATED?

### *A. Methane Hydrate Research and Development Act*

The United States took its first big step in researching methane hydrates with the Methane Hydrate Research and Development Act of 2000 (MHRDA),[38] later amended by the Energy Policy Act of 2005.[39] The MHRDA mandated the Secretary of Energy, acting through the Assistant Secretary for Fossil Energy, to create a methane hydrate research program.[40] The MHRDA authorized the Secretary of Energy to award grants or contracts to industrial enterprises or educational institutions for the purpose of further exploring methane hydrates as an energy resource and developing safe, environmentally friendly technologies to exploit methane hydrate resources.[41] An advisory panel, assembled by the Secretary of Energy, was tapped to assist in developing "recommendations and priorities" for the program.[42] While the 2005 MHRDA amendments did not substantially change the provisions of the Act, they did express renewed urgency to research and develop methane hydrate as an energy resource.[43] Reports submitted to Congress by the National Commission on Energy Policy and the National Academy of Sciences noted that there would likely be a natural gas shortage in or around the year 2020, and that exploiting methane hydrate deposits for natural gas may be a viable solution for overcoming the shortage.[44] Overall, the cost of the methane hydrate program implemented by the MHRDA was $47.5 million.[45]

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37 *Id.* at 13.

38 Methane Hydrate Research and Development Act of 2000, Pub. L. No. 106-193, 114 Stat. 234.

39 Energy Policy Act of 2005, 30 U.S.C. § 2001 (2012).

40 114 Stat. at 235.

41 *Id.*

42 114 Stat. at 236.

43 30 U.S.C. § 2001 (2012).

44 *Id.*

45 Craig H. Allen, *Protecting the Oceanic Gardens of Eden: International Law Issues in Deep-Sea Vent Resource Conservation and Management*, 13 GEO. INT'L ENVTL. L. REV. 563, 578 (2001).

### *B. Mining and Minerals Policy Act of 1970*

The MHRDA also amended the Mining and Minerals Policy Act of 1970 (MPA), adding methane hydrate to the list of "mineral resources" to be regulated by sections 202-205 of the MPA.[46] The MPA more or less addresses many of the same goals and mandates set forth in the MHRDA. Congress' goals for the enactment of the MPA are as follows:

> (1) promote research, identification, assessment, and exploration of marine mineral resources in an environmentally responsible manner; (2) assist in developing domestic technologies required for efficient and environmentally sound development of marine mineral resources; (3) coordinate and promote the use of technologies developed with Federal assistance, and the use of available Federal assets, for research, identification, assessment, exploration, and development of marine mineral resources; and (4) encourage academia and industry to conduct basic and applied research, on a joint basis, through grants, cooperative agreements, or contracts with the Federal Government.[47]

To achieve these goals, the MPA directs the Secretary of the Interior to bring together industry, government, and educational institutions to promote research and exploration of mineral resources in an environmentally friendly manner, gather and distribute information about mineral resources, and identify technology that may aid in the research or development of ocean mineral resources.[48] The Secretary is also required to coordinate communication between agencies, private entities, and universities regarding research and exploration of mineral resources.[49] The Secretary also provides funding through grants and awards contracts to entities that are researching or developing technology necessary to explore mineral resources, providing education or training for exploring or developing marine mineral resources, or developing methods to monitor or remedy any adverse environmental impacts that may occur during exploration or development of a mineral resource.[50] The MPA allows federal government funding for up to eighty percent of the total cost of the project.[51]

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46 Mining and Minerals Policy Act, 30 U.S.C. § 1901 (2012).

47 *Id.* § 1902(b).

48 *Id.* § 1902(c).

49 *Id.*

50 *Id.* § 1903(a)(1).

51 *Id.* § 1903(a)(2).

### *C. Outer Continental Shelf Lands Act*

In addition to statutes explicitly regulating methane hydrate as an energy resource, other more well-known ocean energy development and environmental regulations will apply to potential future production of natural gas from methane hydrate. One of these is the Outer Continental Shelf Lands Act (OCSLA).[52] While the OCSLA does not explicitly mention the development of methane hydrate deposits, the Associate Director for Offshore Minerals Management of the Minerals Management Service (now the Bureau of Ocean Energy Management (BOEM)) wrote in a 1998 letter to Chevron:

> The OCS Lands Act authorizes MMS to manage OCS mineral resources. Therefore, MMS is authorized to manage any future development of gas hydrates. A company has the rights to produce gas from hydrates and any free gas that is below the solid gas hydrate phase on its OCS oil and gas leases.[53]

