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Subseabed Carbon Dioxide Sequestration As A Climate Mitigation Option For The Eastern United States: A Preliminary Assessment Of Technology And Law

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SUBSEABED CARBON DIOXIDE SEQUESTRATION AS A CLIMATE MITIGATION OPTION FOR THE EASTERN UNITED STATES: A PRELIMINARY ASSESSMENT OF TECHNOLOGY AND LAW

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I. INTRODUCTION

The alarm has sounded, again. The recently released Summary of the Fourth Assessment Report of the Intergovernmental Panel on Climate Change[1] starkly asserts that climate change is "unequivocal" and primarily caused by human activity.[2] In particular, carbon dioxide emissions are the "most important anthropogenic greenhouse gas,"[3] and "past and future anthropogenic carbon dioxide emissions will continue to impact warming

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1. Intergovernmental Panel on Climate Change [IPCC], Climate Change 2007: The Physical Science Basis, Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Summary for Policymakers (Feb. 2, 2007, with corrections made as of Feb. 5, 2007) (*prepared by* Richard Alley, et al.) [hereinafter IPCC FAR], *available at* http://www.ipcc.ch/SPM2feb07.pdf. The IPCC is a multi-national expert body established jointly by the World Meteorological Organization and the United Nations Environment Programme. IPCC, Carbon Dioxide Capture and Storage, Special Report of Working Group III of the IPCC at Foreword (2005) [hereinafter IPCC CCS], *available at* http://www.arch.rivm.nl/env/int/ipcc/pages_media/SRCCS-final/SRCCS_WholeReport.pdf. The IPCC provides advice to the Conference of the Parties to the United Nations Framework Convention on Climate Change (UNFCCC). *Id*.

2. IPCC FAR, *supra* note 1, at 5 (citing IPCC FAR §§ 3.2, 4.2, 5.5). *See also* IPCC CCS, *supra* note 1, at 67-68 & Fig. 1.7 (noting that the lifetime of carbon dioxide in the atmosphere is about 100 years, but its climate forcing potential may be longer, and therefore, that it must be stored for periods of time on the order of centuries or millennia).

3. IPCC FAR, *supra* note 1, at 2, 4 & Fig. SPM-2.

and sea level rise for more than a millennium," due to the long periods of time required for natural cycles to remove carbon from the atmosphere.[4] While the Panel "expressly avoided recommending courses of action," experts noted the report "powerfully underscores the need for a massive effort to slow the pace of global climatic disruption before intolerable consequences become inevitable."[5] In short, actions must be taken now to reduce future carbon dioxide emissions and also to isolate and sequester[6] carbon dioxide from existing sources to prevent its release into the world's atmosphere.

Among the near-term options for removing long-lived carbon dioxide from the atmosphere is the development and deployment of systems for capturing this gas from industrial facilities and electric power plants.[7] While carbon capture is only one option among many that must be explored if we are to achieve stabilized or climate-safe levels of these emissions, it has received much technical attention.[8] Existing domestic power production is the largest source of U.S. anthropogenic carbon dioxide emissions; in 2005 this sector alone generated 41.39% of total carbon dioxide emissions.[9] While it is essential that a transition occur to less carbon-intense forms of energy production,[10] it is also clear that existing

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4. *Id.* at 17 (citing IPCC FAR §§ 7.3, 10.3).

5. Elisabeth Rosenthal & Andrew C. Revkin, *Science Panel Says Global Warming is 'Unequivocal,'* NEW YORK TIMES, Feb. 3, 2007, at A1 (quoting John P. Holdren, the president of the American Association for the Advancement of Science, and an energy and climate expert at Harvard University).

6. I use the term "sequestration" rather than "storage" because of the need for long-term isolation of the carbon dioxide (on the order of hundreds to a thousand years) in order to effectuate the purpose of the isolation by preventing release into the atmosphere.

7. IPCC CCS, *supra* note 1, at 3-5, 105-78.

8. *See generally, id. See also* KATE ROBERTSON, ET AL., U.S. DEP'T OF ENERGY/NATIONAL ENERGY TECH. LAB., INTERNATIONAL CARBON CAPTURE AND STORAGE PROJECTS OVERCOMING LEGAL BARRIERS, Report No. DOE/NETL-2006/1236 (2006), *available at* http://www.netl.doe.gov/energy-analyses/pubs/CCSregulatorypaperFinalReport.pdf (asserting that "the number and scope of carbon capture and storage (CCS) projects worldwide are expanding at a rapid rate," and noting the "lack of a clear, defined legal and regulatory framework" for these projects); J.J. DOOLEY, ET AL., BATTELLE MEMORIAL INSTITUTE, GLOBAL ENERGY TECHNOLOGY STRATEGY PROGRAM, CARBON DIOXIDE CAPTURE AND GEOLOGIC STORAGE (2006) (describing CCS as a core element of a global energy technology strategy to address climate change), *available at* http://www.pnl.gov/gtsp/docs/ccs_report.pdf.

9. U.S. ENVTL. PROT. AGENCY, INVENTORY OF U.S. GREENHOUSE GAS EMISSIONS AND SINKS: 1990-2005, PUBLIC REVIEW DRAFT, EXEC. SUMMARY ES-7 through ES-8 (Feb. 20, 2007), *available at* http://www.epa.gov/climatechange/emissions/downloads07/07ES.pdf [hereinafter U.S. EPA INVENTORY].

10. Environmentalists, and the public at large, are likely to be quite wary of any approach

sources play a large role in the ongoing problem. Once released, carbon dioxide is climate forcing[11] for very long time periods; therefore, the near-term deployment of technologies for removing and sequestering carbon dioxide from atmospheric release are critical to achieving long-term climate benefits.

But what is to be done with the captured carbon dioxide? A variety of sequestration options, on land and at sea, are under study. All of these options have associated risks and unanswered regulatory questions.[12]

On November 27, 2006, steps were taken to move one of these carbon sequestration options forward, as a legal matter. The contracting parties to the 1996 London Protocol to the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (London Protocol),[13] a primary international instrument concerning ocean pollution, amended the London Protocol to allow the sequestration of carbon dioxide in subseabed geological formations.[14] In so doing, the parties expressed serious concerns

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to the climate problem that is not presented as part of a larger portfolio of options, including increased reliance on cleaner forms of energy (wind, solar, other renewable sources), energy efficiency, and efforts to reduce electricity demand. *See* David Hawkins, Natural Resources Defense Council, Address at the First National Conference on Carbon Sequestration: Stick It Where?? Public Attitudes toward Carbon Storage (2001), *available at* http://www.netl.doe.gov/publications/proceedings/01/carbon_seq/1c2.pdf.

11. IPCC FAR, *supra* note 1, at 2, n.2. Anthropogenic air pollutants change the chemical composition of the earth's atmosphere and alter the natural balance between incoming solar energy and outgoing heat, so that heat is trapped and not released. This creates a "greenhouse effect." The net result is warming of the earth's surface, causing changes to ocean circulation and the earth's surface climate. National Climactic Data Center, *The Greenhouse Effect*, http://www.ncdc.noaa.gov/paleo/globalwarming/greeneffect.html. Man-made emissions that cause this effect, including carbon dioxide, are referred to in the scientific lexicon as "climate forcing." National Oceanic and Atmospheric Administration, Research, *Climate Forcing*, http://www.esrl.noaa.gov/gmd/about/climate.html.

