Climate Change, Carbon Sequestration, and Property Rights

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CLIMATE CHANGE, CARBON SEQUESTRATION, AND PROPERTY RIGHTS

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ABSTRACT

This Article considers the role of property rights in efforts to transport, inject, and store underground hundreds of million of tons of carbon dioxide (CO₂) per year from power plants and other industrial facilities in order to combat dangerous climate change. This technology, known as carbon capture and sequestration (CCS), could provide deep emission cuts, particularly from coal power generation, on a worldwide basis. In order to implement CCS, private operators and state and federal governments must be able to access hundreds of millions of acres of “pore space” roughly a kilometer below the earth’s surface in which to store CO₂ for hundreds to thousands of years. Here, we explore questions relating to ownership of subsurface pore space, physical takings, regulatory takings, and just compensation that will necessarily accompany the implementation of CCS in the United States. We conclude that subsurface storage of CO₂ may result in a taking where the CO₂ storage interferes directly with existing or reasonably foreseeable economic uses of the subsurface. More often, however, because the public interest in addressing climate change is so strong, and the extent of interference with an owner’s expectations regarding actual use of the subsurface is so small, no taking will occur. In order to accommodate the full range of property rights and takings issues that will arise with CCS, we propose a regulatory framework based in part on the Natural Gas Act to address these issues in connection with subsurface CO₂ storage.

INTRODUCTION

In February 2009, President Obama signed the $787 billion economic stimulus package known as the American Recovery and Economic Reinvestment Act.¹ At that time, representatives from industry, government, and nonprofit groups in the energy and natural resources field focused immediately on the $80 billion in spending, loan guarantees, and tax incentives geared toward promoting energy efficiency, renewable energy, and new technologies to reduce emissions from the use of coal and other fossil fuels.² On its own, these investments constitute the biggest energy bill in history.³

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¹ American Recovery and Reinvestment Act (H.R. 1 2009).
Notably, this $80 billion includes $3.4 billion for carbon capture and sequestration (CCS) demonstration projects, an increase in federal support for this technology in the United States by 70 percent to over $8 billion.  

CCS involves capturing carbon dioxide (CO\textsubscript{2}) emissions, injecting them into deep geologic formations, and sequestering them underground for long periods of time. Areas for potential CO\textsubscript{2} sequestration include oil and gas fields, saline aquifers, and, potentially, deep coal seams. Natural geologic analogs, like geologic formations containing crude oil, natural gas, brine, and CO\textsubscript{2}, have proven storage capability for millions of years. CCS technologies would take advantage of these storage capacities to reduce CO\textsubscript{2} emissions to the atmosphere in an effort to combat climate change.

This Article considers the role of property rights in efforts to develop CCS. In an earlier Article, we discussed the potential environmental and tort liability associated with CCS. In that Article, we argued that existing environmental and tort liability could serve an important role within a federal framework of CCS regulation to ensure proper site selection and monitoring as well as provide compensation for harm to governments and private parties in case of harm from escaping CO\textsubscript{2}. We then proposed an adaptive governance model at the federal level for integrating several different compensation mechanisms, including bonding, insurance, and pooled federal funding, into commercial CCS project management to better provide financial security to investors without destroying existing liability protections for those who may suffer harm from CCS.

In this Article, we turn to property rights in the context of CCS. In order to implement CCS, private operators and state and federal governments must be able to access millions of acres of “pore space” roughly a kilometer below the earth’s surface in which to store the CO\textsubscript{2} for hundreds to thousands of years. Who currently owns that pore space? Are the rights vested in the owner of the surface lands above the pore space? What if the mineral rights have been severed and transferred to a third party, as is the case in many states where CO\textsubscript{2} storage is being proposed? Or does the federal government own the pore space because it is so far beneath the surface that neither the surface owner nor the mineral owner has ever had a reasonable expectation that it would make use of that space? If rights to the pore space are in fact vested in a surface owner or mineral owner, can the federal government exercise the power of eminent domain to implement CCS as a “public use” under the Fifth Amendment? If so, what constitutes

\footnotesize{\textsuperscript{3} Opinion, supra note 2.}
\footnotesize{\textsuperscript{5} See Sally Benson & Peter Cook, Underground Geologic Storage, in IPCC SPECIAL REPORT ON CARBON DIOXIDE CAPTURE AND STORAGE (Bert Metz et al. eds. 2005) (noting that in the Pisgah Anticline, near Jackson, Mississippi, 200 Mt of naturally occurring CO\textsubscript{2} is thought to have been stored for over 65 million years without leakage), available at http://www.ipcc.ch/pdf/special-reports/srcs/srcs_wholereport.pdf [hereinafter IPCC SPECIAL REPORT ON CARBON DIOXIDE CAPTURE AND STORAGE].}
\footnotesize{\textsuperscript{6} Alexandra B. Klass & Elizabeth J. Wilson, Climate Change and Carbon Sequestration: Assessing a Liability Regime for Long-term Storage of Carbon Dioxide, 58 EMORY L.J. 103 (2008).}
“just” compensation? If the government restricts private surface or subsurface use of property to protect the integrity of a nearby CO$_2$ storage basin, does that restriction constitute a regulatory taking giving the surface owner or mineral owner a right to just compensation?

Here, we explore these questions associated with subsurface property rights and CCS, reach some tentative conclusions, and provide some recommendations for policymakers and judges who undoubtedly will be forced to grapple with these questions as efforts to implement CCS move forward. Ultimately, Congress may legislatively declare that the federal government owns the subsurface pore space. If successful, this action would best ensure rapid deployment of CCS with minimal transaction costs involving pore space ownership issues. Such a legislative declaration, however, may be challenged by surface owners and mineral owners who would argue that such action constitutes a taking of private property that would require either voluntary transactions or eminent domain actions accompanied by just compensation. At least one scholar has argued against any private rights to the deep subsurface. The argument is that just as surface owners could no longer claim rights to the airspace far above their property after the advent of airplanes, surface owners and mineral rights owners can no longer assert rights to the deep subsurface in the face of cutting-edge technologies that would make real use of that subsurface for the public goal of combating climate change.\(^7\)

There is also, however, precedent in other areas such as natural gas storage that supports the idea that rights to the pore space that would be used for CO$_2$ in some areas of the country are vested in the surface owner, the mineral owner, or both. Moreover, Wyoming has already declared as a matter of statute that subsurface pore space ownership is vested in the surface owner, with a handful of states proposing similar legislation in 2009.\(^8\) Thus, existing and future creation or modification of subsurface property rights will inevitably be in at least some tension with federal policies attempting to implement CCS with minimal property acquisition costs.

As is evident from the discussion above, under any approach to pore space rights, a host of issues relating to property rights, eminent domain, and regulatory takings arise. This Article systematically analyzes these issues, looking to potential precedent in the areas of oil and gas development, underground waste injection, and subsurface natural gas storage. We conclude that while the federal government can make a legitimate claim to the pore space under some existing authority, other authority may well vest at least some limited property rights in some surface owners, mineral owners, or both. As a result, issues relating to takings and just compensation must remain an integral part of any prospective CCS regulatory regime.

Part I begins with an introduction to CCS technology, its potential role in addressing climate change on a global basis, recent federal, state, and industry efforts to promote CCS technology, and how implementation of CCS technology may intersect with

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\(^7\) See John Spranking, Owning the Center of the Earth, 55 UCLA L. REV. 979 (2008).

\(^8\) See infra notes 95-97 and accompanying text.
subsurface property rights.\(^9\) Part II discusses surface and mineral owner rights to the pore space. In this Part, we conclude that public policy and the most applicable precedent support the idea that surface and mineral owners have some rights in the pore space but that if the federal government creates a regulatory framework to promote CO\(_2\) storage in connection with combating climate change, such regulation could at least partially override existing private property rights in the subsurface. The extent of subsurface rights should be based on the extent to which the surface owner or mineral owner has made use of the pore space prior to the federal or state regulation, the reasonableness of any proposed future use, and the extent to which the storage of CO\(_2\) actually interferes with those pre-existing or reasonably-foreseeable uses. In all cases, CCS injection operators should be liable for any actual harm caused to surface or subsurface uses after injection, such as interference with groundwater access or harm to human health and the environment from CO\(_2\) releases.

Part III places the analysis of porespace rights in the context of takings jurisprudence. In this Part we explore more fully the extent to which CCS operations may result in either a physical taking or a regulatory taking. It is likely that implementation of CCS in some cases will result in a physical occupation of the subsurface pore space virtually in perpetuity. In those cases where a physical occupation interferes with actual or reasonably foreseeable private use of that same subsurface for oil and gas development or underground storage of natural gas or hazardous waste, it is likely that a court would find a per se physical taking and just compensation would be due. In cases, however, where the physical occupation of CO\(_2\) takes place far below any existing or reasonably-foreseeable competing uses, it is likely that no physical taking would occur.

In yet other situations, CO\(_2\) storage may not result in a physical occupation of the subsurface but may still modify, limit, or prohibit existing uses of that subsurface because of regulatory limits imposed to protect the integrity of a nearby CO\(_2\) storage reservoir. In those circumstances, courts would conduct a regulatory takings analysis that would balance the character of the government’s action, the severity of the economic impact, and the extent to which the regulation interferes with the property owner’s distinct, investment-backed expectations. Based on this analysis, we conclude that in most cases, actions to store CO\(_2\) to address climate change goals would outweigh most regulatory restrictions on nearby subsurface use, assuming such restrictions do not eliminate all economic value relating to the property owner’s surface and subsurface use.

Last, in Part IV, we consider a federal legislative proposal for CCS that would be similar to that used for natural gas pipelines and natural gas storage under the Natural Gas Act. This adapted structure would require the government or CCS operators to negotiate with surface owners or mineral rights owners if CCS operations physically interfere with existing, protectable property interests (or if regulation rises to the level of a taking) and, if negotiations break down, that eminent domain be authorized as a public use to obtain the subsurface pore space in question. This Part provides some preliminary

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\(^9\) In this Article, we concentrate our analysis on the “sequestration” part of CCS.
ideas on what this structure would look like, as well as a discussion of the issue of just compensation.

I. CLIMATE CHANGE, THE USE OF COAL, AND CCS

Concern over the potential effects of climate change continues to rise, making the issue a major focus among policymakers, nonprofit organizations, and industry worldwide. Scientists have concluded that immediate measures to control greenhouse gas (GHG) emissions are necessary to avoid “severe and irreversible changes to natural ecosystems,” and that impacts of climate change are likely to impose significant costs. These costs are related to potentially significant impacts on public health, agriculture, food supply, forests, ecosystems, biodiversity, coastal zones, sea levels, water resources, energy production and use, and public lands and recreation.

The election of President Barak Obama has already brought about significant changes in U.S. climate change policy. Until now, despite the growing body of scientific evidence linking GHG emissions, particularly CO\(_2\) emissions, and climate change, EPA refused to take any major action with regard to GHG emissions that would include mandatory caps on emissions. Although the Supreme Court in 2007, in Massachusetts v. EPA, directed EPA to either regulate GHG emissions from motor vehicles as an “air pollutant” under the Clean Air Act or provide a reasonable explanation for failing to do so, EPA failed to propose or enact any such regulations. Moreover, during the Bush Administration, EPA refused to allow California to set its own more restrictive limits on

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10 According to the Environmental Protection Agency (EPA), the term “climate change,” which is often used synonymously with the term “global warming,” refers to “any significant change in measures of climate (such as temperature, precipitation, or wind) lasting for an extended period (decades or longer).” See U.S. EPA, Climate Change, Basic Information, [hereinafter EPA, Basic Information].

11 See Massachusetts v. EPA, 127 S. Ct. 1438, 1455-56 (citing McCracken Aff. ¶ 5(d)); INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE (IPCC), SUMMARY FOR POLICYMAKERS 2-5, 10 (2007), available at [hereinafter IPCC, Summary for Policymakers].


13 See, e.g., James Salzman & David Hunter, Negligence in the Air: The Duty of Care in Climate Change Litigation, 102 U. PA. L. REV. 101, 102-03 (2007) (describing federal government’s failure to take meaningful action with regard to climate change as compared to the significant activity at the state and local levels); Ken Alex, A Period of Consequences: Global Warming as a Public Nuisance, Symposium: Climate Change Risk, 26A STAN. ENVTL. L.J. 77, 82-84 (2007) (describing federal government’s lack of response to global warming); J.R. DeShazo & Jody Freeman, Timing and Form of Federal Regulation: The Case of Climate Change, 155 U. PA. L. REV. 1499, 1517 & n.54 (2007) (describing state climate change initiatives as arising “against the background of a relative vacuum of policy responses at the federal level” and detailing the Bush Administration’s policy positions on the issue).


automobile tailpipe emissions to address climate change, as the state is authorized to do if it receives a federal waiver from EPA under the Clean Air Act.\textsuperscript{16}

Now, however, there have already been significant developments in U.S. climate policy. In January 2009, President Obama directed U.S. EPA Administrator Lisa Jackson to reconsider the agency’s prior decision denying California’s waiver request.\textsuperscript{17} At least seventeen states have adopted or are considering adopting the California standards, which would mean that granting the waiver would result in stricter limits on auto emissions in a significant portion of the country.\textsuperscript{18} Then, in February 2009, Jackson announced that she had directed her staff to review the latest scientific evidence and prepare documentation to act on the Supreme Court’s order in \textit{Massachusetts v. EPA} and prepare an “endangerment” finding under the Clean Air Act to determine whether to regulate CO\textsubscript{2} as a “pollutant.”\textsuperscript{19} Also in February 2009, Jackson stated that the agency would reconsider its policy that power plants and other industrial sources are not required under the Clean Air Act to control carbon dioxide emissions.\textsuperscript{20} Moreover, as part of the effort to address climate change, the economic stimulus package enacted in February 2009 contains $80 billion in spending and tax incentives for renewable energy, energy efficiency, and new coal and fossil fuel technologies.\textsuperscript{21} While it remains to be seen what the new climate change and energy policies will actually look like, the Administration’s focus on climate change, renewable energy, and more environmentally-friendly approaches to the use of existing fossil fuels is significant.

One important piece of the Administration’s plan to change the way we generate energy and deal with the associated emissions is the development of CCS technology. While CCS technology remains undeployed and contentious, it is a technology that could enable the continued use of fossil fuels in general, and coal in particular, while still allowing society to dramatically reduce accompanying greenhouse gas emissions. This Part discusses the potential role of CCS in combating climate change by significantly reducing CO\textsubscript{2} emissions from coal-fired power plants. Section A explains the current role of coal in providing electricity in the United States and worldwide and introduces the arguments for and against CCS as a means of continuing to use coal while reducing its harmful climate effects. Section B explains more precisely how CCS technology works, how it has been implemented to date, and the potential risks associated with CCS. Last, Part C explores how CCS implementation may come into conflict with existing


\textsuperscript{18} Id.


\textsuperscript{21} \textit{See supra} note 4.
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subsurface property rights and surveys existing federal and state legislation on that topic to date.