The letter was then approved by the Department of the Interior Solicitor's Office.[54] Moreover, subsequent BOEM publications, including *Leasing Oil and Gas Resources: Outer Continental Shelf*, include methane hydrate as a resource to be regulated under the OCSLA five-year leasing program.[55] This interpretation of methane hydrate as a resource covered by the OCSLA likely stems from a provision in section 1331 of the Act: "The term 'minerals' includes oil, gas, sulphur, geopressured-geothermal and associated resources, and all other minerals which are authorized by an Act of Congress to be produced from 'public lands' as defined in section 1702 of this title."[56] While no legislative documents specifically clarify whether methane hydrate is a resource included in the term "minerals" under the OCSLA, it appears probable that any commercial production of natural gas from methane hydrate would be governed by the OCSLA.

The OCSLA provides primary authority for outer continental shelf development,[57] specifically, oil and gas activities carried out on the outer continental shelf. The Department of the Interior is responsible

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52 43 U.S.C. § 1331 (2012).

53 MARY C. BOATMAN & JENNIFER PETERSON, MINERALS MGMT. SERV. GULF OF MEX. OCS REGION, OCEANIC GAS HYDRATE RESEARCH AND ACTIVITIES REVIEW 36 (2000).

54 *Id.*

55 BUREAU OF OCEAN ENERGY MGMT., LEASING OIL AND NATURAL GAS RESOURCES: OUTER CONTINENTAL SHELF 7–8 (2005).

56 43 U.S.C. § 1331(q).

57 ALISON RIESER ET AL., OCEAN AND COASTAL LAW 397 (4th ed. 2013).

for administering the provisions of the Act. BOEM, an agency within the Department of the Interior, oversees the leasing and development of tracts on the outer continental shelf. The leasing and development of outer continental shelf lands is divided into four major stages. First, the Secretary of the Interior develops a five-year lease program, including a schedule of potential lease sales.[58] Second, individual lease sales are scheduled.[59] What sets the OCSLA apart from traditional regulations of mineral mining is the fact that cash bonuses—often in the millions of dollars—as well as royalties paid by the lessee, are to be considered by the Secretary when awarding oil and gas leases.[60] Under section 1337, the award of a particular lease must go to the highest responsible and qualified bidder.[61] Third, a lessee must develop an Exploration Plan, which includes descriptions of all exploration activities, the timing of those activities, any information regarding drilling activities, and well location.[62] Finally, the lessee submits a Development and Production Plan for approval, which must include the number of wells, location of wells, equipment used to drill wells, and how transportation of the oil or gas will occur.[63] This step must be completed before the lessee can develop oil or gas from an outer continental shelf.[64]

The OCSLA contains provisions mandating certain steps to be taken by the Secretary of Commerce and lessees to ensure human safety and minimal environmental damage. The Secretary of Commerce, along with the Secretary of the Department in which the Coast Guard is operating, and heads of other agencies, must conduct a "joint study of the adequacy of existing safety and health regulations and of the technology, equipment, and techniques available for the exploration, development, and production of the minerals of the outer Continental Shelf."[65] When there is concern that certain technology may lead to significant health, safety, or environmental effects, the Secretary must require the use of the best, safest, and most

58 43 U.S.C. § 1344(a).

59 *Id.* § 1344(a)(3).

60 *Id.* § 1337(a).

61 *Id.*

62 *Id.* § 1340(c).

63 *Id.* § 1351.

64 *Id.*

65 *Id.* § 1347(a). The Department in which the secretary operates is either the Navy or the Department of Homeland Security. 14 U.S.C. § 3 (2012).

economically feasible technology.[66] With respect to environmental concerns, the OCSLA requires the Secretary of Commerce to conduct studies of potential oil or gas leases to determine the impacts on human and ecosystem health.[67] Even after oil or gas development begins, the Secretary must continue to monitor the region in the event that significant changes in environmental quality occur as a result of development activities.[68] Every three years, the Secretary is required to assess the cumulative environmental impacts of oil and gas activities and submit those findings to Congress.[69] To address both environmental and safety concerns, the Secretary of Commerce may promulgate regulations to oversee activities that are currently not covered by another regulation.[70] These regulations can then be enforced by the Secretary of Commerce, the Secretary of the Department in which the Coast Guard is operating, the Secretary of the Army, and any other federal department by agreement.[71]

### *D. Coastal Zone Management Act*

Another statute that will impact the development of methane hydrate as an energy source is the Coastal Zone Management Act (CZMA). When enacting the CZMA, Congress recognized both the import of promoting energy self-sufficiency within the United States[72] as well as protecting land and water resources of the states.[73] The CZMA provides that