12. IPCC CCS, *supra* note 1, at 12-14, 242-57, 298-309.

13. 1996 London Protocol to the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, Nov. 8, 1996, 36 I.L.M. 1 (1997) [hereinafter London Protocol]. While the United States participated in the drafting and consideration of the London Protocol, see *id*. at 4-5, it has never ratified it. *See also* World Resources Institute, London Protocol Adopts Amendment Allowing for Sub-seabed Carbon Dioxide Storage 1 (2006), *available at* http://pdf.wri.org/css_06_12_08_london_protocol.pdf [hereinafter WRI]; *see also* http://www.imo.org/Conventions/mainframe.asp?topic_id=258&doc_id=681 (follow "Status of Convention by Party" hyperlink) (official list of parties to the 1972 London Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, and the 1996 London Protocol) (last visited Apr. 15, 2007).

14. International Maritime Organization, Notification of Amendments to Annex 1 to the London Protocol 1996 LC-LP.1/Circ. 5 (Nov. 27, 2006), *available at* http://www.imo.org/includes/blastData.asp/doc_id=7450/5.pdf [hereinafter Protocol Amendment]. The Amendment is narrowly drafted to apply only to subseabed geological

about the negative effects of climate change on the marine environment, and recognized that carbon capture and long-term sequestration technologies can be developed now, to serve as an important near-term option to mitigate these adverse effects. The London Protocol amendments, which became effective on February 10, 2007, with respect to each accepting contract party,[15] remove pre-existing ambiguity about whether this method for carbon dioxide isolation is permitted under international law.[16]

This Article describes seabed sequestration of carbon dioxide, and discusses current experience with this technology. It describes briefly some very preliminary technical assessments about its potential for global and U.S. development as one piece of a relatively near-term climate mitigation strategy. The international legal framework on ocean dumping, including the recent London Protocol amendments, is presented and compared with the U.S. domestic law governing ocean dumping, the 1973 Marine Protection Research and Sanctuaries Act (MPRSA).[17] The question whether carbon dioxide sequestration activities are prohibited "dumping" of

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sequestration, and not to disposal of carbon dioxide directly into ocean waters. *See infra* text accompanying notes 89-92. One of the options studied for long-term isolation of carbon dioxide is direct injection into ocean waters at depths greater than 3000 meters. Under this theory, the carbon dioxide would remain trapped by the pressure of the overlying seawater, in a liquid state at the bottom of the ocean as a kind of subsea lake or pool. This option presents significant risks of eventual release of carbon dioxide back to the atmosphere, and would also cause significant adverse impacts to local benthic flora and fauna. For these reasons, it is not being seriously pursued. IPCC CCS, *supra* note 1, at 298, 301, 299 Box 6.4, 397. A full discussion of this "ocean disposal" option is beyond the scope of this Article.

15. Protocol Amendment, *supra* note 14, at 2.2.

16. WRI, *supra* note 13 at 1; *see also* ROBERTSON, ET AL., *supra* note 8, at 8 (citing uncertainty as to whether the London Protocol constrains offshore subseabed CCS); IPCC CCS, *supra* note 1, at 254-55 (citing CONTINENTAL SHELF LIMITS: THE SCIENTIFIC AND LEGAL INTERFACE (P.J. Cook & C.M. Carleton, eds., 2000); J.M. Bewers, REVIEW OF INTERNATIONAL CONVENTIONS HAVING IMPLICATIONS FOR OCEAN STORAGE OF CARBON DIOXIDE (Int'l Energy Agency, Greenhouse Gas Res. & Dev. Prog. 2003); R. Ducroux & J.M. Bewers, ACCEPTANCE OF CCS UNDER INTERNATIONAL CONVENTIONS AND AGREEMENTS, *in* Proc. 7th Int'l Conf. on Greenhouse Gas Control Tech., v. I at 971-78 (2005); W.J. Lenstra & B.C.W. van Englenburg, LEGAL AND POLICY ASPECTS: IMPACTS ON THE DEVELOPMENT OF CO2 STORAGE, *in* Proc. IPCC Wk. Grp. III (IPCC 2002); Ray Purdy & Richard Macrory, *Geological Carbon Sequestration: Critical Legal Issues* (Tyndall Ctr. for Climate Change Research, Working Paper 45, Jan. 2004), *available at* http://www.tyndall.ac.uk/publications/working_papers/wp45.pdf; C. Wall, et al., INTERNATIONAL AND EUROPEAN LEGAL ASPECTS ON UNDERGROUND GEOLOGICAL STORAGE OF CO2, *in* Proc. 7th Int'l Conf. on Greenhouse Gas Control Tech., v. I at 971-78 (2005).

17. Marine Protection Research and Sanctuaries Act, 33 U.S.C. §§ 1401-1445 (2000) [hereinafter MPRSA or the Act].

"industrial wastes" under the MPRSA is evaluated, considering the purpose of the "sequestration," namely the very long-term isolation of carbon dioxide from atmospheric release. Unfortunately, the MPRSA can be read either to ban sequestration outright, if carbon dioxide is found to be an "industrial waste," or to allow it, with a permit. Furthermore, the very limited relevant case law related to the Act's dumping ban contains a cautionary tale.

Taking a precautionary approach to the problem suggests that developing available, feasible, near-term carbon dioxide sequestration methods, with the least environmental impact possible, should be a priority. The urgency of the climate change issue, the role of carbon dioxide in particular, and the emerging degree of clarity about the seriousness of the damage to the world's oceans and other resources all point in the direction of taking sensible steps toward developing sequestration, without waiting for technical certainty. Technical researchers in the United States continue to explore the subseabed sequestration option, as this country draws nearer to a carbon-constrained economy. Because the United States is a primary contributor to world carbon dioxide emissions, and the seabed sequestration option appears increasingly promising, limited amendments to the MPRSA are appropriate. Such amendments should be included as part of a legislative package on climate change, remove existing ambiguities, and allow for near-term *in situ* testing and development if geologically appropriate offshore sites are found.

II. UNITED STATES CARBON DIOXIDE EMISSIONS AND THE MOVE TOWARD A CARBON-CONSTRAINED ECONOMY

The United States produces about 25% of world anthropogenic carbon dioxide emissions,[18] and the most recent U.S. Environmental Protection Agency (EPA) report shows that electricity production makes up about 42% of the national contribution to global carbon dioxide.[19] This figure continues to grow–carbon dioxide from electricity generation in 2005 is up about 22% from 1995.[20]

While there is no current federal regulatory program governing carbon dioxide and other greenhouse gas air emissions from cars, power plants, and industrial facilities, the U.S. Supreme Court has recently declared that carbon dioxide and other greenhouse gases are "air pollutants" subject to

18. Rosenthal & Revkin, *supra* note 5.
19. U.S. EPA INVENTORY, *supra* note 9, at 8.
20. *Id*.

regulation under the Clean Air Act.[21] The Court's decision has implications for domestic regulation of all air emissions of carbon dioxide, including stationary source greenhouse gas emissions. For one example, EPA arguably must set new source performance standards under Clean Air Act section 111 for greenhouse gases emitted by power plants.[22]

Additionally, since the beginning of the 110th Congress in January, a number of bills have been introduced, aimed at managing and controlling domestic emissions of carbon dioxide and other greenhouse gases.[23] Public understanding and awareness of climate change has skyrocketed in the United States during the past year, thanks in part to the publicity generated by the film *An Inconvenient Truth*.[24] It seems clear that the U.S. economy will in the relatively near future become "carbon-constrained"—one in which either regulatory requirements or new statutes will govern emissions of carbon dioxide and other greenhouse gases from power production, and from industrial sources. In a carbon-constrained economy, all practicable and environmentally sound options for reducing dependence on fossil fuels,