A. Electric Power, Industrial Sources, and Greenhouse Gas Emissions

Any potential solution to address climate change must focus on reducing greenhouse gas emissions from the electric power and industrial sectors. The U.S. electric power sector is responsible for roughly 41 percent of CO\textsubscript{2} emissions from fossil fuel combustion and 33 percent of total GHG emissions.\textsuperscript{22} More than 80 percent of the 2.4 billion metric tons of GHG emissions associated with the electric power sector each year are from coal-fired electric plants.\textsuperscript{23} Coal-fired electric power plants play an important role in our energy infrastructure, providing inexpensive base-load electricity generation, but reducing CO\textsubscript{2} emissions from these plants is both technically and politically challenging.\textsuperscript{24} Coal is plentiful in the United States\textsuperscript{25} and worldwide,\textsuperscript{26} and is inexpensive relative to other fuel sources.\textsuperscript{27} It is a key energy resource in countries like China, India, South Africa, and Germany, as well as in the United States.\textsuperscript{28}

Despite the Obama Administration’s focus on climate change, the fact remains that GHG emissions continue to increase as growing global energy demand is satisfied with coal-based electric power. Currently the United States emits roughly two billion tons of CO\textsubscript{2} per year from coal combustion in electric power plants.\textsuperscript{29} Fossil fuels are predicted to remain the


\textsuperscript{24} Electricity cannot be stored and must be generated to meet demand. Because electricity demand varies both throughout the day and across different seasons, plants typically are run as either base load or peaking plants. Base load generating plants are plants that run almost continuously. Typically, base load plants—traditionally nuclear or coal—are inexpensive to operate, but more expensive to build. See generally Stratford Douglas, Measuring Gains from Regional Dispatch: Coal-Fired Power Plant Utilization and Market Reforms, 27 ENERGY J. 119 (2006).

\textsuperscript{25} See ENERGY INFORMATION ADMINISTRATION (EIA), EIA COAL RESERVES DATA (1999), http://www.eia.doe.gov/cneaf/coal/reserves/chapter1.html.

\textsuperscript{26} Coal reserves are especially prominent in North America, Europe and Asia. See BP, BP STATISTICAL REVIEW OF WORLD ENERGY 2008 (2008), http://www.bp.com (follow “Reports and publications” hyperlink; then follow “Statistical Review of World Energy 2008” hyperlink).


\textsuperscript{28} See BP, supra note 26, at 36.

\textsuperscript{29} U.S. EPA, INVENTORY OF U.S. GREENHOUSE GAS EMISSIONS AND SINKS: 1990-2005, supra note 22, at 3-3; Tbl. 3.
“mainstay” in energy production for decades to come, in the U.S. and around the world, thereby steadily increasing atmospheric CO$_2$. More important, putting aside the use of coal-fired electric power in the United States, rapid growth in developing countries, particularly China and India, is significantly escalating CO$_2$ emissions. Since 2000, China has doubled its use of coal-fired power and is expected to represent over 70 percent of the growth in coal-fired power internationally over the next decades. 

Effectively dealing with climate change will require a fundamental transition in how societies throughout the world produce and use energy. Moreover, it is important to recognize that managing atmospheric concentrations of greenhouse gases is fundamentally different than stabilizing concentrations of traditional criteria air pollutants like sulfur dioxide (SO$_2$) or oxides of nitrogen (NO$_x$). Greenhouse gases have long atmospheric lifetimes—decades to hundreds of years—compared to hours or days for most criteria air pollutants. According to the United Nations Framework Convention on Climate Change, deep GHG emissions reductions—roughly 80 percent below today’s levels—will be necessary to stabilize atmospheric concentrations and avoid some of the most dangerous impacts from climate change. 

While many energy technologies are available to make near-term reductions in GHG emissions, it will be necessary to deploy a full portfolio of all available low-carbon technologies to address the immense scale of the cuts required to address climate change. CCS emerges as a potentially promising but contentious technology that could enable the continued use of cheap fossil fuels while still allowing society to dramatically reduce accompanying GHG emissions. This technology could be employed in upstream natural gas processing, industrial operations, and, importantly, to reduce CO$_2$ emissions from coal-fired electric generation.

32. Greenhouse gases include carbon dioxide, methane, nitrous oxide, and fluorinated gases. EPA, Basic Information, supra note 10.
33. See United Nations Framework Convention on Climate Change Art. 2, opened for signature May 9, 1992, 1771 U.N.T.S. 107, available at http://unfccc.int/resource/docs/convkp/conveng.pdf (“The ultimate objective of this Convention and any related legal instruments that the Conference of the Parties may adopt is to achieve, in accordance with the relevant provisions of the Convention, stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner.”). The United States is a signatory to the UNFCCC, but not to the later Kyoto Protocol, which establishes targets for greenhouse gas emission reductions.
The Intergovernmental Panel on Climate Change (IPCC) has written a comprehensive report on CCS technology. This report outlines sources of CO$_2$, capture technologies, transportation modes, and geologic storage and risks; covers economic potential and cost; and describes how CCS could fit within a larger GHG reduction effort. Ultimately, it concludes that CCS could play a significant role in lowering the overall costs of deep emissions reductions.

B. CCS Technology

CCS technology essentially assembles existing technologies which have been developed within the chemical, oil, and natural gas industries to capture and sequester large volumes of CO$_2$. CCS would capture CO$_2$ emissions, transport them, likely by pipeline, and inject the CO$_2$ into deep geologic formations roughly one kilometer below the surface. The goal is thus to avoid the atmospheric release of CO$_2$ by sequestering the captured CO$_2$ emissions deep underground for long periods of time (hundreds to thousands of years). CO$_2$ sequestration could take place in abandoned oil and gas fields, saline formations, and possibly deep coal seams. CO$_2$ injection takes place when CO$_2$ is forced into the rock matrix when the injection pressure exceeds the formation pressure. CO$_2$ will flow through and fill pore spaces in permeable layers in the rock matrix and be trapped from upward migration by less permeable rock layers. CO$_2$ will be sequestered...
either as a gas, a dense supercritical fluid, or a liquid. Depending on reservoir temperature and injection pressure, CO$_2$ will be less dense than the brine present in the reservoir in almost all circumstances except deep ocean subsurface sequestration.

Because injected CO$_2$ will initially be more buoyant than the waters in the geological formation, injected CO$_2$ will have the tendency to move both upwards and laterally within the subsurface. This behavior is important when considering subsurface property rights. Due to differences in site geology, subsurface CO$_2$ will behave differently at different sites. Importantly, after active injection of CO$_2$ ceases, over time CO$_2$ stored underground and trapped in the rock matrix will become more secure and less mobile as chemical and geochemical reactions dissolve CO$_2$ in formation waters and eventually convert it to minerals like calcium carbonate. Thus, an effective geologic sequestration site will keep large volumes of a buoyant fluid underground for centuries to millennia and effectively occupy the pore space in perpetuity.

Natural geologic analogs, like geologic formations containing crude oil, natural gas, brine, and CO$_2$, have proven that CO$_2$ can be stored underground for millions of years. CCS technologies would attempt to take advantage of these storage capacities to reduce CO$_2$ emissions to the atmosphere. Several CCS projects are underway in Norway, Algeria, and Canada and more are planned in the United States, China, Australia, and other European countries. There are currently four active CCS projects, each injecting roughly one million metric tons of CO$_2$ per year.

For example, the Dakota Gasification Company plant in Beulah, North Dakota captures and transports the CO$_2$ by pipeline over 200 miles and an international border to the Canadian Weyburn oil field for enhanced oil recovery.

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45 A supercritical fluid exists when a substance is above its critical temperature and critical pressure. When a fluid is at its critical point, it exists as a gas and liquid in equilibrium, giving it unique properties. See CRC HANDBOOK OF CHEMISTRY AND PHYSICS 6-39 (David R. Lide ed., 88th ed. 2008), available at http://www.hbcpnetbase.com/articles/06_20_88.pdf.

46 CO$_2$ is considered a supercritical fluid at temperatures greater than 31.1 degrees Celsius and 7.38 MPa (critical point). See id.


48 Karsten Pruess et al., Numerical Modeling of Aquifer Disposal of CO$_2$, 8 SOC’Y PETROLEUM ENGINEERS J. 49, 52–53 (2003); William D. Gunter et al., The Role of Hydrogeological and Geothermal Trapping in Sedimentary Basins for Secure Geological Storage of Carbon Dioxide, 233 GEOLOGICAL SOC’Y OF LONDON, SPECIAL PUBLICATION 129, 135 (2004) (asserting that mineralization with carbonates take just days where the same with silicates can take hundreds to thousands of years).

49 See THE INTERNATIONAL ENERGY AGENCY, CO$_2$ CAPTURE AND STORAGE R, D&D DATABASE, available at http://www.co2captureandstorage.info/search.php. Three current CCS projects capture and inject the CO$_2$ produced from natural gas production projects: Sleipner in the North Sea and Snøhvit in the Barents Sea inject deep below the seafloor CO$_2$ captured from produced natural gas; and In Salah, in Algeria, injects the captured CO$_2$ into a deep gas formation. The fourth project, in Saskatchewan, injects and monitors CO$_2$ for the Weyburn enhanced oil recovery project in Beulah, North Dakota.

pilot projects to store 1 million tons or more of CO₂ in various geologic formations across the country. As mentioned earlier, the 2009 American Recovery and Reinvestment Act will provide an additional $3.4 billion for CCS demonstration projects, increasing federal support for CCS by 70 percent to over $8 billion. A U.S. Department of Energy report estimates there is underground storage capacity of 3,500 billion metric tons across the U.S. and Canada for storing CO₂ and other greenhouse gases produced at power plants and other industrial sources. Thus, storage capacity could be significant when compared with the two billion tons of CO₂ emitted from coal-fired power plants annually in the United States. Some electric power industry representatives believe that CCS could reduce power plant emissions by one-quarter in 2030.

Although the idea of injecting CO₂ into the subsurface for the purpose of controlling GHG emissions may be new, the practice of injecting CO₂ into the subsurface for other purposes is not. For decades, oil producers have injected CO₂ into the subsurface to increase oil production from depleted fields. This process, known as “enhanced oil recovery” or EOR, is in widespread use in the Permian Basin in western Texas, where approximately 30 million tons of CO₂ are injected into the ground annually, resulting in a total of 600 million tons injected—though not stored for sequestration—in that area since 1985. These amounts, however, pale in comparison to the massive scale of injection required to implement CCS for climate change purposes, foreshadowing the property

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52 See supra note 4, and accompanying text.
54 See Klass & Wilson, supra note 6, at 112. See also EPA Proposed Rule, supra note 30, at 43496 (stating that worldwide “there appears to be significant capacity in subsurface formations both on land and under the seafloor to sequester CO₂ for hundreds, of not thousands of years.”).
56 Richard C. Maxwell et al., Oil and Gas 13–14 (8th ed. 2007) (discussing enhanced recovery technology); Steven D. Cook, Researchers Optimistic on Prospects for Successful Carbon Capture, Storage, DAILY ENV’T REP. (BNA) No. 94, at A-1 (May 16, 2007) (discussing the use of enhanced oil recovery in Texas as a current example of subsurface injection of CO₂). See also U.S. EPA, Using Class V Experimental Technology Well Classification for Pilot Geologic Sequestration Projects, UIC Program Guidance (UICPG #83) at 2 (Mar. 1, 2007) (“While injection of fluids, including CO₂ into the subsurface, e.g., for enhanced oil recovery (EOR) and enhanced gas recovery (EGR), is a long-standing practice, injection of CO₂ [for CCS] is an experimental application of this existing technology.”).
rights issues associated with CCS. Indeed, for CCS to have a real impact on climate change, individual projects must sequester millions of tons of CO\textsubscript{2} per year and keep the injected CO\textsubscript{2} underground for hundreds to thousands of years. Depending on the formation geology and the depth and permeability of the injection zone, sequestered CO\textsubscript{2} from a single project could potentially spread over tens to hundreds of square kilometers for a single project and subsurface pressure effects—affecting brine displacement—could be felt over even greater distances.

Despite its significant potential to have a real impact on climate change, like any technology, CCS is not without risks. These include the risks to human health and the environment associated with the unintended release of CO\textsubscript{2} into the atmosphere during the process of transporting CO\textsubscript{2} by pipeline to storage sites, the injection of CO\textsubscript{2} into the subsurface, or accidental leakage to the surface after injection is complete. This can result from problems associated with improper transportation, poor site selection, leaking wells, unanticipated problems with the subsurface geology in which CO\textsubscript{2} is injected, or a failure to properly monitor and manage CO\textsubscript{2} once it is injected into the subsurface. There are also climate risks associated with CCS. If CCS becomes a part of forthcoming state or federal CO\textsubscript{2} cap-and-trade systems, incorporating CCS into industrial operations will result in credits for reducing CO\textsubscript{2} through CCS technology. There is a risk, however, that if CO\textsubscript{2} injected into the subsurface prematurely leaked back into the atmosphere, this would limit the long-term climate benefit.

CCS has both its detractors and supporters within the environmental nonprofit community. Greenpeace released a report in May 2008 entitled “False Hope,” in which it contends that CCS wastes energy, creates unacceptable risks of leakage, is too expensive, undermines funding for sustainable solutions, carries significant liability risks, and cannot be implemented in time to avoid dangerous climate change. Greenpeace argues instead for investing in renewable energy technologies and increased energy efficiency that can begin to reverse climate change today. Other environmental nonprofit groups, however, such as Environmental Defense, Natural Resources Defense Council, World Resources Institute, and the Nature Conservancy, see CCS as a necessary mitigation solution to

\footnotesize{\bibliography{references}}
climate change.\textsuperscript{64} As one environmental nonprofit representative has stated, CCS “is a terrible idea that we desperately need.”\textsuperscript{65}

C. Potential Intersection of CCS and Subsurface Property Rights

For CCS to enable continued use of fossil fuels and simultaneous deep emission reductions, it must be widely deployed. To do this, the technology must be integrated into a larger industrial, legal, and regulatory scheme. Of key import are (1) the volume of the CO\textsubscript{2} to be injected—a 1,000 Megawatt coal-fired power plant produces roughly 4–6 million tons of CO\textsubscript{2} per year and the injected CO\textsubscript{2} will pool under a large area; (2) the fact that CO\textsubscript{2} will migrate in the subsurface and initially be more buoyant than the subsurface saline formation water; and (3) the need for injected CO\textsubscript{2} to remain in the subsurface for hundreds to thousands of years, effectively occupying the subsurface pore space in perpetuity.