> [t]he key to more effective protection and use of the land and water resources of the coastal zone is to encourage the states to exercise their full authority over the lands and waters in the coastal zone by assisting the states, in cooperation with Federal and local governments and other vitally affected interests, in developing land and water use programs for the coastal zone, including unified policies, criteria, standards, methods, and processes for dealing with land and water use decisions of more than local significance.[74]

66 *Id.* § 1347(b).
67 *Id.* § 1346(a)(1).
68 *Id.* § 1346(b).
69 *Id.* § 1346(e).
70 *Id.* § 1346(e), § 1347(c).
71 *Id.* § 1348(a).
72 *See* 16 U.S.C. § 1451(j) (2012).
73 *Id.* § 1451(i).
74 *Id.*

A primary goal of the CZMA is to encourage states to develop their own coastal zone management plans (CZMPs).[75] Each state's CZMP shall foster "wise use of the land and water resources of the coastal zone, giving full consideration to ecological, cultural, historic, and esthetic values as well as the needs for compatible economic development . . . ."[76] Some considerations states are asked to take into account when developing their CZMPs are ensuring protection of natural resources, minimizing threats to life and property resulting from coastal development, providing public access to coasts for recreation, and giving priority consideration for siting of facilities to "coastal-dependent uses," including for national defense, ports and transportation, commercial and industrial developments, and fisheries.[77] Upon completion of a CZMP, a state must submit the CZMP to the Secretary of Commerce for review and approval.[78]

As amended in 1976, the CZMA places special emphasis on managing coastal energy activities.[79] The CZMA requires states to create a "planning process" for "energy facilities" that may impact the state's coastal zone before the Secretary of Commerce can approve a state's CZMP.[80] The term "energy facility" applies to the construction or operation of "energy facilities"—equipment or facilities used for "the exploration for, or the development, production, conversion, storage, transfer, processing, or transportation of, any energy resource" or for the "manufacture, production, or assembly" of any equipment necessary to carry out these activities.[81] While the CZMA provides a list of facilities to be regulated according to the Act, the list is by no means exhaustive[82] and would undoubtedly cover methane hydrate facilities.

One key provision in the CZMA, and a major incentive for states to develop CZMPs,[83] is a provision known as the "consistency

75 16 U.S.C. § 1452(2) (2012).

76 *Id.*

77 *Id.* § 1452(2)(A)–(E).

78 *Id.* § 1454.

79 Amendments made to the CZMA in 1976 recognized the importance of state and local management of coastal energy activities. *See* 5 FRANK P. GRAD, TREATISE ON ENVIRONMENTAL LAW § 10.04 (2014).

80 16 U.S.C. § 1455(d).

81 *Id.* § 1453(6).

82 *Id.*

83 RIESER ET AL., *supra* note 57, at 276.

requirement." The consistency requirement provides that any federal activity that may affect the land, water, or other resources of a state, whether or not it occurs within a state's coastal zone, "shall be carried out in a manner which is consistent to the maximum extent practicable with the enforceable policies of approved State management programs."[84] At the earliest time practicable, but no later than ninety days prior to the final federal approval of the activity, the federal agency carrying out the action must certify to the appropriate state agency that the proposed action is consistent with the state's CZMP.[85] If an applicant requires approval for a federal permit to carry out activities that may affect a state's coastal zone, the applicant must also certify to the appropriate permit issuing agency, as well as to the state, that their activities will be consistent with the state's CZMP.[86]

Upon receipt of an applicant's consistency certification, the state has six months to approve or reject certification.[87] If a state fails to provide notification, it is presumed that the state concurs with the consistency certification.[88] Unless a state fails to respond to a consistency certification within six months, the Secretary of Commerce finds that the activity is consistent with the state's CZMP, or there is an overriding necessity to approve the permit for national security, no permit can be issued until the state concurs with the consistency certification of the applicant.[89] If a state rejects a consistency certification from a federal agency or applicant, and the Secretary concurs with the state's rejection or finds that the activity is not in conformance with a state's CZMP, a new or amended application may be submitted for consideration.[90] If a new or amended application is submitted, the time by which a state must respond to a consistency certification is reduced to three months.[91] Rejection of a consistency certification can be appealed to the courts, go through mediation proceedings overseen by the Secretary of Commerce in cooperation with the Executive Office of the President, or ultimately be resolved by the President if he or she believes it is in

84 16 U.S.C. § 1456(c)(1)(A).
85 *Id.* § 1456(c)(1)(C).
86 *Id.* § 1456(c)(3)(A).
87 *Id.*
88 *Id.*
89 *Id.*
90 *Id.* §1456(c)(3)(B)(iii).
91 *Id.*

the paramount interest of the United States to exempt the activity from compliance with a state's CZMP.[92]