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21. Massachusetts v. EPA, 127 S. Ct. 1438 (2007); *see also* 42 U.S.C. § 7602(g) (2000) (Clean Air Act's general definition of "air pollutant"). Petitioners, fourteen states, several other governmental bodies, and nine environmental groups, had challenged EPA's decision not to regulate greenhouse gas emissions from motor vehicles. *See* Brief for the Petitioners, Massachusetts v. EPA, 127 S. Ct. 1438 (No. 05-1120) (2007). They argued, *inter alia,* that because the Clean Air Act defines "welfare" to include effects on climate in 42 U.S.C. § 7602(h), the requirement in section 202(a)(1) that the Administrator "shall" promulgate regulations governing emissions of air pollutants from new motor vehicles, "which in his judgment cause or contribute to air pollution which may reasonably be anticipated to endanger public health or welfare" would require the regulation of carbon dioxide and other greenhouse gas emissions from motor vehicles, if those gases are "pollutants." *Id.* at 1-2, 12-18.

22. 42 U.S.C. § 7411 (2000). Several environmental groups and states also challenged EPA's decision not to regulate carbon dioxide emissions from power plants when setting revised New Source Performance Standards for that industrial sector, pursuant to 42 U.S.C. § 7411. That case, now pending before the U.S. Court of Appeals for the District of Columbia Circuit, was held in abeyance pending the outcome of the Supreme Court's decision in *Massachusetts v. EPA*, but now can be reengaged. Coke Oven Envtl. Task Force v. EPA, 2006 U.S. App. LEXIS 23499 (D.C. Cir. 2006) (order severing and establishing new docket for carbon dioxide issues at *New York v. EPA*, D.C. Cir. No. 06-1322, and ordering the filing of motions to govern within thirty days of the Supreme Court's decision in *Massachusetts v. EPA*).

23. Larry Parker, Climate Change: Greenhouse Gas Reduction Bills in the 110th Congress (Cong. Res. Serv., Report to Congress, Jan. 31, 2007), *available at* http://opencrs.cdt.org/rpts/RL33846_20070131.pdf.

24. Lauren Elmore, *Al Gore Has Some News For You*, MEDIARIGHTS NEWS, Oct. 3, 2006, *available at* http://www.mediarights.org/news/2006/10/03/al_gore_has_some_news_for_you.

and for increasing carbon sequestration opportunities, will need to be exploited. Because power production is the largest industrial emitter of carbon dioxide in the U.S. economy today,[25] this industrial sector is very likely to be among the first to be required to limit its carbon emissions. The availability of carbon dioxide sequestration opportunities can be "pivotal" in achieving near term, real carbon dioxide reductions from this significant industry.[26]

The IPCC has pointed out that "if CO2 storage is to be undertaken on the scale necessary to make deep cuts to atmospheric CO2 emissions, there must be hundreds, and perhaps even thousands, of large-scale geological storage projects underway worldwide."[27] Moreover, cost and other issues associated with transport of captured carbon dioxide suggest that sequestration facilities will need to be located relatively near the sites where the carbon dioxide is produced and captured.[28] Assuming the advent of a carbon-constrained regulatory regime for domestic power production, where could sequestration of the captured carbon from electricity production occur?

Several geological sequestration options are under study,[29] all with associated environmental and public health risks. Land-based geological sequestration options involve injection of compressed carbon dioxide into underground geologic formations including depleted oil and gas reservoirs, unmineable coal seams, and deep saline aquifers. These options present risk to the global environment due to the climate-forcing that would result from unexpected direct atmospheric release of the stored carbon dioxide. Additionally, there are potential significant local public health and environmental risks associated with land-based geologic storage, including immediate dangers to human life and health from a sudden release of carbon dioxide to the atmosphere from the geologic formation, lethal effects on local plants and animals, and contamination of groundwater resources.[30] In

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25. U.S. EPA INVENTORY, *supra* note 9, at ES-7 – ES-8.

26. DOOLEY, ET AL., *supra* note 8, at 7. *See also* Jennie C. Stephens & Bob Van Der Zwaan, *The Case for Carbon Capture and Storage*, 22 ISSUES IN SCI. & TECH. 69, 70 (Fall 2005) (explaining why "large stationary sources of carbon dioxide are good candidates for [carbon capture and storage]").

27. IPCC CCS, *supra* note 1, at 204.

28. *See generally id.* at 10 (noting short transport distances as among the factors leading to deployment of CCS opportunities).

29. *Id*. at 197-276.

30. IPCC CCS, *supra* note 1, at 12-13, 246-49. Carbon dioxide gas pools near the ground on release from storage, because it is denser than the air it displaces. Buildings or other enclosed spaces near a release could contain lethal levels of the gas, which causes asphyxiation at high concentrations. The public health risk of large amounts of carbon

the eastern United States, moreover, many existing coal-fired power plants and other industrial facilities are located in areas characterized by relatively high population densities, particularly the metropolitan areas in the coastal corridor from New England to Washington, D.C..[31] Land-based geologic storage site availability, as well as local public health impacts, are particularly problematic in high population density areas.

Subseabed geological sequestration is also being investigated by U.S. researchers.[32] Under this option, carbon dioxide is captured from land-based point sources, for example from coal-fired power plants, and collected and piped to a shore-based terminal. From that point, the carbon dioxide is transported by ship or pipeline to an ocean platform in at least 3000 meters of water where it would be transferred, as necessary, and then injected into brine-bearing seabed sediments deep below the seafloor.[33] Any local leakage from the subseabed geologic formation, which the researchers assert would be minimal to non-existent, could cause environmental damage, increasing the acidity of the water at the site of the leakage, and killing benthic organisms.[34] If the subseabed sequestration were in a saline sedimentary formation, experience suggests that the risk of leakage would be low.[35] However, because the injection and disposal sites

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dioxide released into populated areas is illustrated by the 1986 Lake Nyos incident in Cameroon. A cloud of carbon dioxide was released from the lake, where it had accumulated as a result of underlying volcanic activity; within hours of the release, the carbon dioxide dispersed along the ground, asphyxiating at least 1700 people and many more animals up to twenty kilometers away from the release. Stephens & Van Der Zwaan, *supra* note 26, at 71-72; George W. Kling, et al., *The 1986 Lake Nyos Gas Disaster In Cameroon, West Africa,* 236 SCIENCE 169 (Apr. 10, 1987).

31. *See* IPCC CCS, *supra* note 1, at 9, figure SPM.6a (showing concentrations of large stationary sources of carbon dioxide emissions in this area of the United States).

32. *See* Kurt Zenz House et al., *Permanent Carbon Dioxide Storage in Deep-sea Sediments*, 103 PROC. NAT'L ACAD. SCI. 12291 (2006). These researchers are evaluating injection of carbon dioxide in a liquid form into deep-sea sediments not necessarily associated with saline aquifer formations. They conclude that chemical changes in the carbon dioxide and the sediments together, at the temperatures and pressures encountered below a few hundred meters of water and hundreds of meters of subsea sediment, would permanently sequester the carbon dioxide from release. *Id.* at 12292-93.