Other economic uses of the subsurface—for water recovery, hydrocarbon production, natural gas storage, or liquid waste disposal—could coincide with subsurface CCS injection. Throughout the United States, subsurface activities vary extensively, as do depths of other economic interests and target CCS formations. Every CCS injection site will be geologically unique, and establishing an effective monitoring program will vary across geologic formations and across sites within a formation. Indeed, state legislators, particularly in oil and gas producing states, are attempting to write CCS legislation that best avoids conflict with other productive subsurface activities.\textsuperscript{66}

As an initial matter, subsurface formations with hydrocarbon reservoirs are often already well-characterized,\textsuperscript{67} and are often stacked within non-hydrocarbon bearing saline formations.\textsuperscript{68} The possibility of developing a CO\textsubscript{2} storage site above or below oil or natural gas reservoirs in use may have advantages in reduced characterization and possibly capital costs, but may also create potential interferences between projects.\textsuperscript{69} The potential subsurface impacts of CO\textsubscript{2} injection are varied. In a reservoir with active hydrocarbon resources, particularly natural gas, migrating CO\textsubscript{2} could mingle directly with the resource and require additional efforts to remove it. Soluble CO\textsubscript{2} can cause the

\begin{itemize}
\item \textsuperscript{64} Gabrielle Wong-Parodi et al., \textit{Environmental Non-Government Organizations’ Perceptions of Geologic Sequestration}, 3 ENVIRON. RES. LETT. 1, 4-7 (2008).
\item \textsuperscript{65} Id. at 3.
\item \textsuperscript{66} April Reese, \textit{Climate: States Moving to Clarify Landowners' Rights over CO\textsubscript{2} Storage Space}, GREENWIRE (Feb. 26, 2009) available at \url{http://www.eenews.net/} (noting that some states are also trying to write clauses in the legislation that protect existing resources and property interests). \textit{See also infra notes 95-99 and accompanying text (discussing state legislation)}.
\item \textsuperscript{67} Christine Doughty & Karsten Pruess, \textit{Modeling Supercritical Carbon Dioxide Injection in Heterogeneous Porous Media}, 3 VADOSE ZONE JOURNAL 837, 837 (2004).
\item \textsuperscript{68} Carl L. Brasso, \textit{Use of Solution – Mined Salt Caverns for the Disposal of Non-Hazardous Oil and Gas (NOW) Waste}, available at \url{http://ipec.utulsa.edu/Conf2001/brasso2_131.pdf}.
\item \textsuperscript{69} \textit{See IPCC SPECIAL REPORT ON CARBON DIOXIDE CAPTURE AND STORAGE, supra} note 5, at 234. (stating that the presence of CO\textsubscript{2} in the basin can lead to corrosion problems and can change the composition of oils such that plugging, erosion, and processing problems arise).}

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precipitation of carbonate minerals and associated plugging of pore space, potentially affecting the extraction efficiency for an existing natural gas facility. The pressure effects from the injection operation, particularly as more injection sites become operable in a basin, could potentially have adverse impacts on other injection operations such as injectibility, plume size and shape, and associated monitoring changes. Currently oil and natural gas operations operate wells at an average depth of 1720 and 1750 meters (5,600-5,700 feet), respectively, which is similar to the depths at which some CO\textsubscript{2} storage is proposed.

Hydrocarbon enterprises also produce large amounts of waste water that need to be disposed. When oil is produced it is mixed with water (an average of seven gallons of water produced for each gallon of oil), and the produced water must be separated and disposed of, usually by underground injection. In the United States, over 750 billion gallons of oil produced waters are injected into the subsurface each year through 154,000 injection wells. This volume of produced water corresponds to approximately the volume that 2 Gt of CO\textsubscript{2} would occupy at one kilometer depth, putting the practice plainly on the scale of future CO\textsubscript{2} storage operations. The waste is generally handled on site, with roughly one quarter of it being injected back into the oil producing formation, in part to help in the oil recovery process. Other operators inject into non-producing formations at varying depths where porous and permeable formations are present. Some inject below the hydrocarbon formation and others inject above it. In Texas, produced water is injected into non-producing formations varying in depth from approximately 300 to 3,000 meters (1,000 to 10,000 feet), with 60 percent of these wells a kilometer or more deep. Both the practice and scale of handling produced water are similar to the expected practices for injecting CO\textsubscript{2}.

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72 U.S. DEPT. OF ENERGY, ENERGY INFORMATION AGENCY, AVERAGE DEPTHS OF CRUDE OIL AND NATURAL GAS WELLS, available at http://tonto.eia.doe.gov/dnav/pet/pet_crd_welldep_s1_a.htm (depths listed were 2006 data).
74 Produced water is the industry term for brine that is extracted as part of oil or gas production.
76 Elizabeth J. Wilson et al., Regulating the Ultimate Sink: Managing the Risks of Geologic CO\textsubscript{2} Storage, ENVT. SCIENCE & TECH. Vol. 37 (2003).
77 See IPCC SPECIAL REPORT ON CARBON DIOXIDE CAPTURE AND STORAGE, supra note 5, at 212.
78 Puder et al., supra note 75, at 13.
80 Melissa Pollack, Informal Survey of approximately 2% of Active Class II UIC wells in Texas, Texas RRC Online Oil and Gas Data Query System, available at
Underground natural gas storage is another area where CCS use of the subsurface may result in conflict. Underground natural gas storage has helped balance supply and demand fluctuations around the globe for nearly 100 years and is thought to be a useful analog for storage of CO$_2$. Just like for storage of CO$_2$, depleted hydrocarbon fields and saline aquifer formations are commonly used for natural gas storage. Because injected CO$_2$ is readily mixed with natural gas, were natural gas storage and CO$_2$ storage projects operated in close proximity within the same basin, the two substances may mingle and degrade the quality of the natural gas.

Today there are roughly 133 operators storing millions of cubic feet of natural gas through a series of roughly 300,000 wells in the United States, with 240,000 million cubic feet of that in salt caverns.

In addition, long-standing and new uses of the subsurface for activities wholly unrelated to hydrocarbon production may take place in formations and depths similar to CO$_2$ storage. UIC Class I waste injection wells, for example, aim to inject far below the lowermost underground source of drinking water and in basins where the freshwater is protected from the injection zone by an impermeable caprock or confining layer, much like what would be used for CO$_2$ storage. Injection zones typically range from slightly over 500 meters to more than 3,000 meters in depth. There are roughly 550 Class I wells in the United States, mostly located in the Gulf Coast and Great Lakes regions. While approximately 50 percent of the Class I wells are for non-hazardous waste, another 30 percent of the wells are dedicated to municipal wastewater disposal in Florida alone. The EPA recently changed its guidelines for Class I wells for Florida waste waters to prevent adverse effects from the noticeable upward migration of the disposed waters into underground sources of drinking water.

Finally, compressed air storage and aquifer storage and recovery have both become increasingly attractive technologies which use the subsurface. Compressed air storage could help to manage the intermittency of large-scale wind produced energy. Wind energy that would otherwise flow to the electric grid is used to compress air that is then pumped and stored in deep geologic reservoirs for later use. A compressed air storage operation in Germany has been compressing roughly 300,000 m$^3$ of air in a natural gas...
storage reservoir roughly 600-800 meters below the surface.\textsuperscript{88} Additionally, Battelle lab has suggested future United States compressed air storage projects be located in formations roughly 650 to 850 meters below the surface and at least 100 meters away from any dissimilar geologic formation.\textsuperscript{89} Aquifer storage and recovery involves injecting water into deep underground reservoirs for later retrieval.\textsuperscript{90} The subsurface formation essentially acts as a “water bank” for future withdrawals.

Thus, there is the real potential for CCS operations to interfere with actual or reasonably-foreseeable uses of subsurface pore space and, consequently, subsurface property rights. At the current time, there is very little federal or state statutory authority governing subsurface property rights issues in the context of CCS and many of these activities are managed within different federal and state agencies. The federal Safe Drinking Water Act (SDWA) gives the U.S. Environmental Protection Agency (EPA) authority to manage the underground injection control (UIC) program, which regulates underground injection activities and enhanced oil recovery but not natural gas storage.\textsuperscript{91} The EPA has determined that its authority under the UIC program confers the authority to regulate geologic sequestration of CO\textsubscript{2}.\textsuperscript{92} In July 2008, the EPA released for comment a draft CCS-specific rule under the UIC program.\textsuperscript{93} The proposed rule includes provisions on site characterization, well construction and operation, post-injection monitoring, and post-closure care. EPA has stated, however, that the SDWA does not give the agency any authority to address CCS-specific property rights concerns and thus these issues are not addressed by the new rule.\textsuperscript{94}

Recently, several states have also begun to develop regulatory frameworks to manage geologic sequestration of CO\textsubscript{2} with increasing attention to the issue of pore space ownership. As shown in Table 1, Wyoming is the only state that has passed legislation explicitly defining pore space ownership but several other states, including Montana, North Dakota, New Mexico, and West Virginia, have proposed similar legislation.\textsuperscript{95} Wyoming H.B. 89 addresses property rights by stating that “[t]he ownership of all pore space in all strata below the surface lands and waters of this state is declared to be vested

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\textsuperscript{91} 40 C.F.R. §§ 144-146.


\textsuperscript{93} 73 Fed. Reg. 43,491-43,541 (July 25, 2008).

\textsuperscript{94} Id.

\textsuperscript{95} See Wyoming H.B. 89; W.S. § 34-1-152; Montana S.B. 66; North Dakota S.B. 2319; New Mexico S.B. 208; West Virginia S.B. 396 and H.B. 2860.
in the several owners of the surface, above the strata.”

In 2009, the Wyoming governor signed into law H.B. 57, which amends the pore space provision in H.B. 89 and clarifies that the mineral estate is still dominant over the surface estate. This assignment of subsurface property rights in Wyoming—and perhaps in other states in the future—has the potential to create a direct conflict between state subsurface property interests and any future federal or state efforts to facilitate the widespread underground storage of CO₂. The number of states moving to adopt similar legislation has recently increased considerably as legislators anticipate future carbon limits and try to settle potential property rights disputes to create a more stable environmental for future project development. The nature of subsurface property rights in general and the potential conflict between state-created subsurface property rights and future federal policies are discussed below in Parts II and III.

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96 Wyoming H.B. 89; Wyo. Stat. § 34-1-152.
Table 1: Existing State CO₂ Sequestration Policies

<table>
<thead>
<tr>
<th>State</th>
<th>Policy</th>
<th>Year</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kansas</td>
<td>HB 2419</td>
<td>2007</td>
<td>Requests agency establish rules for CO₂ storage. Creates fund to pay for regulatory costs, remediation, long-term stewardship.</td>
</tr>
<tr>
<td></td>
<td>KAR 82-3-1100-120</td>
<td></td>
<td>Sets requirements for CO₂ storage facility operating permits.</td>
</tr>
<tr>
<td>Massachusetts</td>
<td>SB 2768</td>
<td>2008</td>
<td>Instructs agency to set sequestration definitions and standards.</td>
</tr>
<tr>
<td>New Mexico</td>
<td>EO 2006-69</td>
<td>2006</td>
<td>Requires agency to study statutory and regulatory requirements for CO₂ storage.</td>
</tr>
<tr>
<td>Oklahoma</td>
<td>SB 1765</td>
<td>2008</td>
<td>Declares CO₂ a commodity. Creates a task force to make recommendations on CCS. Also declares that “the capture, recovery and geologic storage of carbon dioxide will benefit the citizens of this state.”</td>
</tr>
<tr>
<td>Washington</td>
<td>ESSB 6001</td>
<td>2007</td>
<td>Directs agency to set rules for CO₂. Specifies that CO₂ storage can be used to meet GHG emission reduction goals.</td>
</tr>
<tr>
<td>Wyoming</td>
<td>HB 89</td>
<td>2008</td>
<td>Declares pore space the property of surface owner.</td>
</tr>
<tr>
<td></td>
<td>HB 90</td>
<td>2008</td>
<td>Agency to propose rules for CO₂ storage permitting, no set date. Working group to recommend financial assurance and post closure care requirements by September 30, 2009.</td>
</tr>
<tr>
<td></td>
<td>HB 57</td>
<td>2009</td>
<td>Amends HB 89 by establishing mineral rights primacy and indicating mineral owners may prevent CO₂ projects that interfere with their rights.</td>
</tr>
<tr>
<td></td>
<td>HB 58</td>
<td>2009</td>
<td>States that the injector owns and is legally liable for the CO₂ during operation.</td>
</tr>
</tbody>
</table>

II. Subsurface Pore Space Rights

There is little dispute that, subject to reasonable regulation, the surface owner of property has significant rights to use her property as she sees fit and, just as important, has the right to exclude others from making use of her property. If the state or federal government wishes to use that property, take that property, or allow other private parties to use or take that property for a public purpose, the government can do so by virtue of its

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Thus, the question arises as to how far up into the sky and down into the earth do those rights extend? Most law students in their first year property course are taught the maxim “cujus ejus est usque ad coelum et ad infernos” (translated as “the rights of the surface owner extend upwards to the heavens [ad coelum] and downward to the center of the earth [ad infernos]). Students are also taught, however, that with the advent of air travel in the 1930s, courts did away with the “ad coelum” doctrine with regard to ownership of airspace high above the ground. But what of the doctrine’s continued application to the subsurface far below the ground?

This is the question we turn to in this Part. Although the law is now fairly clear on the limits of the surface owner’s rights to airspace, the law is not nearly so clear with regard to the surface owner’s rights to the subsurface. Section A provides a brief history of the “ad coelum” doctrine and how courts modified the doctrine with regard to airspace after the rise of air travel in the early 20th century. Sections B and C analyze case law in the areas of oil and gas development, underground waste injection, and subsurface natural gas storage to show the different approaches courts have taken to the issue of subsurface ownership. These cases show that courts have taken a fairly nuanced approach to subsurface property rights, rejecting many claims for technical trespass, recognizing rights to recover for actual damage or interference with use, and requiring payment for the permanent, physical occupation of the subsurface in some instances but not in others. Thus, instead of vesting absolute ownership of the subsurface in one party or another, courts appear to allow use of the subsurface pursuant to regulation in the public interest (by either the government or private parties) without requiring compensation for surface owners or mineral owners unless that use interferes with actual uses or development of the same area. In these cases, however, the courts are clear to leave open the possibility of requiring payment of just compensation or damages in cases where the subsurface activity in question interferes with actual or reasonably-foreseeable use of the subsurface or results in actual harm to surface or subsurface properties.

A. Breaking Apart the “Ad Coelum” Doctrine from the Top Down

With regard to airspace, until the early part of the 20th century, courts and commentators continued to invoke the ad coelum doctrine, stating that common law ownership of land “extended to the “periphery of the universe.” These statements, even in dicta, however, were put to rest with regard to airspace with the Supreme Court’s 1946

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100 See infra Part III.
101 United States v. Causby, 328 U.S. 256, 260-61 (1945) (“It is ancient doctrine that at common law ownership of the land extended to the periphery of the universe—Cujus est solum ejus est usque ad coelum.”) (citing 1 COKE, INSTITUTES, ch. 1, § 1(4a) (19th ed. 1832); 2 BLACKSTONE, COMMENTARIES 18 (Lewis ed. 1902); 3 KENT COMMENTARIES 621 (Gould ed. 1896)). See also John Sprankling, Owning the Center of the Earth, 55 UCLA L. REV. 979, 1000 (2008) (American courts repeatedly advanced this expansive view of airspace rights—until the invention of the airplane sparked litigation, especially in the 1930s.).
decision in *United States v. Causby*.\(^{102}\) In that case, the Court found that the plaintiff farmers could recover just compensation for a taking of an easement on their farm by the federal government’s frequent low-level military flights over the farm which significantly interfered with their use and enjoyment of land and destroyed their ability to continue to use the property as a commercial chicken farm.\(^{103}\) In reaching that decision, however, the Court contrasted the interference caused by the low-level flights at issue in the case with the general principle that the ad coelum doctrine “has no place in the modern world.”\(^{104}\) Instead, “[t]he air is a public highway” and “private claims to the airspace would clog those highways, seriously interfere with their control and development in the public interest, and transfer into private ownership that to which only the public has a just claim.”\(^{105}\)

The Court then made some attempt to distinguish between a landowner’s protectable property interest in the airspace above the surface of his or her lands and the “public highway” above. The Court recognized that to have full enjoyment of the land, a landowner “must have exclusive control of the immediate reaches of the enveloping atmosphere” or else he or she could not plant trees or construct buildings or fences.\(^{106}\) Thus, a landowner owns as much space above the ground as he or she “can occupy or use in connection with the land.”\(^{107}\) Even if the landowner doesn’t actually occupy that space by erecting a building, the intrusion by an airplane or another structure, even if it didn’t touch the surface, “is as much an appropriation of the use of land as a more conventional entry upon it.”\(^{108}\) As regards airplanes, the Court held that an airplane flight over land is lawful unless it is at such a low altitude as to interfere with “then existing use to which the land or water, or the space over the land or water, is put by the owner.”\(^{109}\) The Court concluded this discussion by noting that the airplane is “part of the modern environment of life,” the inconveniences it causes are not normally compensable under the Fifth Amendment, and the airspace (apart from that immediately above the land) is part of the “public domain.”\(^{110}\)

The Court expressly declined to determine the precise line that divided the public domain of airspace from its lower reaches that were within the realm of private property. Instead, it held simply that flights over private land are not a taking “unless they are so low and frequent as to be a direct and immediate interference with the enjoyment and use of land.”\(^{111}\) Thus, *Causby* and subsequent cases involving airspace rights\(^{112}\) show that

\(^{102}\) 328 U.S. 256 (1945).