While each state that could potentially be affected by development of methane hydrate has different priorities and goals for their CZMPs, the importance of the CZMA for methane hydrate development cannot be understated. While states with CZMPs concur with ninety-three to ninety-five percent of proposed federal actions, significant projects can nonetheless be halted by any rejection of a consistency certification.[93] Thus far, it appears that no methane hydrate research facilities have been located in a coastal area subject to any state's CZMP, given that the bulk of research has occurred in the inland United States or overseas rather than offshore in the United States' Exclusive Economic Zone. However, assuming further research will continue and development of methane hydrate as an energy resource becomes a reality, more and more energy facilities will need to be constructed within the United States' EEZ. This will subject the construction and operation of each methane hydrate facility to the respective states' CZMPs.

### *E. Clean Water Act*

The Clean Water Act, enacted in 1972, is the primary law governing the pollution of the nation's waters. Congress had the goal of completely eliminating the discharge of pollutants into the nation's waters by 1985.[94] The foundation of the Clean Water Act is the National Pollutant Discharge Elimination System (NPDES). Under NPDES, any discharge of any pollutant from a point source is prohibited, unless a NPDES permit is obtained from the Environmental Protection Agency (EPA) or an approved state agency.[95] "Discharge of a pollutant" is defined as "(A) any addition of any pollutant to navigable waters from any point source, [or] (B) any addition of any pollutant to the waters of the contiguous zone or the ocean from any point source other than a vessel or other floating craft."[96] The term "pollutant" means "dredged spoil, solid waste, incinerator residue, sewage, garbage, sewage sludge, munitions,

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92 *Id.* § 1456(c)(3)(B)(iii), §1456(h).
93 71 Fed. Reg. 788, 789 (2006).
94 33 U.S.C. § 1251(a)(1) (2012).
95 *Id.* § 1311(a), §1342(a)(1).
96 *Id.* § 1362(12).

chemical wastes, biological materials, radioactive materials, heat, wrecked or discarded equipment, rock, sand, cellar dirt and industrial, municipal, and agricultural waste discharged into water."[97] Sewage from vessels and "water, gas, or other material which is injected into a well to facilitate production of oil or gas, or water derived in association with oil or gas production and disposed of in a well" is excluded from the definition of "pollutant" so long as the well is used "either to facilitate production or for disposal purposes is approved by authority of the State in which the well is located, and if such State determines that such injection or disposal will not result in the degradation of ground or surface water resources."[98] While NPDES permits must be renewed every five years, backlogs in the EPA and state agencies have led to delayed renewals.[99] Typically, so long as a timely request for renewal is filed by the permit holder, activities under the permit may continue until the respective agency can review the application for renewal.[100]

For conventional oil and gas activities, the NPDES permit program is relied upon heavily for pollutants such as aluminum, arsenic, barium, benzene, cadmium, chromium, copper, cyanide, lead, mercury, nickel, selenium, silver, zinc, and radium.[101] Given that proposed technologies to produce natural gas from methane hydrate are similar to those used in the conventional oil and gas industry, many of these same pollutants will likely be produced, and thus will require a NPDES permit to discharge.

### *F. National Environmental Policy Act*

The National Environmental Policy Act (NEPA) was enacted in 1969 "to create and maintain conditions under which man and nature can exist in productive harmony, and fulfill the social, economic, and other requirements of present and future generations of Americans."[102] NEPA requires federal agencies to take a "hard

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97 *Id.* § 1362(6).

98 *Id.*

99 HOLLY DOREMUS ET AL., ENVIRONMENTAL POLICY LAW 768 (6th ed. 2012).

100 *Id.*

101 *See, e.g.*, UNITED STATES ENVIRONMENTAL PROTECTION AGENCY REGION 6, THE NPDES GENERAL PERMIT FOR NEW AND EXISTING SOURCES AND NEW DISCHARGES IN THE OFFSHORE SUBCATEGORY OF THE OIL AND GAS EXTRACTION POINT SOURCE CATEGORY FOR THE WESTERN PORTION OF THE OUTER CONTINENTAL SHELF OF THE GULF OF MEXICO 1-132 (2012).