33. *See* Purdy & Macrory, *supra* note 16, at 3 (noting also that carbon dioxide "is largely inert and can be relatively easily handled"). *See also* IPCC CCS, *supra* note 1, at 5 (noting that carbon dioxide transport by pipeline occurs today on the order of several million metric tons daily).

34. *See* House et al., *supra* note 32, at 12292 (asserting that carbon dioxide sequestered deep in mud below several hundred meters of seawater would remain permanently sequestered).

35. *See* IPCC CCS, *supra* note 1, at 246, 248 (discussing small potential for local environmental damage due to carbon dioxide release from sequestration in subseabed saline sedimentary formations).

are isolated from major population centers of the east coast and are overlain by 3000 meters of water, which adds an additional barrier to release, this option, if technically feasible and legally available, might become the preferred east coast strategy of the United States.[36]

III. SUBSEABED SEQUESTRATION OF CARBON DIOXIDE—CURRENT EXPERIENCE AND THE UNITED STATES' POTENTIAL

There is a reasonable amount of empirical experience with subseabed geologic sequestration in brine-bearing sediments. Since 1996, carbon dioxide sequestration in subseabed geologic formations has been undertaken in a deep saline sedimentary basin underlying the North Sea. The "Sleipner Project" is a commercial enterprise of the Norwegian company Statoil and its partners, including the International Energy Agency (IEA) Greenhouse Gas R&D Programme.[37] Carbon dioxide sequestration at Sleipner is associated with a natural gas production facility.[38] At Sleipner, the natural gas is harvested in one offshore location, and then piped to another offshore platform where the carbon dioxide is separated out[39] and then injected into a subseabed sedimentary brine-saturated rock formation 800 meters below the seabed beneath.[40] The "cleaned" natural gas is then transported by ship to its ultimate destination. Almost one

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36. This assumes that all other risks are equal—i.e., that the risks associated with the carbon dioxide collection pipelines will be the same whether the ultimate resting place of the gas is land-based or in the seabed.

37. IPCC CCS, *supra* note 1, at 197, 199, 200-03 & Box 5.4.

38. Other oil and gas production operations also are currently demonstrating the feasibility of carbon dioxide sequestration in land-based underground geologic formations. In enhanced oil recovery (EOR) projects, for example, carbon dioxide injection is part of the process of recovering the oil from the underground formation. In simplest terms, in an EOR operation, the carbon dioxide replaces the harvested oil within the oil-bearing geological formation. *Id*. at 203-04. There is little if any experience with carbon dioxide sequestration as a by-product of enhanced oil recovery offshore, however. *Id*. at 204.

39. The Sleipner natural gas contains too much carbon dioxide to be commercially viable as harvested before the carbon dioxide is stripped out. Jason Heinrich, *Legal Implications of CO2 Ocean Storage* 9 (Massachusetts Institute of Technology, Working Paper, July 2000), *available at* http://sequestration.mit.edu/pdf/Legal_Implications_Ocean_Storage.pdf (citing International Energy Agency, Saline Aquifer CO2 Storage Project (May 2002), http://www.ieagreen.org.uk/sacshome.htm). Statoil's original motivation for injecting the carbon dioxide into the subseabed, rather than releasing it to the atmosphere, was the avoidance of penalties of 1 million Norwegian kroner per day under Norway's carbon tax. *Id*. at 7 (citing Statoil, Carbon Dioxide Storage Prized (May 2000), http://www.statoil.com).

40. IPCC CCS, *supra* note 1, at 202, Box 5.4.

million metric tons of carbon dioxide has been injected annually at Sleipner since 1996.[41]

Consistent monitoring of the Sleipner project shows that the carbon dioxide has so far remained contained within the formation.[42] The caprock above the sedimentary rock basin, and the chemical interactions between the carbon dioxide gas and the briny solution in the interstices of the rock, serve as barriers against release to the ocean.[43] Additionally, the low temperatures and high pressure of the ocean water above the seabed, and the chemical changes that occur to the carbon dioxide in these conditions, could act as an additional barrier to keep the carbon dioxide from rising to the ocean surface and entering the atmosphere.[44]

Could Sleipner, or a project similar to it, happen in the United States? Researchers have reported, on a very preliminary basis, that at least twenty percent of the seafloor within the U.S. 200-mile Exclusive Economic Zone (EEZ) is under at least 3000 meters of water, and would, if the underlying geology is suitable, provide potentially limitless and permanent carbon dioxide storage.[45] While not all of this area contains appropriate geology, other very preliminary research results show that there are some areas of "high prospectivity" on the continental shelf off the east coast of the United States.[46] There is the possibility that these offshore sites may, on further

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41. *Id.*

42. *Id. See also* Karen N. Scott, *The Day After Tomorrow: Ocean CO2 Sequestration and the Future of Climate Change*, 18 GEO INT'L. ENVTL. L. REV. 57, 63-64 (2005) (describing Sleipner, and noting the impending opening of another Norwegian sequestration facility related to gas production, in the Berents Sea at the Snøhvit site).

43. IPCC CCS, *supra* note 1, at 202, Box 5.4.

44. House et al., *supra* note 32, at 12,291-92. These authors conclude that deep-sea sediment at high pressure and low temperature provides a virtually unlimited and permanent reservoir for carbon dioxide captured from fossil fuel combustion. *Id*. at 12,295. Indeed, one of the options that has been under discussion for long-term isolation of carbon dioxide is direct injection into ocean waters at depths greater than 3000 meters, where it would be transformed by the pressure of the overlying water, and would remain as a subsea lake or pool. *Id*. at 12,291. However, there is a risk that a significant amount of the carbon dioxide stored in this way would be eventually released to the atmosphere. *Id.* Additionally, it is estimated that although such seabed lakes could isolate carbon dioxide from atmospheric release for long time periods, they also can potentially cause significant adverse environmental impacts to the local benthic environment. IPCC CCS, *supra* note 1, at 298, 301, 299 Box 6.4, & 397. A full discussion of this "ocean disposal" option is beyond the scope of this article, but is contained in the IPCC CCS, *supra* note 1, at 279-301.

45. House et al., *supra* note 32, at 12,291-92.

46. *See* JOHN BRADSHAW & TESS DANCE, MAPPING GEOLOGICAL STORAGE PROSPECTIVITY OF CO2 FOR THE WORLD'S SEDIMENTARY BASINS AND REGIONAL SOURCE TO SINK MATCHING 1, 3-4 & figs. 2, 4 & 6 (Sept. 2004), *presented at* 7TH INT'L CONF. ON GREENHOUSE GAS CONTROL TECH., *available at* http://www.co2crc.com.au/PUBFILES/STOR

(and much needed) detailed study, emerge as technically suitable or even attractive for carbon dioxide sequestration. If so, they could be the safest, from a local human health perspective, technically feasible sites for carbon dioxide sequestration, and also the closest geographically to east coast industrial and power plant sources.

IV. BUT IS SUBSEABED SEQUESTRATION PERMISSIBLE UNDER INTERNATIONAL AND U.S. LAW?

Several authors[47] have discussed whether subseabed geological carbon dioxide sequestration is permitted under the international law of the sea, including the 1982 United Nations Convention on the Law of the Sea (UNCLOS),[48] the 1972 London Convention[49] and the 1996 London Protocol,[50] and regional agreements such as the 1992 Convention on the Protection of the Marine Environment of the North East Atlantic (OSPAR Convention).[51] Their focus has primarily been on the legal regimes governing the North Sea, as that is the location of the ongoing Sleipner carbon dioxide subseabed sequestration project. U.S. domestic law has not been fully analyzed. The international legal situation is not completely binding on the United States because it is not a party to all of the relevant agreements—in particular, the 1996 London Protocol.[52] It is briefly summarized here for purposes of comparison with U.S. law.