\(^{103}\) *Causby*, 328 U.S. at 259, 265.

\(^{104}\) *Id.* at 261.

\(^{105}\) *Id.*

\(^{106}\) *Id.* at 264.

\(^{107}\) *Id.*

\(^{108}\) *Id.* at 264-65.

\(^{109}\) *Id.* at 266.

\(^{110}\) *Id.*

\(^{111}\) *Id.*
once there developed a significant use of airspace in the public interest, courts quickly modified the ad coelum doctrine to limit a landowner’s protectable property interests to that part of the airspace in actual or reasonably-foreseeable future use and to eliminate takings claims for use of airspace except in cases, like *Causby*, where there is “a direct and immediate interference with the enjoyment and use of land.”

**B. Looking for Precedent: Ownership of Space versus Ownership of Resources**

Notably, the courts have taken a similar path when it comes to subsurface rights, although the case law in this area is much more complicated than that involving airspace. This complication arises from two primary factors. The first complicating factor is that unlike airspace rights, subsurface rights have been carved up, conveyed, used, bought, sold, and developed by parties and federal and state governments since nearly the founding of the country, resulting in ownership, use, and exploitation of the subsurface in a manner far more tangible than ever existed for airspace rights. The second complicating factor is that unlike the airspace cases where there was only one “public interest”—national airspace travel—competing against surface interests, with the subsurface cases, the surface owners’ rights come up against multiple competing rights in the public interest such as oil and gas development, subsurface groundwater use, underground injection of hazardous waste, and underground natural gas storage. All of these competing uses of the subsurface are arguably in the public interest, they often conflict with each other, and all are subject to a federal or a state regulatory system designed to promote one or more public interests.

Because of these differences, it is helpful to see how courts have analyzed subsurface rights to pore space in three primary types of situations: (1) regulatory creation of unitized oil fields and enhanced oil recovery that interferes with neighboring subsurface rights; (2) regulatory approval for subsurface waste injection; and (3) regulatory approval for subsurface natural gas storage. Each of these situations shows courts balancing private surface interests, private subsurface interests, and the public interest in various ways based on the resource or use at issue.

These situations, like CO₂ storage, differ from the numerous judicial decisions involving subsurface water rights, oil and gas rights, hard-rock mining rights, or coal-bed methane (CBM) gas ownership, which are the other categories of subsurface rights that are regularly litigated today. In all of these situations, courts are called upon to resolve disputes over who is entitled by common law, statute, or contract (in the case of a

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112 *Id.*; United Masonry v. Jefferson Mews, Inc., 237 S.E.2d 171, 181 (Va. 1977) (stating that the common law ad coelum doctrine “has been modified so that now the landowner is generally held to own only that amount of airspace he can reasonably use”).

113 *Id.*

114 For a succinct discussion of how courts have historically resolved ownership disputes in each of these areas, see Sprankling, *supra* note 7, at 1005-13; Elizabeth J. Wilson & Mark A. de Figueiredo, *Geologic Carbon Dioxide Sequestration: An Analysis of Subsurface Property Law*, 36 ELR 10114, 10116-10118 (2006).
conveyance or reservation of mineral or oil and gas interests) to own, extract, or develop a valuable resource. For instance, subsurface water rights require the resolution of multiple and competing claims to a finite and valuable resource—water—that is subject to a complex regulatory regime that differs from state to state, depending on the water availability and needs of that state.\(^\text{115}\) In the CBM cases, courts are called upon to determine whether the surface owner, coal owner, or natural gas owner has the right to develop and sell CBM gas under government land patents or private conveyance documents that did not anticipate the technology that has recently created a commercial use for CBM gas.\(^\text{116}\) Thus, instead of involving the use of space in the subsurface, these

\(^{115}\) See McNamara v. City of Rittman, 838 N.E.2d 640, 646 (Ohio 2005) (holding that landowners have a property interest in the groundwater underlying their land and governmental interference with that right can be an unconstitutional taking based in part on Ohio’s “unique water resources and water needs”); West Maricopa Combine, Inc. v. Arizona Dept. of Water Resources, 26 P.3d 1171 (Ariz. Ct. App. 2001) (holding that statutorily-authorized diversion of water over private property was not a government taking or trespass based in part on the fact that “Arizona is an arid desert” and has a “policy predating statehood that encourages the full and beneficial use and scarce water resources.”); South West Sand & Gravel, Inc. v. Central Arizona Water Conserv. Dist., __ P.3d __, 2008 WL 4837693 (Ariz. Ct. App., Nov. 10, 2008) (holding that water district’s right to divert water into a river abutting company’s land was not limited by doctrine of non-injurious use, company did not have power to preclude district from diverting water into the river, and company could not prevail on claims for negligence, trespass, nuisance, or inverse condemnation); County Commissioners v. Park County Sportsmen’s Ranch, 45 P.3d 693 (Colo. 2002) (holding landowners did not have a property right under the ad coelum doctrine to require that ranch obtain their consent before recharging aquifer, ranch was not required to pay compensation, and basing decision on the “Colorado doctrine” which established that water is a public resource; the right to water includes the right to cross the land of others; and natural, water-bearing formations within the state may be used for the transport and retention of water); Alameda County Water Dist. v. Niles Sand and Gravel Co., 112 Cal. Rptr. 846 (Ct. App. 1974) (denying excavation company’s claim for inverse condemnation against water district on grounds that flooding of excavation pit under district’s water replenishment program constituted a taking of property and discussing California’s rejection of the ad coelum doctrine based on the “realities of the underground water situation in California” and its replacement with the “correlative rights doctrine” which limits the rights of each surface owner to reasonable use of percolating waters in correlation with those of other users); State v. Michaels Pipeline Construction Co., 217 N.W.2d 339 (Wis. 1974) (rejecting doctrine of correlative rights because water is not scarce in Wisconsin and adopting “reasonable use” rule, which places no restrictions on the taking of groundwater so long it is used in a reasonable and beneficial manner on the extractor’s land). See also REST. (SECOND) OF TORTS § 858 (stating a landowner who withdraws groundwater from the land and uses it for a beneficial purpose is not liable for interference with the use of water by another unless the withdrawal unreasonably causes harm to neighboring landowners by lowering the water table or reducing pressure, the withdrawal exceeds the landowner’s reasonable share of the annual supply or total supply of groundwater, or the withdrawal of groundwater has a direct and substantial effect upon a watercourse or lake and unreasonable causes harm to a person entitled to use of its water); Wilson & de Figueiredo, supra note 114, at 10117 (discussing various doctrines states have created to resolve property rights disputes over groundwater, including the absolute dominion doctrine, reasonable use doctrine, correlative rights doctrine, restatement rule, and prior appropriation doctrine). See also JOSEPH L. SAX ET AL., LEGAL CONTROL OF WATER RESOURCES 364-65 (3d ed. 2000) (summarizing the different legal regimes that states apply to groundwater rights).

\(^{116}\) See Amoco Production Co. v. Southern Ute Indian Tribe, 526 U.S. 865, 878 (1999) (holding that surface owner, not tribe holding equitable title to reserved coal in lands patented under Coal Lands Acts of 1909 and 1910, owned CBM gas contained in the coal based in part on grounds that Congress did not “appear to have given consideration to the possibility that CBM gas would one day be a profitable energy source developed on a large scale.”); Newman v. RAG Wyoming Land Co., 53 P.3d 540 (Wyo. 2002)
cases involve the use of valuable resources to be taken from the subsurface for commercial gain. Both the subsurface water cases and the CBM and other mineral rights cases involve disputes over ownership of a valuable commodity found within the subsurface rather than disputes over ownership of the subsurface itself which can be used to store either a waste product (like the underground waste injection cases) or a valuable commodity (like the natural gas storage cases). Said another way, both the subsurface pore space below and the airspace above provide valuable space for competing uses such as airplanes and buildings above and oil, gas, water, and CBM below. As a result, the cases focusing on ownership of the space for the resource, commodity, or development are more helpful than cases focusing on ownership of the resource, commodity, or development itself. Accordingly, we put aside the subsurface water, CBM, and mineral rights cases and focus in the next Section on judicial decisions in the areas of oil and gas development, underground waste injection, and subsurface natural gas storage.

C. “Absolute” Ownership of the Subsurface Meets the “Public Interest”

In cases involving enhanced oil recovery, subsurface waste storage, and natural gas storage, courts have modified the ad coelum doctrine and limited surface owner rights to recover for trespass or to establish a taking as a result of federal or state regulation authorizing the invasive activity at issue to promote the public interest. It is not a stretch for future courts to look to these cases for guidance in determining whether the rights of surface owners to the deep pore space beneath the surface should be similarly modified in favor of allowing use of that pore space to store CO$_2$ to address climate change, at least in cases where that storage does not adversely impact the existing use and enjoyment of that space by the surface owner or, in the case of split-estate land, the mineral owner.\footnote{Recent white papers and articles have analyzed whether, in the first instance, the surface owner or the mineral owner on split-estate land has property rights in the pore space. While most of these papers and articles conclude that the surface owner would prevail over the mineral owner in most cases, the issue is far from resolved. See David Cooney, \textit{Analysis of Property Rights Issues Related to Underground Storage Space Used for Geologic Sequestration of Carbon Dioxide, IOGCC Task Force on Carbon Capture and Geologic Storage, Subgroup of State Oil and Gas Attorneys} (2007); Wilson & de Figueiredo, \textit{supra} note 114, at 10121-22 (stating that most courts have held that after the removal of underground minerals, oil, or gas, the surface owner retains the right to use the remaining space for storage but that mineral rights holders often retain some rights to access the pore space for continued exploration or extraction of minerals in other areas); Owen L. Anderson, \textit{Geologic CO$_2$ Sequestration: Who Owns the Pore Space}, 2008 Randolph Lecture, University of Wyoming College of Law (April 14, 2008) (stating that Texas and other jurisdictions have not specifically determined who owns subterranean pore space as between a mineral owner and a surface owner but, based on existing case law and legal doctrine, the most “likely” owner of the pore space is the surface owner).} If courts addressing disputes over pore space rights for CO$_2$ storage follow this line of
cases, the government (or private parties with the right of eminent domain in connection with CCS) would be liable for trespass or be required to provide just compensation for use of the pore space under takings law only if use of the pore space for CO₂ storage actually interfered with existing or reasonably-foreseeable uses of the subsurface.

1. Oil and gas operations: secondary oil recovery and field unitization

For decades, oil producers have injected fluids into the subsurface to increase oil production from depleted fields. This process, known as “secondary recovery” repressurizes the reservoir and can significantly increase oil and gas recovery. Secondary recovery can also result in migration of injected fluids to a neighboring oil and gas lease, affecting that owner’s ability to recover the resource. Most secondary recovery activities take place in a field that has been “unitized,” pursuant to state regulatory board orders. With “field unitization,” the oil or gas leases for development are combined and production and profits are shared by the unit members. For those areas that are not unitized or where neighboring owners have not joined the unit, trespass claims and other disputes arise when secondary recovery operations invade those oil and gas leases that are not part of the unit.

For the most part, courts have rejected claims for trespass in these cases on grounds that secondary recovery is authorized by state regulation, results in the most efficient recovery of the resource, and is therefore in the public interest. For instance, in Railroad Commission of Texas v. Manziel, the Texas Supreme Court in 1964 rejected a trespass claim by a mineral owner against the Texas Railroad Commission for its approval of a secondary recovery project where the injection of salt water could potentially migrate across the property lines and damage the plaintiff’s producing well. In dismissing the claim, the court did not determine whether the injecting operator would be liable for actual damages to the adjoining property or whether the Commission’s authorization of such secondary recovery operations would instead throw “a protective cloak” around the injecting operator. Instead, the court decided only the question of “whether a trespass is committed when secondary recovery waters from an authorized secondary recovery project cross lease lines.” On that question, the court found that the “orthodox rules and principles applied by the courts as regards surface invasions of land may not be appropriately applied to subsurface invasions as arise out of the secondary recovery of natural resources.” To apply the general rules of surface invasions would interfere with the public policy considerations behind secondary recovery operations which, the court found, should be encouraged as a matter of “public necessity.”

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118 See RICHARD C. MAXWELL ET AL., OIL AND GAS 13-14 (8th ed. 2007) (discussing enhanced oil recovery technology).
119 361 S.W.2d 560 (Tex. 1962).
120 Manziel, 361 S.W.2d at 568-69.
121 Id. at 566-67.
122 Id.
123 Id. at 568.
124 Id.
The Alabama Supreme Court reached a similar decision in *Phillips Petroleum Co. v. Stryker*, where secondary recovery through injection of dry gas within a unitized oil and gas field allegedly drained the plaintiff’s oil reserves. In reversing a jury award of $26.9 million to the plaintiff based on claims of trespass, negligence, fraud, and nuisance, the court found that to hold the defendant liable in the case would be against the state’s policy to promote secondary recovery in order to prevent oil and gas waste. Instead of suing for damages, the plaintiff should have engaged in his own recovery operations or sought to participate in the unit.

The Louisiana Supreme Court has similarly allowed the public interest in field unitization to trump any absolute property rights. In *Nunez v. Wainoco Oil & Gas Co.*, the court rejected a landowner’s trespass claim against a well operator where the operator drilled a well that allegedly bottomed out on the plaintiff’s property two miles below the surface. Notably, the plaintiff’s property was within a drilling unit created by the Commissioner of Conservation but the plaintiff had declined to lease his land to the defendant that had received approval for the unit. In rejecting the trespass claim, the court recognized that Louisiana law historically allowed claims of subsurface trespass where a well bottoms out on the land of another without his or her consent. Here, though, the court found that the state’s creation of the Conservation Commission and the state policy to ensure that “an irreplaceable natural resource should not be subjected to avoidable waste” created “a qualification of sorts in one’s rights in private property.” In light of these statutory developments and the current regulatory structure favoring unitization as the method to reconcile the correlative rights of resource owners in a common pool, the court found there was no legally actionable trespass in the case.