102 42 U.S.C. § 4331(a) (2012).

look"[103] at actions impacting the environment by requiring the agency to develop an Environmental Impact Statement (EIS) for "major Federal actions significantly affecting the quality of the human environment."[104] EISs require analysis of the environmental impact of a proposed federal action, any environmental impacts that cannot be avoided if the action is carried out, alternatives of the proposed action, including the proposed action and a no-action alternative, the relationship between "local short-term uses of man's environment and the maintenance and enhancement of long-term productivity," and finally, "any irreversible and irretrievable commitments of resources which would be involved in the proposed action should it be implemented."[105] To determine whether an agency is required to conduct an EIS, an Environmental Assessment (EA) may be performed.[106] The EA must be a concise document that contains sufficient evidence and analysis to determine whether or not there will be a significant impact on the environment.[107] If there will be no significant impact, the agency may issue a Finding of No Significant Impact (FONSI).[108] If through the EA it is determined that there will be a significant impact on the human environment, the agency must conduct an EIS.[109] The NEPA process has widely been held to apply to each individual stage of oil and gas development under the OCSLA, from the initial leasing decision to the approval of the oil and gas production and development plan.[110]

Like conventional oil and gas activities, it is probable that any agency action dealing with the production of natural gas from methane hydrate would utilize a programmatic EIS. Programmatic EISs "cover[] all aspects of the proposed action and related proposals."[111] After a programmatic EIS is prepared, agencies can "tier" more specific EAs or EISs to the overarching programmatic

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103 Not long after NEPA was enacted, the D.C. Circuit Court of Appeals heard the landmark case *Natural Resources Defense Council v. Morton*. In the opinion, Judge Leventhal articulated the now-famous "hard look" requirement. Natural Res. Def. Council, Inc. v. Morton, 458 F.2d 827, 838 (D.C. Cir. 1972).

104 42 U.S.C. § 4332(2)(C).

105 *Id.* § 4332(2)(C)(i)–(v).

106 40 C.F.R. § 1508.9(a) (2013).

107 *Id.* § 1508.9(a)(1).

108 *Id.* § 1508.9(a)(1), § 1501.4(e).

109 *Id.* § 1508.9(a)(1).

110 RIESER, *supra* note 57, at 401.

111 JAN G. LAITOS ET AL., NATURAL RESOURCES LAW 271 (2d ed. 2012).

EIS to prevent recreating the wheel.[112] While programmatic EISs are often criticized for being overly generalized, they are acceptable so long as the project alternatives and impacts are discussed with more specificity.[113] The nature of oil and gas leasing lends itself well to the use of programmatic EISs, given the multi-step approach to leasing, exploration, and development under the OCSLA. Because any future commercial development of methane hydrate would likely fall under the OCSLA, the use of programmatic EISs by involved agencies is likely.

Categorical exclusions also come into play when conducting NEPA analysis for oil and gas activities. These categorical exclusions apply to activities that have been pre-determined to not have a significant impact on the human environment, and thus do not require the preparation of an EA or an EIS.[114] In the wake of the Deepwater Horizon oil disaster, Secretary of the Interior Ken Salazar and BOEM Director Michael Bromwich committed to limiting the use of categorical exclusions for offshore oil and gas activities until a comprehensive review of the NEPA process for such activities could be undertaken.[115] This limitation, however, does not appear to be permanent.

While NEPA is a procedural requirement and is often criticized for being a "paper tiger,"[116] the statute has been widely used to slow—or sometimes halt—actions that may have a devastating effect on the environment. According to some estimates, "at least 40 percent of all environmental litigation brought against the federal government has involved NEPA."[117] Conventional oil and gas activities are often challenged under NEPA, and especially given the controversy surrounding the exploitation of a new fossil fuel source, methane hydrate exploitation will likely be no exception.

### *G. Marine Mammal Protection Act and Endangered Species Act*

Two critical statutes concerning environmental protection—specifically, the protection of marine mammals and other endangered

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112 40 C.F.R. 1502.20 (2014).

113 LAITOS ET AL., *supra* note 111, at 271.

114 40 C.F.R. § 1508.4 (2013).

115 Press Release, Bureau of Ocean Energy Management, Categorical Exclusions for Gulf Offshore Activity to be Limited While Interior Reviews NEPA Process and Develops Revised Policy (Aug. 16, 2010) (on file with author).

116 LAITOS ET AL., *supra* note 111, at 200.

117 *Id.*

species—are the Marine Mammal Protection Act (MMPA) and the Endangered Species Act (ESA). The MMPA was enacted after concerned scientists and conservationists called for the protection of marine mammals they considered to be in jeopardy.[118] Some members of Congress believed such mammals required protection because of their intelligence, complex social interactions, or beauty, while others believed they needed protection as a valuable natural resource for human use.[119] Then, in 1972, Congress enacted the MMPA. The MMPA makes it illegal for any individual to "take" a marine mammal within the United States.[120] "Take" is defined broadly to include harassment, hunting, killing, capturing, or attempting to complete any of these activities.[121] While there are some exceptions to the "no take" provision, including takes for research or public display, takes incidental to fishing activities, and takes for subsistence purposes by Native Alaskans,[122] the MMPA is nonetheless a powerful tool to protect marine mammals from harm caused by oil and gas activities. Because the majority of methane hydrate development would occur on the outer continental shelf, companies involved in the production of natural gas from methane hydrate would have to ensure compliance with the provisions of the MMPA.