V. UNITED NATIONS CONVENTION ON THE LAW OF THE SEA—UNCLOS

UNCLOS has been described as a "constitution for the oceans,"[53] because it describes rights of nation states to the resources of the ocean, and

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0405/GHGT7_Bradshaw_potentialworldsedbasins.pdf. The authors' overlay an International Energy Agency dataset of large point sources of carbon dioxide on a map of geologically possible carbon dioxide storage areas, to develop and present a "first pass estimate" of the world's carbon dioxide storage potential. *Id*. at fig. 4.

47. Scott, *supra* note 42; Purdy & Macrory, *supra* note 16; the IPCC CCS also considered this question, although not in great detail. IPCC CCS, *supra* note 1, at 252-55 *See also* list of the IPCC CCS citations, *supra* note 16.

48. United Nations Convention on the Law of the Sea, Dec. 10, 1982, 21 I.L.M. 1261 [hereinafter UNCLOS].

49. Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, Aug. 30, 1975, 26 U.S.T. 2403 [hereinafter London Convention].

50. London Protocol, *supra* note 13.

51. Convention for the Protection of the Marine Environment of the North-East Atlantic, Sept. 22, 1992, 32 I.L.M. 1072.

52. *See infra* text accompanying note 95.

53. Scott, *supra* note 42, at 64.

delimits territorial seas, exclusive economic zones, and the area beyond national jurisdiction.[54] UNCLOS also proclaims the obligations of the parties to "protect and preserve the marine environment."[55] UNCLOS recognizes coastal states' sovereign rights to the natural resources of their EEZ and continental shelf areas, including "non-living resources," of the sea and the seabed.[56] From this perspective alone it would seem that carbon dioxide sequestration might be permitted in the seabed under a state's EEZ, for example on the U.S. eastern continental shelf,[57] as the carbon-storage capacity of subseabed geologic features could be considered a non-living resource of the seabed.[58]

The obligation under UNCLOS of states to "take . . . all measures . . . necessary to prevent, reduce and control pollution of the marine environment,"[59] and "to minimize to the fullest possible extent . . . the release of . . . harmful . . . substances, especially those which are persistent, from land-based sources . . . by dumping,"[60] however, could subject carbon dioxide sequestration in the seabed to the state-specific laws and regulations that UNCLOS requires signatory states enact to "prevent, reduce and control pollution from land-based sources"[61] and from seabed activities.[62]

If carbon dioxide sequestration is not "carried out for the purposes of disposal," however, it arguably falls under an explicit exemption to the definition of "dumping." UNCLOS Article 1.1(5)(b) states that "dumping does not include: . . . the placement of matter for a purpose other than the mere disposal thereof, provided that such placement is not contrary to the aims of [UNCLOS]."[63] If the subseabed sequestration activity were undertaken so as to allow for the subsequent recovery of the carbon dioxide, perhaps for later commercial use, one might argue that its purpose is storage, not "mere disposal." On the other hand, the time frames for which carbon dioxide sequestration is contemplated are on the order of hundreds

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54. *Id*. at 64-68.
55. UNCLOS, *supra* note 48, art. 192, at 1308.
56. Scott, *supra* note 42, at 65.
57. *Id*. at 66-67 and notes 61-65.
58. Scott, *supra* note 42, at 65 & n.47.
59. UNCLOS, *supra* note 48, art. 194.1, at 1308.
60. *Id*. art. 194.3(a), at 1308.
61. Scott, *supra* note 42, at 72.
62. Article 208 of UNCLOS addresses "pollution from seabed activities subject to national jurisdiction," and obliges states to "adopt laws and regulations to prevent, reduce and control pollution of the marine environment arising from or in connection with sea-bed activities subject to their jurisdiction." UNCLOS, *supra* note 48, art. 208.1, at 1308.
63. UNCLOS, *supra* note 48, art. 1.1(5)(b), at 1271.

to a thousand years.[64] Subseabed carbon sequestration undertaken as a climate change mitigation measure, therefore, has more of the hallmarks of "disposal" than of "storage."

VI. THE 1972 CONVENTION ON THE PREVENTION OF MARINE POLLUTION BY DUMPING OF WASTES AND OTHER MATTER (LONDON CONVENTION)

The 1972 London Convention establishes the global agreement of states to cooperate on the protection and preservation of the marine environment, as called for in UNCLOS Article 197 and section 5.[65] The United States is a party to the London Convention, which establishes a complete prohibition on ocean dumping of "wastes and other matter" listed in Annex I,[66] but permits ocean dumping of materials listed in Annex II,[67] if a permit is issued

64. IPCC CCS, *supra* note 1, at 29.

65. UNCLOS calls for nations to cooperate "in formulating and elaborating international rules, standards and recommended practices and procedures . . . for the protection and preservation of the marine environment . . . ." UNCLOS, *supra* note 48, art. 197, at 1308. Part XII, section 5 of UNCLOS calls for, *inter alia*, "[s]tates, acting . . . through competent international organizations . . . to endeavour to establish global . . . rules, standards and recommended practices and procedures to prevent, reduce and control pollution of the marine environment from land-based sources." *Id*. art. 207.4, at 1310. UNCLOS also calls for states to "prevent, reduce and control pollution of the marine environment arising from or in connection with seabed activities . . . ." *Id*. arts. 208.1 & 208.5, at 1310.

66. London Convention, *supra* note 49, art. IV.1. The Annex I list does not include carbon dioxide. *Id*. at Annex I. Annex I further states that substances which are rapidly rendered harmless by physical, chemical or biological processes in the sea are not covered by Annex I, provided they do not . . . endanger human health," and, if there is any question about whether a substance is harmless, it must be brought to the other contracting parties. *Id.* at Annex I.8. Purdy & Macrory, *supra* note 16, at 21; note that Annex I was amended to forbid dumping of "industrial waste," but it is ambiguous whether the definition of "industrial waste" could encompass carbon dioxide from electric power production. *Id*. (noting the definition is "waste materials generated by manufacturing or processing operations"). It does not appear that the United States has acceded to this amendment to the London Convention. *See* London Convention, *supra* note 49, at 2465 (Annex I as ratified by the United States does not include "industrial waste").

67. Annex II does not refer to carbon dioxide. It lists "materials requiring special care," including "[w]astes containing significant amounts of . . . arsenic, lead, copper, zinc and their compounds, organosilicon compounds, cyanides, fluorides, pesticides and their by-products not covered in Annex I." London Convention, *supra* note 49, Annex II.A. It also includes substances containing "large quantities of acids and alkalis" and also includes "beryllium, chromium, nickel, vanadium and their compounds." *Id.* Annex II.B. Low-level radioactive wastes and "[c]ontainers, scrap metal and other bulky wastes [that are] liable to sink to the sea bottom" are included in Annex II. *Id*. Annex II.B-C.

by the country undertaking the dumping.[68] Annex III sets forth factors that must be considered before issuance of any permit for ocean dumping.[69]

"Dumping" is defined as "any deliberate *disposal at sea* of wastes or other matter from vessels, aircraft, platforms, or other man-made structures at sea."[70] As does UNCLOS, the London Convention's definition refers to "disposal," reflecting the idea of permanent, unrecoverable placement, not placement with the intention of short-term or long-term storage. Additionally, the London Convention specifically refers to activities "at sea," not in the seabed. Finally, just as in UNCLOS, "dumping" specifically does not include "placement of matter for a purpose other than the mere disposal thereof."[71] These ambiguities led to debates during the 1980s over the question whether the London Convention permitted radioactive waste storage in the subseabed,[72] and would also suggest that carbon dioxide seabed sequestration might be permissible, if it were not permanent.