The Texas Supreme Court again addressed the ability of a mineral owner to sue for trespass as a result of secondary recovery operations in 2008. In *Coastal Oil & Gas Corp. v. Garza Energy Trust*, the court considered whether a defendant well operator engaging in “fracing” (stimulating a natural gas well by pumping fluid down the well at high pressure in order to create cracks in the rock to allow oil and gas to flow) would be liable for trespass if “proppants” (sand, ceramic beads, or bauxite that follow the fluid and prop open the cracks in the rock) used in the process migrated to the plaintiff’s land two miles below the surface and drained the oil and gas on the plaintiff’s property. In that case, the plaintiff sought damages equal to the value of the royalty on the gas that

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125 723 So. 2d 585 (Ala. 1998).
126 *Phillips Petroleum Co.*, 723 So. 2d at 586-87.
127 *Id.* at 588.
128 *Id.* at 591.
129 488 So. 2d 955 (La. 1986).
130 *Nunez*, 488 So. 2d at 956.
131 *Id.*
132 *Id.* at 958.
133 *Id.* at 960-62.
134 *Id.* at 963-64.
135 268 S.W.3d 1 (Tex. 2008).
136 *Coastal Oil and Gas Corp.*, 268 S.W.3d at 1-2.
would be drained from the land.\textsuperscript{137} The court began its discussion by noting that if the defendant had caused something like proppants to be deposited on the surface of the plaintiff’s land, it would be liable for trespass.\textsuperscript{138} The court noted, however, that just as the Supreme Court in \textit{Causby} found the ad coelum doctrine had no place “in the modern world” with regard to airspace two miles above the ground, the doctrine also no longer applied two miles below the ground.\textsuperscript{139} The court then stated that the plaintiff might have a claim for damages if he could show the defendant’s fracing operations damaged the plaintiff’s wells or the formation beneath his property. The plaintiff could not show that, however, and simply alleged the trespass of proppants would result in gas flowing from the plaintiff’s property to the defendant’s wells.\textsuperscript{140}

This claim, the court found, was prevented by the rule of capture, which holds that the plaintiff does not own the oil and gas under his property until he has “captured” it.\textsuperscript{141} Thus, the gas the plaintiff alleged he would lose “simply does not belong to him.”\textsuperscript{142} Instead, his remedy under the rule of capture was to drill an offset well to protect against the drainage or, if that was not effective, to make an offer to pool the resources or apply to the Railroad Commission for forced pooling.\textsuperscript{143} The court reasoned that the rule of capture makes it possible for the Commission to enact and enforce rules governing spacing, density, and number of wells to protect the correlative rights of owners with interests in the same mineral deposits while “securing the state goals of preventing waste and conserving natural resources.”\textsuperscript{144} Moreover, allowing litigation over recovery for draining resulting in fracing would force judges and juries to make difficult factual determinations based on proof “hidden below miles of rock” and make decisions without taking into account “social policies, industry operations, and the greater good” which are important in determining whether fracing should or should not be against the law.\textsuperscript{145} Thus, the court held that subsurface draining of oil and gas through fracing was not actionable in tort, but that non-draining damages to wells or the oil and gas formation might be.\textsuperscript{146}

In all of these cases, the courts placed great emphasis on the state’s statutory policy to encourage secondary recovery operations to promote the efficient use and development of oil and gas resources.

\begin{itemize}
\item \textsuperscript{137} \textit{Id.} at 1.
\item \textsuperscript{138} \textit{Id.} at 11.
\item \textsuperscript{139} \textit{Id.}
\item \textsuperscript{140} \textit{Id.} at 12-13.
\item \textsuperscript{141} \textit{Id.} In Texas, a mineral rights owner “has a real interest in oil and gas in place,” but that right does not extend to any particular gas beneath the property. Instead, ownership must “be considered in connection with the law of capture which is recognized as a property right.” \textit{Id.} Today, states having commercial production of oil and gas are primarily divided by whether they follow the rule of capture or recognize ownership of oil and gas in place similar to ownership of hard minerals. \textit{See} OWEN L. ANDERSSON ET AL., HEMMINGWAY OIL AND GAS LAW AND TAXATION 29-31 (4th ed. 2004).
\item \textsuperscript{142} \textit{Coastal Oil and Gas Corp.}, 268 S.W.3d at 12-13.
\item \textsuperscript{143} \textit{Id.} at 14.
\item \textsuperscript{144} \textit{Id.} at 14-15.
\item \textsuperscript{145} \textit{Id.} at 15-16.
\item \textsuperscript{146} \textit{Id.} at 17.
\end{itemize}
of natural resources, which was in the public interest. The courts focused on the existence of a state regulatory body to balance the needs of the various rights-holders and refused tort recovery for those who declined to participate in unitization or otherwise capture or exploit resources on their lands in a manner consistent with state policy and state regulation. Also in these cases, though, there is at least the recognition that future plaintiffs may be able to recover where there is actual damage to a plaintiff’s wells, formation, or other tangible property rather than simply a technical trespass of fluid or other materials. This supports the idea that if there is actual interference with commercial use of the subsurface, some recovery under tort law may be warranted even if the defendant’s operations are authorized under state law. This is consistent with case law in other states, where plaintiffs have been able to recover for actual damages resulting from secondary recovery.\footnote{Boyce v. Dundee Healdton Sand Unit, 560 P.2d 234, 237 (Okla. Ct. App. 1975) (granting recovery for nuisance claim for damages caused by water flooding); Greyhound Leasing & Fin. Corp. v. Joiner City Unit, 444 F.2d 439, 440 (10th Cir. 1971) (granting recovery based on private nuisance for damage caused by salt water encroachment associated with secondary recovery operations).} Allowing recovery in tort for actual damage to property is different, however, than finding the plaintiff in these cases has the type of “property” right in the subsurface that would allow the plaintiff to exclude others from invading the property with fluids, \( \text{CO}_2 \), proppants, or other substances in connection with resource development. It is this type of absolute ownership doctrine courts seem to have rejected in the secondary recovery and field unitization cases and which act as a potential precedent in future cases involving storage of \( \text{CO}_2 \) for CCS purposes.

2. \textit{Underground waste injection}

Judicial decisions in the area of underground waste injection also provide helpful precedent in determining the extent to which courts recognize and protect surface owners’ rights to the subsurface. Since the 1930s, oil producers have disposed of brine and other oil-producing waste by injecting it underground into deep, subsurface rock formations.\footnote{U.S. Environmental Protection Agency, Underground Injection Control Program, Basic Information, at \url{http://www.epa.gov/OGWDW/uic/basicinformation.html}.} Chemical companies began using the process a few decades later to dispose of non-hazardous and hazardous industrial wastes.\footnote{Id.} Today, the EPA and delegated state agencies regulate the underground injection of wastes under the Underground Injection Control (UIC) program by creating “classes” of injection wells and setting standards for injection to protect underground sources of drinking water.\footnote{Id.} There are approximately 260 non-hazardous and 120 hazardous waste wells operating in 19 states, most injecting at depths of about 1,400 meters (4,500 feet).\footnote{Elizabeth J. Wilson et al., \textit{Regulating the Ultimate Sink: Managing the Risks of Geologic CO}_2 \textit{Storage}, 37 ENVTL. SCI. & TECH. 3476, 3480 (2003).}

Like in the secondary recovery and field unitization cases, courts faced with attempts by surface owners to prevent waste disposal below the surface of their properties have not
been successful in the absence of establishing harm to their actual use of that subsurface. For instance, in *Chance v. BP Chemicals, Inc.*, the Ohio Supreme Court rejected the plaintiff property owners’ claims of trespass, strict liability, nuisance, negligence, and fraud for damage allegedly caused by lateral migration of hazardous waste refining products more than 790 meters (2,600 feet) below the surface produced in connection with the defendants’ deepwell injection technology. The defendant operated the injection wells pursuant to permits and regulatory practices of both the U.S. EPA and Ohio EPA. As part of their claim, plaintiffs contended that they owned everything below the surface of their properties, including the geologic formations into which the injectate was allegedly going, and that they had the right to exclude the defendants from their properties.

The court began its discussion by noting that even though the defendants were operating pursuant to valid state and federal permits, that in itself did not shield them from liability. In reviewing the plaintiffs’ claims for relief, however, the court placed weight on the fact that the plaintiffs had no specific evidence the defendants’ wells were causing any problems, only opinion testimony that problems may arise in the future. That left primarily the trespass claim and the argument that plaintiffs had the right to exclude the injectate from deep below the surface of their properties under the ad coelum doctrine. The court rejected strict application of the doctrine, finding that “ownership rights in today’s world are not so clear-cut as they were before the advent of airplanes and injection wells.” It found that just as a property owner “must accept some limitations on the ownership rights extending above the surface of the property,” there are “limitations on property owners’ subsurface rights.” Thus, the court found that although the plaintiffs did have a property interest in the rock in which the injectate was placed, it was a “potentially limited one.” As a result, it rejected the idea of “presumed” damages as would be available in cases of surface trespass, and instead held there must be some type of physical damages or interference with use for the plaintiffs to recover for subsurface trespass.

In *FPL Farming Ltd. v. Texas Natural Resource Conservation Commission*, the Texas Court of Appeals conducted a similar analysis when faced with a landowner’s claim that the Texas Natural Resource Conservation Commission’s grant of two non-hazardous Class I permits for injection of waste 2,200 to 2,500 meters (7,350 to 8,200...

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152 670 N.E.2d 985 (Ohio 1996).
153 *Chance*, 670 N.E.2d at 986-89.
154 *Id.* at 987.
155 *Id.* at 987.
156 *Id.* at 990.
157 *Id.*
158 *Id.* 991.
159 *Id.* at 992.
160 *Id.*
161 *Id.*
162 *Id.* at 993.
feet) below the surface into a salt water formation under the plaintiff’s property constituted a taking of private property without just compensation. First, the Court expressly rejected the ad coelum doctrine and refused to accept the plaintiff’s argument that migration of the waste plume under the plaintiff’s property, without some measure of harm, could constitute a trespass. Instead, it deferred to the Commission’s expertise in the geological effects of subsurface migration of injectates and its conclusion in the administrative proceeding below that the injectate would not impair any existing rights and would be in the public interest. Although the plaintiff had testified in the proceedings that it was now prohibited from acquiring its own permit to store salt water or subsurface waste on its property because of the permit that had already been granted for that area, the court found there was no evidence the existing permits would hamper the plaintiff’s ability to use the deep subsurface in the same manner in the future.

As for the takings claim itself, the court rejected the idea that approval of the injection constituted a “permanent, physical occupation of property” of the type the U.S. Supreme Court’s held was a per se taking requiring just compensation in Loretto v. Teleprompter Manhattan CATV Corp. The court found that Loretto did not apply here because the plaintiff could not show that migration of the waste plume would prevent it from engaging in a brine mining operation or conducting its own injection well, and thus could not show it had lost the right to use the property. The court concluded, however, that if the waste plume did migrate to the plaintiff’s property and did cause harm, the plaintiff could then seek damage from the well operator because, under state statute, the existence of a permit did not relieve a party for civil liability for harm.

Finally, the District Court for the Eastern District of Louisiana reached a similar conclusion in Raymond v. Union Texas Petroleum Corporation. In that case, the defendant injected salt water into a disposal well on neighboring property which allegedly migrated and invaded the subsurface of the plaintiffs’ property. The plaintiffs did not seek to enjoin the injection or challenge the state-issued disposal permit but instead sought to be paid rentals for the disposal of salt water under their land just as one of their neighbors had been paid. In rejecting the trespass claim, the court relied upon the Louisiana Supreme Court’s decision in Nunez (discussed supra) which had found that traditional property concepts like trespass must “yield to the important interest of conserving the natural resources of the state.” It concluded that based on Nunez, there

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164 FPL Farming, 2003 WL at *1.
165 Id. at ** 3-4.
166 Id. at *4.
167 Id.
168 Id. at *5 (citing 458 U.S. 419 (1982)). See also infra Part III.
169 Id.
170 Id.
172 Id. at 271.
173 Id. at 273.
174 Id. at 274. See also supra notes 129-34.
was no legally actionable trespass in this case but that *Nunez* did not preclude a landowner from recovering compensation for damage to property or measurable inconvenience. The court found that in this case, the rentals that were paid to the neighbor were to compensate for surface use of the property and any inconvenience caused by the disposal operations, but that there was no evidence the underground disposal of salt water damaged the subsurface formation, fresh water, or mineral-bearing strata, or that it caused any surface or subsurface inconvenience to the plaintiff.

The underground waste injection cases—hazardous, non-hazardous, and hydrocarbon associated water—show that courts have rejected any form of the ad coelum doctrine when it comes to surface owner efforts to prevent the underground migration of waste on their property in the absence of actual harm when the injection of waste is conducted pursuant to federal or state permits. In each case, the court placed great weight on the public interest and regulatory approval associated with the underground injection of waste products and modified existing doctrines relating to subsurface property rights accordingly. At the same time, however, each of the courts held open the possibility that a plaintiff could recover if it could show actual damage or actual interference with use of either the surface or the subsurface. Thus, the courts refused any absolute property rights in the deep subsurface but retained limited property rights that would allow surface owners to seek damages or just compensation for a condemnation in case of actual interference or harm.

3. *Subsurface natural gas storage*

The last set of cases relevant to the issue of property rights and CO\(_2\) storage are those that have resolved disputes over property rights and the subsurface storage of natural gas. Natural gas is stored underground in depleted oil and gas reservoirs, salt caverns, and other natural aquifers to provide for increased demand for natural gas during the winter. Domestic natural gas storage capacity is approximately 230 billion cubic meters (8.1 trillion cubic feet). Under the Natural Gas Act and judicial decisions interpreting the Act, natural gas operators that have obtained a “certificate of public convenience and necessity” from the Federal Energy Regulatory Commission (FERC) have the power of eminent domain to take land to create not only interstate natural gas pipelines but also associated underground natural gas storage facilities. Not surprisingly, courts have been forced to resolve disputes over ownership and valuation of the pore space in which

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175 *Id.*
176 *Id.* at 274-75. *See also* Mongrue v. Monsanto, 249 F.3d 422 (5th Cir 2001) (holding that wastewater injected by defendant on its property that migrated under the plaintiff’s property did not constitute a taking without just compensation).
177 *See JASON HEINRICH ET AL., ENVIRONMENTAL ASSESSMENT OF GEOLOGIC STORAGE OF CO\(_2\), WORKING PAPER NO. 2003-02, at 21 (MIT Laboratory for Energy and the Environment 2004); Wilson & DeFigueiredo, *supra* note 114, at 10121.
the natural gas is stored when that pore space also is in potential or actual use by surface owners or mineral rights owners.

As an initial matter, numerous courts have held that after the removal of underground minerals, oil, or gas, the surface owner retains the right to use the remaining space for storage, although mineral rights holders have also been found to have some retained interest in the storage space if they hold exploratory rights or where the mineral rights holder constructed the storage space. Thus, in developing natural gas storage rights, natural gas companies often have included both the surface owner and mineral owner in condemnation actions, providing just compensation to both sets of interests. Accordingly, although the rest of this subsection refers to disputes between natural gas owners and surface owners, mineral owners may also have subsurface rights that come into conflict with natural gas storage efforts.