Like the MMPA, the ESA prohibits the take of any listed species—those determined to be endangered or threatened by the Secretary of the Interior (for species living on land) or Secretary of Commerce (for marine species and anadromous fish). In some respects, however, the ESA provides stronger protections for listed species. First, the definition of "take" is expanded to harassing, harming, pursuing, hunting, shooting, wounding, killing, trapping, capturing, or collecting.[123] In 1995, the Supreme Court further broadened "harm" to include habitat modification that actually leads to harm of a listed species.[124] Second, the ESA not only makes it unlawful for individuals to take a listed species, but federal agencies are proactively required to ensure any federal action does not result in placing any listed species in jeopardy. When a federal action is

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118 RIESER ET AL., *supra* note 57, at 747.

119 *Id.*

120 16 U.S.C. § 1372(a)(2)(A) (2012).

121 *Id.* § 1362(13).

122 RIESER ET AL., *supra* note 57, at 749.

123 16 U.S.C. § 1532(19).

124 *See* Babbit v. Sweet Home Chapter, 515 U.S. 687 (1995).

proposed, the agency taking the action must (1) request information from the Secretary of the Interior or Secretary of Commerce to determine whether any listed species are present in the area where the action would take place,[125] (2) perform a biological assessment to determine whether the action would likely affect the listed species if the species is present,[126] and (3) formally consult with the Secretary of the Interior or the Secretary of Commerce to determine whether the agency's action is "likely to jeopardize the continued existence of" the species if it is present.[127] After the third step, the Secretary of the respective Department will issue a biological opinion.[128] If, in the biological opinion, the Secretary determines that the continued existence of the species is likely to be jeopardized, the Secretary must suggest reasonable and prudent alternatives to the agency action.[129] If no reasonable and prudent alternatives exist, the action may not proceed.[130] If no jeopardy is likely, the Secretary will issue a "no jeopardy" opinion, likely accompanied by an incidental take statement.[131] Any agency involved with permit or plan approval for methane hydrate activities would have to undertake this process.

The Secretary of the appropriate Department also has an obligation to list critical habitat at the time of listing.[132] While the Secretary may be excused from designating critical habitat if it is not prudent to do so (i.e., when such a designation would lead to increased takings, or if it would not benefit the species),[133] critical habitat has been designated for about 600 species in the United States.[134] This includes designations for marine species, including the Atlantic Northern Right Whale. Designation of critical habitat could potentially impact methane hydrate development where critical habitat is rich in the resource.

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125 16 U.S.C. § 1536(c)(1).
126 *Id.*
127 *Id.* § 1536(a)(2).
128 *Id.* § 1536(b)(3)(A).
129 *Id.*
130 *Id.* § 1536(a)(2).
131 *Id.* § 1536(b)(4)(A)–(C).
132 *Id.* § 1533(a)(3)(A)(i).
133 50 C.F.R. § 424.12(a) (2013).
134 LAITOS ET AL., *supra* note 111, at 1099.

### *H. Other Applicable Laws*

While this list is by no means exhaustive, it provides a look at the regulations that tend to have the biggest impact on traditional oil and gas activities on the outer continental shelf, and therefore would similarly impact methane hydrate development activities. Other laws that may impact methane hydrate development include the Clean Air Act, Magnuson-Stevens Fishery Conservation and Management Act, National Historic Preservation Act, Federal Oil and Gas Royalty Management Act, and others.

## IV
## WHAT ENVIRONMENTAL AND SAFETY CONCERNS ARISE WHEN CONSIDERING THE POTENTIAL FOR METHANE HYDRATE MINING?

### *A. Destabilization of Sea Floor*

One significant risk faced by outer continental shelf energy activities, and a risk that has received some media attention, is destabilization resulting from the disruption of methane hydrate deposits beneath the seafloor. The destabilization that can occur from oil and gas activities on the outer continental shelf can lead to considerable safety concerns. Uncontrolled gas release during drilling operations, well-casing collapse, dissociation from warm drilling fluids, and decreased pressure in methane hydrate deposits from drilling beneath the deposits can lead to "a dramatic change in the geotechnical properties of the sediment, leading to borehole instability, release of gas, and potential structural and safety concerns."[135]

One well-documented case of the destabilization of methane hydrate came during the BP Deepwater Horizon oil disaster in the Gulf of Mexico. Prior to the Deepwater Horizon blowout, Halliburton was in the process of sealing a well with cement—a process that required heat to be used.[136] As Halliburton representatives acknowledged, these activities have the potential to destabilize

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135 COMMITTEE TO REVIEW THE ACTIVITIES AUTHORIZED UNDER THE METHANE HYDRATE RESEARCH AND DEVELOPMENT ACT OF 2000, *supra* note 27, at 32.