Particularly relevant to carbon dioxide sequestration, the London Convention also excludes entirely from the provisions "[t]he disposal of wastes or other matter directly arising from, or related to the . . . exploitation and associated offshore processing of sea-bed mineral resources."[73] Carbon dioxide seabed sequestration undertaken as part of an offshore enhanced oil recovery operation, or, as in the case of Sleipner, as one element of a larger operation for the harvesting of natural gas, therefore, may not to be covered by the London Convention provisions.[74] Subseabed carbon dioxide sequestration undertaken solely for the purpose of climate change mitigation, however, is not excluded under this provision, and would be covered by the London Convention. Additionally, because the London Convention's purpose is to "improve protection of the marine

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68. London Convention, *supra* note 49, art. IV.1(b).

69. *Id.* Annex III. Annex III requires consideration of "[c]haracteristics and composition of the matter . . . characteristics of [the] dumping site and method of deposit . . .[and] general considerations and conditions," including "the practical availability of alternative land-based methods of . . . disposal or elimination . . . ." *Id*. Annex III.A-C.

70. *Id*. art. III.1(a)(i) [emphasis added].

71. *Id*. art. III.1(b)(ii).

72. Scott, *supra* note 42, at 74-75 and n. 116 (citing Clifton E. Curtis, *Legality of Seabed Disposal of High-Level Radioactive Wastes Under the London Convention*, 14 OCEAN DEV. & INT'L L. 383 (1984); Marianne MacKintosh, *The Development of International Law in Relation to the Dumping and Disposal of Radioactive Waste at Sea*, 9 J. INT'L MARITIME L. 354 (2003); and others).

73. London Convention, *supra* note 49, art. III.1(c).

74. ROBERTSON, ET AL., *supra* note 8, at 8.

environment"[75] and "prevent the pollution of the sea by dumping,"[76] carbon dioxide sequestration activities in the seabed would be precluded or strictly limited if there is any risk of carbon dioxide escaping into ocean waters and causing local environmental harm.[77]

VII. THE 1996 PROTOCOL TO THE CONVENTION ON THE PREVENTION OF MARINE POLLUTION BY DUMPING OF WASTES AND OTHER MATTER (LONDON PROTOCOL) AND THE 2007 AMENDMENTS

In 1996, many of the contracting parties to the London Convention recognized that "more stringent measures [were necessary] with respect to prevention and elimination of pollution of the marine environment from dumping at sea" and that this required "further international action."[78] The London Protocol made significant revisions to the London Convention; it prohibits the "dumping of any wastes or other matter" except those specifically listed in Annex I.[79] Additionally, under the London Protocol, the definition of "dumping" is extended to include "any storage of wastes or other matter in the seabed and the subsoil."[80]

The London Protocol thus takes a much more strict approach to ocean dumping than did the London Convention, and indeed expressly adopts a precautionary approach and applies the "polluter pays" concepts to ocean dumping activities.[81] Specifically, the London Protocol requires contracting parties to:

> [A]pply a precautionary approach to environmental protection from dumping of wastes or other matter whereby appropriate

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75. London Convention, *supra* note 49, By the President of the United States of America A Proclamation.

76. *Id.* art. I.

77. Purdy & Macrory, *supra* note 16, at 19.

78. London Protocol, *supra* note 13, at 7-8.

79. *Id.* art. 4.1.1. The dumping of Annex I substances requires a permit. *Id*. art. 4.1.2.

80. *Id*. art. 1.4.3. "Sea" includes "seabed" and "subsoil thereof," but not "sub-seabed repositories accessed only from land." *Id.* art. 1.7. As in the London Convention, the definition of dumping excludes "placement of matter for a purpose other than the mere disposal thereof." *Id*. art. 1.4.2.2. The disposal or storage of materials associated with seabed mineral resource development continues to be expressly excluded from the provisions of the London Protocol, just as it is from the London Convention, however. *Id*. art. 1.4.3.

81. *Id.* arts. 3.1, 3.2. The "polluter pays" concept raises issues of long-term liability for sub-seabed sequestration that are beyond the scope of this article. The MPRSA provides for the assessment of civil and criminal penalties for violations of the Act. 33 U.S.C. § 1415 (2000).

> preventative measures are taken when there is reason to believe that wastes or other matter introduced into the marine environment are likely to cause harm even when there is no conclusive evidence to prove a causal relation between inputs and their effects.[82]

Following the "precautionary principle" in environmental decision-making requires anticipating environmental harm and taking action without waiting for scientific certainty as to the extent of the harm. It has been described as the doctrinal version of the old adages, "an ounce of prevention is worth a pound of cure," and "better safe than sorry."[83] As stated in the 1992 Rio Declaration on Environment and Development:

> [i]n order to protect the environment, the precautionary approach shall be widely applied by states according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation.[84]

The London Protocol's objective is protection of the marine environment from pollution, which is defined as any human activity that would "introduc[e], directly or indirectly . . . wastes or other matter into the sea which results or is likely to result in such deleterious effects as harm to living resources and marine ecosystems, [and] hazards to human health."[85] In light of the London Protocol's emphasis on precaution, it seemed probable that seabed sequestration of carbon dioxide undertaken for purposes other than facilitating offshore oil or gas development would be prohibited.[86]

In late 2006, however, the Annex I list of "wastes or other matter . . . that may be considered for dumping" was amended to add "carbon dioxide streams from carbon dioxide capture processes for sequestration."[87] In addition, a new section was added to Annex I, which reads:

> Carbon dioxide streams referred to in paragraph 1.8 may only be considered for dumping, if:
>
> 1 disposal is into a sub-seabed geological formation; and

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82. London Protocol, *supra* note 13, art. 3.1.

83. Carl Smith, *The Precautionary Principle and Environmental Policy – Science, Uncertainty, and Sustainability*, 6 INT'L J. OCCUP. ENVT'L HEALTH 263 (2000).

84. Rio Declaration on Environment and Development, June 4, 1992, Principle 15, 31 I.L.M. 874, 879.

85. London Protocol, *supra* note 13, arts. 1.10 & 2, 36 I.L.M. at 9.

86. Scott, *supra* note 42, at 107; Purdy & Macrory, *supra* note 16, at 38-39.

87. Protocol Amendment, *supra* note 14, ¶ 1.8.

> 2 they consist overwhelmingly of carbon dioxide. They may contain incidental associated substances derived from the source material and the capture and sequestration processes used; and
>
> 3 no wastes or other matter are added for the purpose of disposing of those wastes or other matter.[88]

The parties restate the 1996 London Protocol's objective ("protection and preservation of the marine environment from all sources of pollution") and do not amend those portions of the London Protocol adopting a precautionary approach, nor do they otherwise back away from that approach in the language of the resolution adopting the amendments.[89] The amendments are expressly restricted "solely to carbon dioxide sequestration in sub-seabed geological formations," due to "the implications for the marine environment of climate change and ocean acidification due to elevated concentrations of carbon dioxide in the atmosphere."[90] While "emphasizing the need to further develop low carbon forms of energy" and expressly noting that carbon sequestration "is but one option in a portfolio of options to reduce levels of atmospheric carbon dioxide, . . . that . . . should not be considered as a substitute to other measures to reduce carbon dioxide emissions" the parties "recogniz[e] [that] carbon dioxide capture and sequestration represents an important interim solution."[91]

The resolution to the amendment on its face applies a precautionary approach, noting the importance of carbon dioxide seabed sequestration as an interim solution, and expressing serious concern about the potential for damage to the world's oceans if the action were not taken. The contracting parties express a "desire to regulate the sequestration of captured carbon dioxide streams into sub-seabed geological formations to seek to ensure protection of the marine environment."[92] "Better safe than sorry," in this instance, translates into allowing seabed sequestration (although associated long-term risks of carbon dioxide release are not known with certainty).