Two main types of disputes arise in these cases. The first is where the natural gas company obtains a certificate of public convenience and necessity from FERC and then attempts to contract with the surface owner to obtain the necessary storage rights and, if they are unable to reach agreement, exercises the power of eminent domain to take the subsurface within the area covered by the certificate. In these cases, there may be disputes surrounding valuation of the storage space but the access rights are settled. The second type of dispute is where the natural gas company fails to obtain all of the storage rights within the area in which it intends to operate, creating a “window” in the storage field. In such a case, the owner of a window property may attempt to sue for trespass once storage operations begin or, when a window owner threatens to drill into the storage field or surrounding area, the gas company may file a condemnation action to prevent the owner from either withdrawing the company’s stored gas or damaging the integrity of the storage field. At that point, the window owner may counterclaim for trespass, seeking an injunction, compensatory damages, and punitive damages. As shown below, in both types of disputes, it is clear that the courts and Congress have recognized the existence of a subsurface property interest that requires either purchase or condemnation in order to obtain the storage space.

A more difficult question is whether a landowner always has a property interest in the subsurface sufficient to require the gas company to condemn the subsurface rights prior to using it for gas storage and, if the company fails to do so, whether the surface owner can sue for trespass and seek not only compensatory damages (if any) but punitive damages based on the technical trespass. The gas company could certainly argue that

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180 Wilson & de Figueiredo, *supra* note 114, at 10122.
182 See id.
183 See id. (discussing claims for punitive damages in subsurface trespass cases); Alexandra B. Klass, *Punitive Damages and Valuing Harm*, 92 MINN. L. REV. 83, 105-07 (2007) (discussing availability of punitive damages in surface trespass cases). To the extent a property is in split estate, and the natural gas
just as courts have recognized that surface owners have no absolute rights to the airspace above their property they should have no absolute rights to the subsurface below their property. In the natural gas storage cases, however, the natural gas company is attempting to use portions of the subsurface for commercial gain that the surface owner could sell to other natural gas companies or, if there is any natural gas remaining in the subsurface, develop itself for profit. While surface owners rarely if ever made commercial use of the airspace now occupied by airplanes, surface owners have made commercial use of the minerals, oil, and gas in the subsurface for over 100 years. Nevertheless, the fact that the Natural Gas Act and judicial decisions interpreting the Act provide for condemnation authority to obtain subsurface rights to store natural gas is a recognition that there are existing rights that need to be condemned. Thus, the Natural Gas Act and related regulations recognize at least a limited subsurface property right that requires an eminent domain action (or voluntary transaction) in order to use the subsurface for storing natural gas.

4. Conclusion

The natural gas storage cases show that both Congress and the courts recognize surface owner and mineral owner rights to subsurface pore space, at least when it comes to using that pore space for natural gas storage. Moreover, in the natural gas storage cases, the landowner can argue without much difficulty that there is an affirmative, physical occupation of the subsurface by the defendant so that even if the Natural Gas Act did not authorize eminent domain actions, such occupation would constitute a taking under Loretto. As a result, even though subsurface natural gas storage may be in the public interest, the natural gas company must pay for those storage rights.

By contrast, in the secondary recovery, field unitization, and underground injection cases, there was no intent by the defendants to occupy the landowner’s subsurface property on either a temporary or permanent basis. Instead, the defendant was engaging in oil and gas development or waste injection that had the possibility of migrating onto the landowner’s subsurface property. Under those circumstances, in the absence of evidence of actual harm or damage, the courts were more willing to hold the state or federally-authorized activity was not a trespass or a taking and allow the potential for tort claims in the future in the event of actual harm.

Thus, there are two main themes in the cases that may be relevant to subsurface storage of CO₂ in connection with CCS. First, a federal or state regulatory program can authorize some invasions of the subsurface and can serve to protect against claims of takings or trespass when the invasion is incidental, the landowner had an opportunity to participate in the regulatory program, or the landowner cannot show actual harm to its use or enjoyment of the surface or subsurface. Second, however, the intentional, storage interferes with the mineral rights owner’s ability to develop the oil or gas then the mineral rights owner may also have a claim for trespass or a right to just compensation resulting from condemnation.

184 See McGrew, supra note 178, at 176-79 (arguing that surface owners should be able to sue for trespass when natural gas companies fail to use condemnation authority to obtain storage rights).
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knowing, physical occupation of the subsurface is more likely to result in the recognition of a protectable property interest that would support either the right to just compensation or a trespass claim even in the absence of actual harm. Thus, while courts have rejected any absolute rights to the subsurface on the part of the landowner, they have retained limited rights on the part of the landowner to use and exploit rights to the subsurface and recover for actual harm caused by subsurface invasions.

In many ways, this is similar to what courts have done with airspace rights at least near the surface, as opposed to airspace rights miles above. In recent years, courts have been quite willing to allow landowners to sue for trespass and nuisance when airborne particles and pollution invade the landowner’s airspace and cause harm. While landowners cannot sue for just any invasion of particles, courts routinely allow such suits upon a showing of harm. Thus, in the airspace pollution cases, the court looks to see whether the invasion is actually interfering with the plaintiff’s use and enjoyment of the property and has caused actual harm. In the subsurface invasion cases, as shown above, the courts are looking at almost precisely the same factors and reaching similar conclusions.

Thus, to the extent the case law analyzed above provides precedent for CO₂ storage in connection with CCS, the two major factors to consider are: (1) whether Congress or state governments will declare that CO₂ storage is in the public interest and create a regulatory structure to allow for CO₂ storage; and (2) the extent to which CO₂ storage will actually interfere with use and enjoyment of the surface or subsurface. Both of these issues are discussed in Parts III and IV.

III. SUBSURFACE CO₂ STORAGE AND TAKINGS

The Fifth Amendment Takings Clause states that private property shall not “be taken for public use, without just compensation.” The Constitution does not create or define the scope of property interests protectable under the Fifth Amendment but instead requires compensation in the event of an interference that amounts to a taking. Thus, in determining whether a protectable property interest exists, courts look to “existing rules or understandings” and “background principles” derived from independent sources such

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185 See, e.g., Davis v. Georgia-Pacific Corp., 445 P.2d 481 (Or. 1968) (holding that intrusion of fumes, gases, and microscopic particles on the property of another can constitute a trespass in addition to a nuisance); JAMES A. HENDERSON ET AL., THE TORTS PROCESS 402-03 (7th ed. 2007) (discussing how some courts have allowed claims for trespass, in addition to nuisance, for claims based on the intrusion of smoke, gases, or odors).

186 See HENDERSON ET AL., supra note 185, at 386, 389 (discussing requirement of harm to prevail on claims for nuisance and unintentional trespass with no showing of harm required for intentional trespass cases); see also REST. (SECOND) OF TORTS §§ 826-829A (setting forth harm component of nuisance claim).

187 U.S. CONST. amend. V.

As state law, federal law, or common law.¹⁸⁹ Although property interests are often defined by state law, state-created property interests may be limited by federal law, even in the area of real property.¹⁹⁰ The Supreme Court has stated that the Takings Clause “was designed to bar Government from forcing some people alone to bear public burdens which, in all fairness and justice, should be borne by the public as a whole.”¹⁹¹

Once a protectable property interest is found, a court must decide whether to analyze the government action in question as a physical taking or as a regulatory taking. A per se physical taking occurs when the government engages in a permanent, physical occupation of private property or authorizes a third party to engage in such occupation.¹⁹² In the case of physical invasions, “no matter how minute the intrusion, and no matter how weighty the public purpose behind it,” a taking has occurred and just compensation is required.¹⁹³ Even if there is no physical occupation of private property, a “regulatory taking” can occur if government regulation places too great a burden on the owner’s use of the property. A regulatory taking can take place under two circumstances. First, a regulatory action can be a per se taking just like a physical occupation when the regulation completely deprives an owner of all reasonably beneficial use of her property.¹⁹⁴ In the absence of a complete deprivation of all economic use of the property, courts generally consider whether the regulatory restriction has risen to the level of a compensable taking under the multi-factor balancing test set out in *Penn Central Transportation Co. v. New York.*¹⁹⁵ This test considers (1) the character of the government action; (2) the severity of the economic impact; and (3) the extent to which the regulation interferes with the property owner’s distinct, “investment-backed” expectations.¹⁹⁶

Based on this framework, this Part discusses a range of issues relating to physical takings and regulatory takings in the context of subsurface CO² storage. With regard to a physical taking, the first question is whether the landowner (or mineral owner) has a sufficient interest in the subsurface pore space to implicating the Takings Clause. This would occur if (1) the federal (or state) government injects or stores CO² directly into the

¹⁹⁰ See Lucas, 505 U.S. at 1032, n.18 (stating that state-law definitions of private property rights must be based on an “objectively reasonable application of relevant precedents’’); Bair v. U.S., 515 F.3d 1323, 1328 (Fed. Cir. 2008) (stating an objective basis in defining property rights is “vital” if the integrity of the Takings Clause is to be preserved “as against entirely novel and unprincipled definitions of property designated artificially to defeat or buttress a takings claim”) (citing Lucas, 505 U.S. at 1029; Webb’s Fabulous Pharmacies v. Beckwith, 449 U.S. 155, 164 (1980)).
¹⁹² Lingle v. Chevron U.S.A., 544 U.S. 528, 537 (2005); Loretto v. Teleprompter Manhattan CATV Corp., 458 U.S. 419, 426 (1982) (holding that state regulation requiring landlords to allow television cable companies to place cable facilities in their apartment buildings constituted a taking even though the facilities occupied at most only one and one-half cubic feet of the landlord’s property).
¹⁹³ Lucas, 505 U.S. at 1015; see also Loretto, 458 U.S. 419.
¹⁹⁴ See Lucas, 505 U.S. at 1029 (holding regulations that prohibit all economically-beneficial use of land are just as much of a taking requiring compensation as permanent physical occupations of land).
¹⁹⁶ *Penn Central*, 438 U.S. at 124.
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subsurface underlying the owner’s property or (2) injects the CO$_2$ nearby in such a manner than CO$_2$ or displaced brine migrates and invades the pore space underlying the landowner’s property. If the answer is yes, the next question is whether such actions constitute a permanent, physical occupation of that property. As for regulatory takings, there may be some circumstances where there is no physical injection of CO$_2$ under the landowner’s property and no migration from a neighboring storage basin but the federal (or state) regulatory authority has enacted regulations that prevent the landowner or mineral owner from conducting a range of subsurface operations relating to oil and gas development or natural gas storage in order to ensure the integrity of a nearby CO$_2$ storage basin. Section A considers first whether there is a protectable property interest in the subsurface that is protected by the Takings Clause. Section B considers the issue of physical takings and Section C addresses regulatory takings.

A. The Extent of a Protectable Property Interest in Subsurface Pore Space

In Part II we explored the issue of subsurface property rights in the context of oil and gas operations, hazardous and non-hazardous waste injection, and natural gas storage. In those cases, although courts have recognized a limited property interest in the subsurface, that limited interest was not enough for the landowner to prevent third parties (particularly those third parties with government permits or other authorization) from using the subsurface for oil and gas development or waste injection so long as those operations did not result actual physical or economic harm to the subsurface.\textsuperscript{197} In the natural gas storage cases, however, where the natural gas company intended to physically occupy the subsurface rather than the occupation being either speculative or an unfortunate consequence of nearby operations, the natural gas company generally proceeded to either acquire that space by contract or exercise the right of eminent domain under the Natural Gas Act.\textsuperscript{198} Thus, there are two different strands of case law involving subsurface property rights that may apply in the CO$_2$ storage context when it comes to whether the property interest in the subsurface is sufficient to establish a taking.

On the one hand, numerous courts have held, as detailed in Part II, that a surface owner’s interest in the subsurface is “limited” at best, relying on \textit{Causby} and other cases limiting the surface owner’s rights to control the airspace.\textsuperscript{199} Arguably, even if states expressly provide by statute that a surface owner has a property right in the pore space, as Wyoming has done, such a state-created property interest may be limited by the judicial application of \textit{Causby} to subsurface rights that places “objective” limits on rights to the subsurface.\textsuperscript{200} In other words, the argument would be that just as Wyoming could not vest in surface owners the right to the airspace far above their property as a result of the objective, background principles expressed in \textit{Causby}, Wyoming cannot vest in surface

\textsuperscript{197} See \textit{supra} Part II.C.
\textsuperscript{198} See \textit{supra} notes 177-84. See also \textit{infra} Part IV.
\textsuperscript{199} See, e.g., \textit{Chance} v. BP Chemicals, 670 N.E.2d 985 (Ohio 1996); \textit{supra} Part II.C.
\textsuperscript{200} See \textit{Chance}, 670 N.E.2d at 992; Coastal Oil and Gas Corp. v. Garza Energy Trust, 268 S.W.3d 1, 11 (Tex. 2008); \textit{supra} Part II.C.
owners the right to the deep subsurface as a result of courts’ application of *Causby* to the subsurface.\(^{201}\)

This argument would be consistent with a 2008 article by John Sprankling in the *UCLA Law Review* entitled *Owning the Center of the Earth*.\(^{202}\) In that article, Sprankling takes the position that private property rights to land should not extend more than 300 meters (1000 feet) below the surface of the earth but should instead be lodged with the federal government.\(^{203}\) The article did not focus on CCS specifically but instead focused on the issue of subsurface ownership in connection with today’s technological ability to develop various energy and climate change technologies including CCS and enhanced geothermal systems that must make use of the subsurface in ways not contemplated in the past.\(^{204}\) Sprankling contends that based on case law involving subsurface water, oil and gas development, and hazardous waste injection, among others, American law has never determined whether a landowner’s rights extend more than two miles below the surface and that even case law within two miles of the surface is largely inconsistent.\(^{205}\) He then concludes that property owners should have some rights below the surface to accommodate foundations, trees, and other normal surface facilities, but those rights should not extend more than 1000 feet below the surface.\(^{206}\)

He bases this conclusion on the following: (1) most homeowners believe their rights extend only to the immediate subsurface beneath their homes and property rights are based in part on expectations; (2) almost all of the deep subsurface, like airspace, is unpossessed, physical possession has “long been the touchstone of property rights,” and it is questionable whether deep injection wells or oil wells should be considered “possession;” (3) enforcement of subsurface boundaries is difficult if not impossible; (4) the earth’s interior can be regarded as a form of “wilderness” that should be safeguarded for future generations by restricting subsurface ownership; (5) new and valuable technologies that require use of the subsurface such as CCS and heat mining should act to modify any abstract ownership principles in the name of the public interest, just as the public interest supporting national air travel modified abstract rights to airspace.\(^{207}\)

While this argument has some appeal as a means to facilitate new technologies like CCS, it fails to recognize the realities of how the subsurface is used today.\(^{208}\) In many parts of the country, subsurface property far below 1000 feet is used, bought, sold, condemned, and valued. Underground activities at depths below 1000 feet, or roughly 300 meters, include coal production; oil and natural gas exploration, production, and

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\(^{201}\) *See supra* Part II.C.


\(^{203}\) Sprankling, *supra* note 7, at 982.