136 Mike Baker & Jason Dearen, *Rush to Drill Deeper Carries Added Risks*, SEATTLE TIMES (May 12, 2010), http://www.seattletimes.com/html/businesstechnology/2011841115_apusgulfoilspilldeepwaterdrilling.html.

methane hydrate deposits well below the sea floor.[137] Those studying the blast now believe "a bubble of methane escaped from the well and rocketed up the drill column, expanding as it approached the surface," contributing to the blowout.[138] The explosion killed eleven workers and led to the worst offshore oil spill in the history of the United States.[139]

Because natural gas production from methane hydrate would likely use similar methods of production to those used to produce conventional natural gas, similar concerns will likely arise with methane hydrate development. While conventional oil and gas activities may not always encounter issues associated with methane hydrate, the production of natural gas from methane hydrate will require developers to drill directly into these hydrate deposits. Thus, the safety risks will likely be even greater for methane hydrate activities. These concerns would need to be thoroughly explored before commercial production of natural gas from methane hydrate could begin.

### *B. Global Warming*

Like carbon dioxide, methane gas is a potent greenhouse gas. However, methane differs from carbon dioxide in some key respects. While carbon dioxide is by far the most abundant greenhouse gas, methane gas has much greater heat-trapping ability than carbon dioxide.[140] In fact, a release of just ten percent of the methane gas trapped in gas hydrates would be equivalent to an increase of atmospheric carbon dioxide by a factor of ten.[141] Some scientists have asserted that the disruption of methane hydrate reservoirs beneath the seafloor and in permafrost could have a devastating impact on our climate—one scientist has gone as far as to say the effect could be "comparable to the destructive potential from nuclear winter."[142]

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137 *Id.*

138 *Id.*

139 John M. Broder, *U.S. Acts to Fine BP and Top Contractors for Gulf Oil Spill*, N.Y. TIMES (Oct. 12, 2011), http://www.nytimes.com/2011/10/13/us/us-cites-bp-and-contractors-for-deepwater-horizon-spill.html.

140 D. Archer, *Methane Hydrate Stability and Anthropogenic Climate Change*, 4 BIOGEOSCIENCES DISCUSSIONS 993, 997–98 (2007).

141 *Id.* at 998.

142 *Id.* at 1031.

While this dramatic consequence would take millennia to occur if left up to gradual melting of methane hydrates,[143] exploiting methane hydrate as an energy resource could very well speed up the process. Researchers at the University of Alaska recently reported that "methane release creates a feedback loop. As temperatures increase, more methane is released, and as more methane is released, temperatures increase."[144] In fact, the process of releasing methane from hydrate deposits has already sped up due to anthropogenic causes, particularly in methane hydrate deposits in permafrost.[145] Releasing more methane into the atmosphere by exploiting methane hydrate as an energy resource has the potential to warm the climate further, leading to even greater discharges of methane gas from hydrate.

### *C. Protection of Species*

Many scholars have raised concerns about how development of methane hydrate will impact the marine ecosystem. For instance, research has shown that many hydrothermal and cold seep vent biotic communities reside atop methane hydrate deposits and around the vents where methane hydrate is often found.[146] These communities may be valuable to researchers in the fields of life science and plate tectonics. Some scientists even believe these vents and the biotic organisms living in and around them "may hold the key to understanding the origin of life on Earth and might guide 'astrobiologists' in their search for other life in our solar system and beyond."[147] Disruption of methane hydrate deposits around such communities could have catastrophic consequences for these biotic organisms and their habitats, which are offered no protection under current regulatory schemes.

Even species that have been offered protection under the ESA or MMPA could face further jeopardy with commercial exploitation of methane hydrate deposits. The Northern Right Whale, a species that has been listed as endangered under the ESA since 1971, is still

143 *Id.*

144 Weston Morrow, *Arctic Ocean Leaking Methane at Alarming Rate, Researchers Say*, SEATTLE TIMES, Nov. 29, 2013, http://seattletimes.com/html/localnews/2022364942_arcticmethanexml.html.