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88. *Id*.
89. *Id*.
90. *Id.*
91. *Id.*
92. *Id.*

VII. U.S. LAW—THE MARINE PROTECTION RESEARCH AND SANCTUARIES ACT (MPRSA)

Because the United States has not ratified, or acceded to, the 1996 London Protocol,[93] it has not agreed to the 2007 Amendment permitting carbon dioxide sub-seabed geologic sequestration.[94] For the United States, then, it is the London Convention[95] and the federal MPRSA[96] that primarily govern the legality of carbon dioxide sequestration in the subseabed beneath U.S. territorial waters and the EEZ.[97] Unsurprisingly, the plain text of the MPRSA includes many of the same ambiguities as the London Convention with respect to its application to subseabed carbon dioxide sequestration.

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93. *See supra* note 13. Also, although the United States signed the 1992 Rio Declaration including Principle 15, it is risk assessment, not precaution, that is the predominant paradigm underlying current domestic environmental decision-making. Carolyn Raffensperger, Ted Schettler, & Nancy Myers, *Precaution: Belief, Regulatory System, and Overarching Principle*, 6 INT'L J. OCCUP. ENVT'L HEALTH 266, 267-68 (2000). In a nutshell:

> [r]isk assessment tries to determine how much harm we will tolerate. Precaution asks how much harm we can avoid. Precaution addresses uncertainty and the potential for major harm, even if it is not immediate. Risk assessment focuses on known, quantifiable hazards and often misses the big uncertainties.

Id. at 267.

94. *See* Purdy & Macrory, *supra* note 16, at 9 ("[i]n general, states are only bound to conventions to which they ratify or accede").

95. London Convention, *supra* note 49. It appears that the United States also has not acceded to or ratified the amendments to the London Convention that added "industrial waste" to the Annex I list. One can speculate that this was in part to avoid the need to amend the MPRSA, as the statutory definition of "industrial waste" is less broad than the (later) definition in the amended London Convention and is defined as "any solid, semisolid, or liquid waste generated by a manufacturing or processing plant." 33 U.S.C. § 1414b(k)(4) (2000). In comparison, the London Convention contains the revised definition of "industrial waste" as "waste materials generated by manufacturing or processing operations." Purdy & Macrory, *supra* note 16, at 21.

96. 33 U.S.C. §§ 1401-1445 (2000).

97. Initially, a portion of the Outer Continental Shelf Lands Act, 43 U.S.C. § 1331 (2000), seems applicable to subseabed sequestration research projects, as the Act encourages permissive "geological and geophysical explorations in the outer Continental Shelf." 43 U.S.C. § 1340(a)(1). One of the policy statements asserts that "the outer Continental Shelf is a vital natural resource reserve . . . which should be made available for expeditious and orderly development, subject to environmental safeguards, in a manner which is consistent with … other national needs." *Id.* § 1332(3). The term "explorations" is limited by the statutory definitions to "the process of searching for minerals." *Id.* § 1331(k). Thus, permission granted to "any agency of the United States and any person authorized by the Secretary" of the Interior to undertake such explorations does not allow research into the storage capability of the subseabed, unless it is linked to a search for oil, gas, or other minerals. *Id.* § 1340(a)(1).

The MPRSA's purpose is "to regulate the dumping of all types of materials into ocean waters and to prevent or strictly limit the dumping into ocean waters of any material which would adversely affect human health, welfare, or amenities, or the marine environment, ecological systems, or economic potentialities."[98] In this way, it generally reflects the 1972 London Convention.[99] Like the London Convention, the MPRSA prohibits the "dumping" of certain listed substances, and otherwise allows ocean dumping of other "material" provided a permit is obtained.[100] Also, like the London Convention, the MPRSA includes a list of factors that must be considered in the decision to grant a permit for ocean dumping.[101]

The MPRSA completely prohibits dumping "sewage sludge or industrial waste . . . into ocean waters" after December 31, 1991,[102] and no permit may be granted for the "transportation" of "radiological, chemical, and biological warfare agents, high-level radioactive waste, and medical waste" for the purposes of dumping into ocean waters.[103] But is carbon dioxide "industrial waste," so that it cannot be dumped? The MPRSA defines "industrial waste" as "any solid, semisolid, or liquid waste generated by a manufacturing or processing plant."[104] Read literally, carbon dioxide gas is not covered by this definition and it also can be argued that electricity production is neither "manufacturing" nor "processing," so carbon dioxide in any form produced by a power plant is not covered by the ban.[105] Also, carbon dioxide is not sewage sludge, or dredging waste;

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98. 33 U.S.C. § 1401(b) (2000).

99. Charles B. Anderson, *Ocean Dumping and the Marine Protection, Research and Sanctuaries Act*, 1 LOY. MAR. L.J. 79, 82, 84 (2002). The United States ratified the London Convention in September 1973, just months after the MPRSA was enacted.

100. 33 U.S.C. §§ 1412(a), 1414b (2000).

101. *Id.* § 1412(a)(A)-(I). The MPRSA required the Administrator of the U.S. Environmental Protection Agency to "establish and apply criteria for reviewing and evaluating [] permit applications." *Id.* § 1412(a). For EPA regulations, see 40 C.F.R. § 227 (2000).

102. *Id.* § 1414b(a)(1)(B).

103. *Id.* § 1412(a).

104. *Id.* § 1414b(k)(4). The definition excludes dredged material discharged by the U.S. Army Corps of Engineers or pursuant to a permit, and "any waste from tuna cannery operations located in American Samoa or Puerto Rico discharged pursuant to a permit." *Id.* § 1414b(k)(3)(A)&(B).

105. *See* Purdy & Macrory, *supra* note 16, at 21 (same argument with respect to London Convention definition). "Material" is defined very broadly in the MPRSA as "matter of any kind or description," which would certainly include carbon dioxide emitted by domestic power plants. 33 U.S.C. § 1402(c) (2000).

therefore it is "material" for which transportation and dumping is to be "regulate[d]."[106]

Is "sequestration" "dumping?" One relevant point is temporal, because the MPRSA excludes "placement . . . for purposes other than disposal."[107] Can sequestration accurately be described as anything other than intended permanent isolation of the carbon dioxide from atmospheric release? Avoiding climate impacts due to release of carbon dioxide into the atmosphere requires more than "storage."[108]

Additionally, "dumping" under the MPRSA is defined generally as "a disposition of material,"[109] and "material" means "matter of any kind."[110] "Disposition," moreover, is not defined in the Act, but suggests a sense of permanent isolation or disposal of the material. Merriam Webster offers: "the act or the power of disposing or the state of being disposed."[111]

However, it is "dumping into ocean waters" that is regulated, or prohibited in the case of industrial wastes, by the MPRSA.[112] Moreover, similar to the exclusion in the London Convention, the MPRSA excludes from the definition of "dumping" the "intentional placement of any device . . . on or in the submerged land beneath [ocean] waters" when such placement is "otherwise regulated by Federal or State law or occurs pursuant to an authorized Federal or State program."[113] This is MPRSA's only reference to the subseabed; with the definition of "ocean waters" limited to the water column and without reference to the sea floor, seabed, or subsoil underneath it.[114] While "dumping . . . material . . . into ocean waters,"[115] therefore, is prevented or strictly limited, some placements for purposes other than dumping are allowed.