\(^{204}\) *Id.* at 1029-32.

\(^{205}\) *Id.* at 1020.

\(^{206}\) *Id.* at 1026-28, 1031.

\(^{207}\) *Id.* at 1022-33.

\(^{208}\) Sprankling does acknowledge the potential need to acknowledge and honor “all existing rights to extract specific valuable minerals, at least to the extent appropriate to ensure a reasonable return on prior investments.” *Id.* at 1037-38.
storage; produced waters reinjection; hazardous and municipal waste water reinjection; and potentially aquifer storage and recovery and compressed air storage. Congress has recognized those property rights (through the eminent domain provisions of the Natural Gas Act) and courts have recognized those rights by allowing for claims of trespass and nuisance in cases of actual interference or harm and created mechanisms to determine just compensation when those subsurface areas are needed for a public use such as natural gas storage. Thus, the country’s history of the use of the subsurface is in fact different than its use of airspace, and if new technologies in the public interest require portions of the deep subsurface for implementation, there is not in fact a “blank slate” on which to write.

Moreover, there is a two-fold problem with a declaration that surface owners have no more property rights in the deep subsurface than they have in airspace. First, even though there may be federal background principles (i.e., *Causby*) that would prevent property rights in the airspace above that used in connection with the surface, the same is far less true with regard to the subsurface. There is no federal statutory or common law that prevents the states from vesting subsurface property rights in the surface owner or the mineral owner and, more important, unlike airspace, there has been a long history of subsurface use of property for private economic gain. That use of the subsurface may end at a certain depth, for instance, any deeper than necessary for existing and future natural gas storage, waste injection, and oil and gas exploration. But to the extent that CO$_2$ storage will be at depths that are currently subject to existing and reasonably-anticipated future economic use (and it appears that it will be) there do not appear to be any background principles of statutory or common law that would prevent states from vesting those property rights in surface owners or mineral owners if they choose to do so.

Second, to the extent CO$_2$ storage occurs at the same depths and in the same locations as natural gas or other storage, there may be circumstances where the surface owner (or mineral owner) can no longer use the subsurface for any other economic purpose. When analyzing a physical taking, the size and scope of the physical invasion is immaterial to whether a taking has occurred. Thus, some precedent would appear to support the idea that CO$_2$ storage, at least at depths that are at the same level as existing or reasonably foreseeable subsurface uses, would interfere with a protectable property interest. This

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209 See *supra* Part I.C.

210 See *Sprankling*, *supra* note 7, at 1020 (describing American law on ownership of the deep subsurface even within two miles of the surface as a “blank slate”).

211 See *Lucas* v. South Carolina Coastal Comm’n, 505 U.S. 1003, 1029 (1992) (looking to “background principles” of the state’s law of property and nuisance as an exception to the per se takings rule for regulations that deprive a landowner of all economic use of property); *Bair* v. U.S., 515 F.3d 1323, 1327-23 (Fed. Cir. 2008) (recognizing that state-created property interests can be limited by federal law and that federal law can constitute “background principles” that can prevent a per se takings claim).

212 See *supra* Part I.C.

213 See *Lucas*, 505 U.S. at 1029 (discussing “background principles”).

would be even more true in states like Wyoming that have expressly vested subsurface pore space rights in the surface owner or the mineral owner.

Based on this discussion, we conclude that at least some surface and mineral owners may have a sufficient interest in the subsurface pore space to constitute a protectable property interest under the U.S. Constitution. Such property rights would be bolstered even further in states, like Wyoming, that have expressly recognized such rights as a matter of statute or common law. For those property owners, actions by the government which interfere with those rights may constitute a taking under some circumstances if the CO$_2$ storage is sought at depths that would conflict with existing or reasonably-foreseeable uses of the subsurface or if regulations protecting CO$_2$ storage in neighboring areas would unduly limit those uses. These issues are discussed below.

B. Physical Takings

To the extent there are at least limited private property rights in subsurface pore space, any action by the government to inject and store large amounts of CO$_2$ in that pore space could be a per se physical taking requiring just compensation. In *Loretto v. Manhattan CATV Corp.*,\(^{215}\) The Court held that a state law requiring landlords to allow television cable companies to place cable facilities in their apartment buildings constituted a taking even though the facilities occupied at most only one and one-half cubic feet of the landlord’s property.\(^{216}\) In its analysis, the Court found the cable legislation’s purpose—to promote rapid development of communication—was in the public interest, but found the state action authorizing the permanent invasion of private land by a third party so frustrated the property interest that a taking should be found.\(^{217}\) Even though the just compensation owed to the plaintiff was ultimately determined to be only one dollar, the decision is significant in its ruling that any regulation that results in a permanent physical invasion or occupation, no matter how small, constitutes a per se taking. Moreover, both before and after *Loretto*, the Court has distinguished between a “permanent” physical invasion which will always constitute a taking and temporary physical invasions which often will not constitute a taking.\(^{218}\)

\(^{215}\) 458 U.S. 419 (1982).
\(^{216}\) *Loretto*, 458 U.S. at 426.
\(^{217}\) *Id*.
\(^{218}\) *Id.* at 428 (“Since these early cases, this Court has consistently distinguished between flooding cases involving a permanent physical occupation, on the one hand, and cases involving a more temporary invasion, or government action outside the owner’s property that causes consequential damages within, on the other. A taking has always been found only in the former situation.”). *See also* City of St. Louis v. Western Union Tel. Co. 148 U.S. 92, 99 (1893) (holding the installation of telephone poles in the public interest but noting the action “effectually and permanently dispossesses the general public as if it had destroyed that amount of ground”); McKay v. United States, 199 F.3d 1376 (Fed. Cir. 1999) (holding that the installation by federal agencies of groundwater monitoring wells extending into the plaintiffs’ mineral estate for several years constituted a per se taking because it was a physical occupation of private property by the government and distinguishing other cases involving test hole borings which did not interfere with the mineral estate and were discrete, transitory invasions rather than a permanent invasion).
The Court has held many things to be a physical intrusion on land (e.g., telephone lines, pipes, and rails), but these are typically concrete invasions of the surface estate. Likewise, in the context of water rights, the Supreme Court and lower courts have found in some circumstances that diversion of water onto or away from the plaintiffs’ property to accomplish public purposes such as supporting the war effort, preserving endangered species, or building dams can constitute a per se physical taking requiring just compensation. Is the injection and storage of CO$_2$ in the deep subsurface comparable to these other physical occupations? Certainly, the occupation of the subsurface appears to be “permanent” in that there is an expectation the CO$_2$ will remain in the subsurface for hundreds to thousands of years. On the other hand, placing an odorless, colorless gas nearly a mile below the surface seems much less like the tangible, physical invasion of a cable wire, telephone line, or water and is less likely to so completely “frustrate” the owner’s interest in either the surface or mineral estate.

Ultimately, the question appears to come down, once again, to the property owner’s reasonable expectations with regard to the subsurface. Currently, there is no reasonable expectation among property owners that they can control the airspace far above their property. With regard to most property owners around the country, the same is true with regard to the deep subsurface. For some surface and mineral owners, however, they are already making economic use of the subsurface at the same depths as proposed CO$_2$ storage or such uses are reasonably foreseeable. Just as those owners have more arguments to support a claim to a protectable property interest in the subsurface, they also have more arguments to support a claim that there is a physical taking of those rights if the government acts to inject and store CO$_2$ into that subsurface in perpetuity.

Likewise, a surface owner or mineral owner affected, not by the injected CO$_2$, but by the associated displaced brines from nearby CO$_2$ storage, might have a similar physical takings claim. In such a case, however, the owner would still need to show actual or reasonably foreseeable interference with use of the subsurface and that the displaced brines are sufficiently tied to the government authorization or are a reasonably

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219 See Loretto, 458 U.S. at 430 (“Later cases, relying on the character of a physical occupation, clearly establish that permanent occupations of land by such installations as telegraph and telephone lines, rails, and underground pipes or wires are takings even if they occupy only relatively insubstantial amounts of space and do not seriously interfere with the landowner’s use of the rest of his land”).

220 See International Paper Co. v. United States, 292 U.S. 399 (1931) (holding U.S. requisition order diverting all the hydroelectric power of the Niagara Falls Power Company to increase power production for third-party use in connection with war effort constituted a taking of water from International Paper which had a lease for a portion of that water); United States v. Gerlach Live Stock Co., 339 U.S. 725 (1950) (holding that federal construction of dam that resulted in diversion of plaintiffs’ riparian water rights used for irrigation was a physical taking); Dugan v. Rank, 372 U.S. 609 (1963) (same); Casitas Mun. Water Dist. v. U.S., 543 F.3d 1276 (Fed. Cir. 2008) (holding that federal diversion of irrigation water to protect steelhead trout under Endangered Species Act constituted a physical taking of municipal water district’s water rights where government had concede for purposes of summary judgment that plaintiff had a property interest in the water at issue). But see Hudson County Water Co. v. McCarter, 209 U.S. 349 (1908) (holding that New Jersey statute that barred a company with riparian water rights from diverting water was not a taking because state law did not create any rights to the diversion).
foreseeable consequence of the government action.\footnote{See e.g., Jan G. Laitos & Elizabeth H. Getches, \textit{Multi-layered, and Sequential, State and Local Barriers to Extractive Resource Development}, 23 VA. ENVTL. L.J. 1, 26-29 (2004).} While the Court has found the permanent flooding of the surface to be a physical taking,\footnote{See supra note 218 and accompanying text.} it is unclear whether the same analysis would apply to underground flooding or migration of subsurface waters, particularly based on the oil and gas and underground waste injection cases discussed in Part II. Thus, where such an invasion from nearby CO$_2$ operations occurs and where no economically-valuable resources are affected, it is likely that there would be no physical taking or, even if there were, any compensation would likely be de minimus as it was in \textit{Loretto}. If, however, displaced brines actually interfered with existing and reasonably-foreseeable subsurface operations, such an invasion may constitute a physical taking resulting in just compensation as well as any actual damages.

\subsection{C. Regulatory Takings}

As stated earlier, even if there is no physical occupation of private property, a “regulatory taking” can occur if government regulation places too great a burden on the owner’s use of the property. A regulatory taking can take place under two circumstances. First, a regulatory action can be a per se taking just like a physical occupation when the regulation completely deprives an owner of all reasonably beneficial use of her property.\footnote{See Lucas \textit{v. South Carolina Coastal Comm’n}, 505 U.S. 1003, 1029 (1992) (holding regulations that prohibit all economically-beneficial use of land are just as much of a taking requiring compensation as permanent physical occupations of land).} In the absence of a complete deprivation of all economic use of the property, courts generally consider whether the regulatory restriction has risen to the level of a compensable taking until the multi-factor balancing test set out in \textit{Penn Central Transportation Co. v. New York},\footnote{438 U.S. 104 (1978).} which considers: (1) the character of the government action; (2) the severity of the economic impact; and (3) the extent to which the regulation interferes with the property owner’s distinct, “investment-backed” expectations.\footnote{\textit{Penn Central}, 438 U.S. at 124.}

Although it is uncertain at this point what regulations governing subsurface CO$_2$ storage will look like, it is highly likely that CCS implementation will be accompanied by regulations prohibiting certain activities that might interfere with the safety and permanent storage of CO$_2$ in a given basin. Notably surface and mineral estate owners both within the storage basin area and near the storage basin area might be prohibited from drilling through the confining layer or in such a way that punctures or compromises the CO$_2$ storage area itself. Thus, the first question is whether such a regulatory prohibition would deprive a surface owner or mineral owner of all economic value of the property. If not, the next question is whether under the \textit{Penn Central} balancing test, the extent of the deprivation unreasonably interferes with the owner’s distinct, investment-backed expectations for economic use of that property.
To answer these questions, once again it is necessary to consider the nature of the property interest. If a court were to determine that the pore space is a property interest separate and distinct from either the surface interest or the mineral interest, it would be possible to conclude that regulations restricting use of or access to that pore space would be a complete deprivation of economic use resulting in a per se taking. The Supreme Court precedent in this area is somewhat mixed, particularly in the area of subsurface rights that have arisen with regard to the regulation of coal mining operations.

For instance, in Pennsylvania Coal Co. v. Mahon, the plaintiffs owned the surface rights under their home but not the mineral rights, which had been severed and conveyed to the defendant coal company. A state law, the Kohler Act, prohibited the mining of anthracite coal within city limits in such a manner as would cause the subsidence of any dwelling or other building. When the plaintiffs sued to enjoin further mining of coal under their property pursuant to the Kohler Act, the defendant contended application of the law amounted to an unconstitutional taking of its property (the coal) without just compensation. In an opinion by Justice Holmes, the Court found that application of the law was a taking. In reaching the decision, Justice Holmes balanced the extent of the defendant’s deprivation against the private interest of the homeowners rather than the state’s interest in preventing a public nuisance, which had historically been a defense to similar regulatory takings claims in the past. The Court found that the extent of the deprivation was “great” because the law purported to abolish the entire “support” estate in coal—a separately defined estate under state law. The Court concluded with its now-famous line stating that “while property may be regulated to a certain extent, if the regulation goes too far it will be recognized as a taking.”