145 Archer, *supra* note 140, at 1031.

146 Allen, *supra* note 45, at 578.

147 *Id.* at 568.

declining in numbers.[148] Despite this listing and an international moratorium on hunting the Right Whale, seabed mining and oil and gas activities have further degraded its habitat.[149] Expanding oil and gas activities to include the production of natural gas from methane hydrate could further imperil dwindling populations of Right Whales and other sensitive species that have already been listed.

## V
## HOW SHOULD THE UNITED STATES PROCEED IN CONSIDERING THE POTENTIAL FOR METHANE HYDRATE MINING?

To mitigate the risk of undertaking methane hydrate activities, it would be beneficial for Congress to enact a statute that ensures damage to property and the environment will be paid for by the responsible party. Such regulatory mechanisms currently exist for oil spills through the Oil Pollution Act[150] and other toxic substances through the Comprehensive Environmental Response, Compensation, and Liability Act.[151] A similar scheme does not currently exist for emissions of methane resulting from natural gas production. Given the tendency of methane hydrate to dissociate with fluctuations in temperature and pressure, there is a chance for extensive release of methane gas into the atmosphere from commercial production of natural gas from methane hydrate. While the effects of pervasive methane hydrate destabilization may not be felt as quickly as would be the case in an oil spill, a chronic release of methane would nonetheless have a substantial impact on human health and the environment.

With respect to NEPA, agencies must ensure proper environmental analysis is conducted for any and all methane hydrate activities. Concerns have already arisen with respect to programmatic EISs and categorical exclusions as they apply to conventional oil and gas activities. For instance, the Council on Environmental Quality (CEQ) recently criticized the use of programmatic EISs for offshore oil activities because they did not adequately ensure information from one level of review was carried to the next, and failed to conduct

148 Ctr. for Biological Diversity v. Evans, No. C 04-04496 WHA, 2005 U.S. Dist. LEXIS 44984, *3–4 (N.D. Cal. 2005).

149 *Id.*

150 33 U.S.C. § 2702 (2012).

151 42 U.S.C. § 9607 (2012).

specific enough analysis for particular projects.[152] The CEQ also questioned the use of categorical exclusions for oil activities because they did not account for certain necessary mitigation measures or the risk of oil spills.[153] These oversights in the NEPA process may have ultimately contributed to the Deepwater Horizon blowout. If commercial production of natural gas from methane hydrate were to begin, the use of generalized programmatic EISs and categorical exclusions should be limited to the maximum extent practicable.

Additional regulations, and improvements to existing regulations, should also be put in place to ensure protection of marine species. Given the communities of biotic organisms that have been discovered living atop methane hydrate deposits and around sea vents where methane hydrate is often found, one scholar suggests the need for a regime that ensures protection of these organisms from "conflicts likely to be generated by hydrate research, prospecting, and exploitation."[154] This may include designation of "reserves" for vent communities, to be managed by "consensus decision-making for the common good."[155] For species that are already afforded some protections under the ESA or MMPA, the National Marine Fisheries Service, the agency charged with the task of listing species and designating critical habitat, must ensure compliance with the provisions of the ESA and MMPA to prevent endangered or threatened species from facing a fate similar to that of the Right Whale. This includes making timely designations of critical habitat for species dependent on habitat that may be potentially rich in methane hydrate deposits.

Of course, with global temperatures on the rise and no indication of climate warming slowing down, it may be prudent for the United States to simply put its dollars towards investing in renewable energy. While methane hydrate is abundant and a cleaner source of energy than coal, it is nonetheless a fossil fuel that, if exploited, could lead to unprecedented temperature rise. Tidal, wind, and solar sources, on the other hand, are truly unlimited and have minimal carbon footprints. Especially considering the risk of initiating a serious feedback loop of warming and subsequent methane releases, renewable energy may

152 RIESER ET AL., *supra* note 57, at 435.
153 *Id.*
154 Allen, *supra* note 45, at 578.
155 *Id.* at 566.

prove to be a better investment for the United States and other countries looking to methane hydrate as an energy source.

## CONCLUSION

Much more research is needed before commercial production of natural gas from methane hydrate can commence in the United States. How to best address the safety and environmental issues—including destabilization of the sea floor, global warming, and harm to marine species—that would result from exploitation of the resource is still under debate. Additional regulations are needed to address the unique risks posed by commercial production of methane hydrate. With Japan's recent production of a significant amount of natural gas from methane hydrate, however, it is likely the United States will soon follow in utilizing methane hydrate as an energy source.