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106. 33 U.S.C. § 1401(c).

107. *Id.* § 1402(f).

108. *See supra* text accompanying notes 2-6.

109. 33 U.S.C. § 1402(f) (2000).

110. *Id.* § 1402(c).

111. Merriam Webster, http://www.m-w.com/dictionary/disposition.

112. *See, e.g.*, 33 U.S.C. § 1401(a) (2000) (dangers of unregulated dumping "into ocean waters"); (b) (policy to regulate dumping of all types of materials "into ocean waters"); (c) (purpose of the Act is to regulate transport for the purposes of dumping the material "into ocean waters"); *see also* §§ 1411, 1412, 1413(a), 1414b(a)-(b), (referencing dumping "into ocean waters" or "into the territorial sea . . . or into a zone contiguous to the territorial sea of the United States").

113. 33 U.S.C. § 1402(f) (2000).

114. *Id.* § 1402(b). Ocean waters are "those waters of the open seas lying seaward of the base line from which the territorial sea is measured, as provided for in the Convention on the Territorial Sea and the Contiguous Zone." *Id.*

115. *Id.* § 1401(b).

Additionally, "device" also is not defined. Merriam Webster defines device as: "something devised or contrived: as a (1): plan, procedure, technique . . . (f): a piece of equipment or a mechanism designed to serve a special purpose or perform a special function."[116] Under this reading, the plan, procedure, technique, equipment, and mechanism for subseabed sequestration of carbon dioxide would be allowed if undertaken for a purpose other than "disposition" of the carbon dioxide.[117] It would seem that the MPRSA could be interpreted to allow the EPA to grant a permit for placement of carbon dioxide in the seabed if the purpose of the placement were "other than disposal" and if the emplacement is regulated by federal or state law or is part of a federal or state program. This interpretation, however, is far from straightforward.

Furthermore, the very limited relevant case law under the MPRSA's dumping ban tells a cautionary tale. In *Seaburn, Inc. v. U.S. EPA,*[118] the D.C. District Court upheld as "reasonable" the EPA's interpretation that the MPRSA's dumping ban prohibits intentional *indirect* placement into ocean waters of the residue or stack emissions from at-sea industrial waste incineration.[119] In *Seaburn*, a commercial waste disposal company challenged the EPA's decision, made in response to the MPRSA dumping ban, to cease reviewing the company's application for a permit to incinerate certain industrial wastes at sea when the by-products of the incineration were meant to enter ocean waters.[120] The *Seaburn* court noted, "neither the general prohibition . . . nor the definitional language . . . [of the MPRSA dumping ban] has a precise application to ocean incineration."[121] The court held that the EPA was reasonable in concluding that indirect placement of the byproducts of ocean incineration is prohibited "dumping" under the MPRSA's dumping ban, in light of Congress' "increasing awareness of

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116. Merriam Webster, http://www.m-w.com/dictionary/device.

117. *See supra* text accompanying notes 111-13. If seabed emplacement of carbon dioxide is not "dumping," therefore, then it does not matter whether carbon dioxide is an "industrial waste," since the ban is on "dumping" such waste into "ocean waters," or transporting it to be dumped. Although the Act does not define transportation, the Act outlines specific prohibitions "in the case of a vessel or aircraft registered in the United States or flying the United States flag or in the case of a United States department, agency or instrumentality," 33 U.S.C. § 1411(a)(2) (2000), suggesting that "transport" means "to transfer or convey from one place to another," including by pipeline. Merriam Webster, http://www.m-w.com/dictionary/transport.

118. 712 F.Supp. 218 (D.D.C. 1989).

119. *Id*. at 222-23.

120. *Id*. at 220-21.

121. *Id*. at 222.

environmental concerns," the broad definition of "material" contained in the MPRSA, and the fact that in the legislative history Congress asserted that it intended to preclude the EPA "from making after-the-fact determinations that a particular type of material could be dumped."[122]

Seaburn is cautionary not only because accidental or unintentional release of carbon dioxide from subseabed sequestration might arguably be analogous to indirect "dumping" into ocean waters,[123] but also because *Seaburn* suggests that the EPA cannot expand the concept of "materials" that can be "dumped" or "placed in the seabed." Congress must direct the Agency. Moreover, *Seaburn* demonstrates that statutory ambiguities are litigated, adding additional time to the period between the start of a program for subseabed sequestration and its realization.[124]

In order to facilitate an *in-situ* research program—and potentially the deployment of subseabed carbon sequestration—in the near-term, then, what must be done? Congress should, as part of the impending climate bills, include limited amendments to the MPRSA to allow this approach to be tested if and when an appropriate site is located. The amendments could insert language as limited as the language inserted into the London Protocol. Making these amendments part of climate change legislation, moreover, clarifies their purpose as climate mitigating and as part of an

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122. *Id.* (citing H.R. Conf. Rep. No. 1090, 100th Cong., 2d Sess. 24, 35 (1988)).

123. Indeed, *Seaburn* can be distinguished from accidental or incidental release cases because the incineration was *certain* to produce ash which would fall out on ocean waters; indirect "dumping" therefore was an intended outcome of the process for which Seaburn sought a permit. By contrast, experience to date in the North Sea suggests that there is little likelihood that the carbon dioxide will escape geologic sequestration, if the subseabed formation is adequate to the task.

124. Of course, issues are often litigated even where the underlying statute is unambiguous. *See supra* text accompanying notes 21-23 (discussing *Massachusetts v. EPA*). Where the statutory text is unambiguous, there is less likelihood of judicial deference to Agency decision-making under the doctrine of *Chevron, U.S.A. v. Natural Res. Def. Council. See, e.g., Seaburn*, 712 F.Supp. at 222 (quoting *Chevron*: "where the intent of Congress is clear, both the court and the agency 'must give effect to the unambiguously expressed intent of Congress.'") If ambiguity exists, reviewing courts are more likely to examine the legislative history to interpret whether the Agency action is consistent with the statute. The *Seaburn* court's reading that Congress intended that the EPA cannot expand the definition of "material" in new ways could cause a court to remand for interpretation of the EPA rules allowing subseabed sequestration, absent revisions to the MPRSA to remove the ambiguity. As there is currently no deadline for the issuance of such rules, the process under the current law could stretch out indefinitely. Unambiguous MPRSA provisions allowing subseabed emplacement, therefore, would certainly expedite the development of this opportunity. As subseabed sequestration is a near-term interim measure for use during the period when the economy moves toward less carbon-intense energy production, amending the statute now makes the most sense.

overall portfolio of actions. Congress should not miss the opportunity to remove the existing statutory ambiguity and allow this sequestration option. A precautionary approach to climate change requires it. Better safe than sorry.