Several decades later, however, in Keystone Bituminous Coal Ass’n v. DeBenedictis, the Court revisited the issue of subsurface takings relating to regulation of coal mining in Pennsylvania but reached a different result. In Keystone Bituminous, coal companies challenged the Pennsylvania Subsidence Act which required 50 percent of coal beneath surface structures be left in place to provide surface support. In finding that the law did not result in an unconstitutional taking, the Court distinguished Mahon and applied the Penn Central balancing test. In finding that Mahon did not apply, the Court focused on the

226 See Lucas, 505 U.S. at 1029.
227 260 U.S. 393 (1922).
228 Mahon, 260 U.S. at 414 (“To make it commercially impracticable to mine certain coal has very nearly the same effect for constitutional purposes as appropriating or destroying it.”).
229 Id. at 413 (focusing on the fact that this is a case “of a single private house” and not a public nuisance); id at 417-18 (Brandeis, J. dissenting) (stating that Kohler Act did not work an unconstitutional taking of property because the restriction “is merely the prohibition of a noxious use” and citing precedent that such legislation is not a taking even if it deprives the owner of all economic use of the property).
230 Id. at 414.; JESSE DUKE MINIER ET AL., PROPERTY 989 (6th ed. 2006) (stating that Pennsylvania law recognizes three separate estates in mining property—the surface estate, the mineral estate, and the support estate).
231 Id. at 415.
233 Keystone Bituminous, 480 U.S. at 476.
important public purpose of the law in promoting public health and safety and found that when balanced against the extent of deprivation, the regulation did not go “too far” and did not work a taking.\footnote{Id. at 485-93.}

More important, departing from \textit{Mahon}, the Court refused to consider the support estate as a separate estate in property in determining the extent of the deprivation. The Court found that the 27 million tons of coal owned by the plaintiffs that would need to be left in place under the law “do not constitute a separate segment of property for takings law purposes.”\footnote{Id. at 498.} Instead, the regulation limiting the extraction of coal was no different than a requirement that a building occupy no more than a specific percentage of the lot on which it is located; zoning setback requirements; the Court’s decision in \textit{Penn Central} itself which refused to sever the company’s “air rights” from the remainder of its property; or other restrictions in the public interest that place limits on the property owner’s right to make profitable use of some segments of his or her property.\footnote{Id. at 498-501.} Relying on the lower court’s decision, the Court reasoned that even though Pennsylvania law recognized the support estate as a “separate” property interest, that estate could not be used profitably by one who does not also possess either the mineral estate or the surface estate, and thus it must be considered together with those other estates for purposes of conducting the takings analysis.\footnote{Id. at 501.}

Since the decision in \textit{Keystone Bituminous}, the Court has continued to struggle with how to define property interests for purposes of determining whether a regulation works a complete elimination of economic use of property resulting in a per se taking as well as for determining the extent of deprivation under the \textit{Penn Central} balancing test.\footnote{DUKEMINIER ET AL., \textit{supra} note 230, at 989, 1022 (discussing continuing uncertainty over the idea of “conceptual severance” in regulatory takings jurisprudence).} In 1992, in \textit{Lucas v. South Carolina Coastal Commission},\footnote{505 U.S. 1003 (1992).} the Court announced its controversial per se regulatory takings rule in cases where the government denies all economic use of property unless “background principles” of nuisance and property law would have precluded the activity in question.\footnote{Lucas, 505 U.S. at 1028-32.} Since that time, however, the Supreme Court and lower courts generally have declined to apply the per se rule in their takings cases. Instead, courts either have declined to sever property interests in space or time in a way that would result in a denial of all economic value of the property or relied on the “background principles” exception in \textit{Lucas} to uphold the regulation in question.\footnote{See, e.g., Tahoe-Sierra Pres. Council v. Tahoe Reg’l Planning Agency, 535 U.S. 302 (2002) (holding that moratorium imposed on development as part of land use planning was not a per se taking on grounds that after moratorium was lifted, the claimants could pursue their development rights); Esplanade Props., LLC v. City of Seattle, 307 F.3d 978 (9th Cir. 2002) (holding that city’s denial of a shoreline development permit application was not a taking based on the “background principles” of Washington law which restricted the type of development at issue under the public trust doctrine); Palazzolo v. Rhode}
approach to this issue, the trend among courts in recent years appears to be away from allowing the property owner to define discrete rights in property in either time or space in a way that enhances arguments that favor per se regulatory takings claims.

In the context of CO\textsubscript{2} storage, it would appear to be very difficult for a surface owner or mineral owner to successfully make the case that a regulatory restriction or even outright prohibition on deep subsurface use would eliminate all economically beneficial use of the property, resulting in a per se regulatory taking under \textit{Lucas}. Based on the authority in this area, it is difficult to argue that a “pore estate” could be reasonably severed from the rest of the surface or mineral estate. For extraction operations, the pore space contains the extractable resource. This relationship is not unlike that in \textit{Keystone Bituminous}, where the Court determined the support estate had value only with regard to its relation to the other estates. Although recent lower courts have split over whether coal bed methane gas is part of the coal estate or the surface estate, all courts have held it to be part of one or other at least with regard to disputes between surface owners and mineral owners.\textsuperscript{242} Indeed, even if one accepts severability for related resources that can be physically separated, it is even more difficult to assert that the pore space should be separated from the rock formation as there quite literally is no “pore” without the surrounding rock.

Alternatively, one could argue that there should be a severance of property interests for takings purposes not with regard to any discrete portion of the resource but rather in sections along a vertical axis. To date, the Court has rejected efforts to sever property along the horizontal access for takings purposes where one landowner owns multiple parcels and only some of those parcels are burdened by regulation at issue.\textsuperscript{243} Likewise, in \textit{Penn Central}, the

\textsuperscript{242} \textit{See} Newman v. RAG Wyoming Land Co., 53 P.3d 540 (Wyo. 2002) (holding coal bed methane was not a mineral mined in association with coal, but rather a separate process); Harrison-Wyatt LLC v. Donald Ratliff, No. 030634 (Va. March 5, 2004); Carbon County v. Union Reserve Coal Co., 898 P.2d 680, 687 (Mont. 1995) (holding that coalbed methane was not a constituent part of the coal). \textit{But see} Vines v. McKenzie Methane Corp., 619 So.2d 1305, 1308 (Ala. 1993). \textit{See also} Laitos & Getches, \textit{supra} note 221, at 6.

\textsuperscript{243} \textit{See e.g.}, Palazzolo v. Rhode Island, 533 U.S. 606, 616 (2001) (holding that the petitioner could not sever the discrete piece of land affected by the coastal wetlands legislation from the whole parcel he owned, and noting that the lower court “was correct to conclude that the owner is not deprived of all economic use of his property because the value of upland portions is substantial”). For a more extensive analysis of conceptual severance applied to both a vertical and horizontal axis, see Raymond R. Coletta,
Court refused to sever “air rights” along a vertical axis. Even if the deep subsurface were severed from the shallower subsurface and surface estates, it is still unclear whether any loss resulting from regulation of CO$_2$ storage would represent a total loss of economic value of that parcel.

On the other hand, if the surface estate and mineral estate are in separate ownership, and restrictions on use of the subsurface completely prohibit the ability of a mineral owner to access or use the entire mineral estate, that would appear to provide a better basis for arguing that the regulation has resulted in a reduction of all economic value of the mineral owner’s property. Thus, the impact of the regulation on the mineral owner will be critical. If the mineral owner’s property is limited, and the regulation eliminates its economic value entirely, there might be a per se takings claim under *Lucas*. On the other hand, if the mineral owner’s subsurface holdings are extensive, as was the case in *Keystone Bituminous*, it is more likely that a court would find that regulatory restrictions on some but not all of the mineral holdings owned by that party would be balanced against that which remains, using a *Penn Central* balancing test rather than finding a per se taking. In sum, it is unlikely a court would find that restrictions on subsurface use and exploration for purposes of preserving the integrity of the CO$_2$ reservoir would constitute a per se taking except in the case where the regulations completely prevent a mineral owner from accessing all of its mineral holdings.

If regulations protecting the CO$_2$ reservoir are found to deprive a surface or mineral owner of some but not all of the economic value of the surface or mineral estate, courts will then conduct a takings analysis using the *Penn Central* balancing factors: (1) the character of the government action; (2) the severity of the economic impact; and (3) the extent to which the regulation interferes with the property owner’s distinct, “investment-backed” expectations. With regard to the character of the government action, the purpose of any regulation to protect the integrity of the CO$_2$ storage basin would be to facilitate the deployment of a critical technology to address climate change. The regulations would also be intended to promote public health and safety by ensuring that stored CO$_2$ does not cause harm to resources outside the storage area or escape into the atmosphere and cause harm to nearby surface and subsurface resources. As to the severity of the economic impact, it remains uncertain precisely how the use of pore space and the surrounding area will be allocated and regulated. It is likely, however, that surface owners and mineral owners may be prohibited from drilling through a confining layer in a way that punctures or compromises the storage area. For some property owners, these restrictions will have a minimal impact on their existing or reasonably-foreseeable surface or subsurface operations, but for others, the impact may result in additional restrictions or costs.

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245 *Penn Central*, 438 U.S. at 124.

246 See, e.g., *KAN. ADMIN. REGS.* §§ 82-3-1100 to 82-3-1120 (proposed January 2009) (regulations for the underground storage of CO$_2$ that include provisions on permitting, monitoring, and leakage reporting, as well as requirements for drilling through a CO$_2$ storage facility). *See also supra* Table 1.
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Finally, the weight of the third factor, interference with reasonable, investment-backed expectations, will depend in large part on the extent to which the surface owner or mineral owner currently makes use of the subsurface or could reasonably expect to do so in the future, as opposed to having merely an abstract desire for future use. These owners already using the pore space for underground waste injection or natural gas storage may have a cognizable investment-backed expectation, whereas the vast majority of surface owners will have a difficult time establishing current or even plausible uses for the pore space a kilometer underground.

Ultimately, unless a court finds there is a deprivation of all economic use of the property, it is unlikely a court would find that regulations restricting some portion of the surface or subsurface would constitute a taking under the *Penn Central* balancing factors. This would be in large part because of the critical importance of addressing climate change as well as the important public health and safety concerns associated with the release of CO\(_2\) vertically into the atmosphere. In any particular case, however, there is the possibility that if regulatory restrictions interfere substantially with existing uses of the surface or subsurface, a court may find that the extent of deprivation is so great as to constitute a taking on grounds that the regulation has “gone too far” and the government must pay its way.

IV. CREATING A FEDERAL REGULATORY STRUCTURE FOR SUBSURFACE PORE SPACE RIGHTS FOR CO\(_2\) STORAGE

In order for CO\(_2\) storage to be used effectively on a widespread basis as a climate change technology, there must be some federal regulatory structure to approve and regulate CO\(_2\) storage projects. In the absence of a regulatory structure, state regulation is possible but regulation at the state level will have difficulty addressing problems related to storage under federal lands, storage basins that cross state lines, and other interstate issues relating to the transport and injection of CO\(_2\) into the subsurface on the massive scale necessary to address dangerous climate change. Because of the government and private investment that will be necessary to create and implement such a regulatory system, how much money CO\(_2\) operators or the government will actually have to pay to obtain pore space and the complexity of the underlying transactions are important questions.

As discussed in Part III, we believe it is not consistent with the precedent in the area of subsurface property rights to simply declare there are no private property rights more than 1000 feet below the surface of the earth. Instead, we propose that lawmakers and courts continued to recognize “limited” property rights in the subsurface, with those

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247 *Penn Central*, 438 U.S. at 130.
248 *Lucas*, 505 U.S. at 1014 (“while property may be regulated to a certain extent, if the regulation goes too far it will be recognized as a taking”) (quoting Pennsylvania Coal Co. v. Mahon, 260 U.S. 393, 415 (1922)).
limitations arising from: (1) whether or not the surface owner or mineral owner has made actual use of the subsurface property at issue; (2) whether there are valuable, commercially-exploitable resources in the subsurface; (3) the extent to which Congress or state legislatures have declared that the use of the subsurface for CO₂ storage is in the public interest; (4) the extent to which CO₂ injection and storage will interfere with the landowner’s or mineral owner’s actual use of the surface or subsurface; and (5) the federal or state regulatory structure in place to balance the rights of surface owners, mineral owners, and CO₂ operators working in the public interest.

We see this as a middle ground with regard private property rights and transaction costs surrounding implementation of CCS and a position that best reflects the existing precedent in the area of subsurface property rights. John Sprankling’s proposal (discussed in Part III) that there be no property rights more than 1000 feet below the surface certainly has the least transaction costs with regard to CCS—if there are no subsurface rights more than 1000 feet below the surface, there is no need to negotiate with surface owners or mineral owners for any injection of CO₂ below that depth. A strict application of the ad coelum doctrine, on the other hand, would recognize absolute property rights to the subsurface in all cases, requiring voluntary transactions or eminent domain actions to obtain all of the subsurface within a storage basin.

As discussed in more detail in Part II, neither the ad coelum doctrine nor an absolute rule of federal government ownership of the subsurface reflects either the judicial precedent or reality when it comes to subsurface property rights. Much of the subsurface that would make up CO₂ storage basins, particularly in the West, may be owned by federal or state governments, allowing CO₂ operators to negotiate with a limited number of owners, if negotiation is required at all for subsurface in public ownership (as opposed to simply obtaining a permit). Other portions of the subsurface may be in private ownership but have never been used by the surface owner and, under existing case law, those owners would appear to have limited or no rights to the subsurface other than to have standing to sue for trespass or nuisance to recover damages or seek an injunction in case of actual harm. In some cases, however, surface owners, mineral owners, natural gas companies, or entities using underground injection techniques for oil and gas development or waste disposal may be making actual use of the subsurface (or such use is reasonably foreseeable) and CO₂ storage could interfere with those uses. In those cases, lawmakers and courts should recognize a property right to the subsurface and create a regulatory structure that provides a means for CO₂ operators to take that property by eminent domain if it is necessary, assuming that lawmakers deem CO₂ storage to be a higher public interest than the current use being made of the subsurface. The remainder of this Part considers a framework for implementing such a regulatory structure and discusses the related issue of just compensation.

A. Eminent Domain Authority for the Acquisition of Subsurface Pore Space

As is likely obvious at this point, in order for CO₂ storage to become a reality under our proposal, federal legislation (or at the very least state legislation in all states that
would authorize CO₂ storage for CCS) is necessary. This legislation would need to declare that CO₂ storage for purposes of addressing climate change is in the public interest and grant eminent domain authority to private parties to facilitate CO₂ storage upon receipt of a permit or certificate creating the storage basin. Many states are already pursuing this step as shown in Table 1. This would be similar to the framework created in the Natural Gas Act for condemnation of surface and subsurface lands for the transmission and storage of natural gas. Such a framework would recognize the limited property rights in the subsurface that currently exist and allow CO₂ storage in the public interest to override those rights without payment of compensation when those rights have not been “in use,” and to override those rights with payment of compensation when those rights have been “in use.”

EPA currently regulates and permits injection of substances, including CO₂, pursuant to its Underground Injection Program (“UIC”) Program administered under the Safe Drinking Water Act. In order to implement large-scale injection and storage of CO₂ to reduce GHG emissions, however, there will likely need to be federal legislation that specifically authorizes such injection and storage into designated underground storage basins that cover multi-state areas. Based on the analysis above, at least some of the subsurface area within those storage basins will lie beneath private property. As a result, any federal legislation governing large-scale CO₂ storage should include provisions that authorize the federal government, state governments and/or private parties to exercise the right of eminent domain.

As discussed in Part III, under the Fifth Amendment to the U.S. Constitution, the government has the power to take private property by eminent domain so long as it is taken for “a public use” and “just compensation” is paid. Courts have interpreted “public use” very broadly to include not only the use of property for schools, railroads, post offices and the like that will be put into “use by the public,” but also a wide-range of more controversial “public purposes” connected to land development such as the government transfer of private property to another private owner to develop the property in a way that will eliminate blight or simply increase the tax base for the community. Establishing that the storage of CO₂ to reduce GHG emissions is a “public purpose” that justifies the use of eminent domain consistent with the Fifth Amendment will be made easier by the growing recognition of the dangers of climate change. There is now broad consensus that climate change poses a significant national and international threat to human health and the environment. The use of private property to aid in addressing that threat would appear to be in the public interest, for a public benefit, and for a public purpose, and thus is likely constitutional so long as just compensation is paid.

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249 U.S. CONST. amend. V.
250 See Kelo v. New London, 545 U.S. 469 (2005) (finding that City of New London’s exercise of its eminent domain power to take private residences in connection with development of a corporate headquarters for Pfizer Corporation to increase the city’s tax base and spur development in an economically distressed area was a “public purpose” consistent with the Fifth Amendment).
Moreover, in 2005, in *Kelo v. City of New London*, the Supreme Court reaffirmed a very broad interpretation of the public use clause, confirming that it was not limited to “use by the public” but included any purpose of public benefit, public interest, or value to the community. Thus, in *Kelo*, the Court held that the City of New London’s actions to take a private residence to facilitate development of a new corporate headquarters for Pfizer Corporation and increase the community’s tax base was a “public use” that supported the exercise of eminent domain authority with payment of just compensation. Likewise, courts have upheld the use of eminent domain authority in connection with the creation of subsurface natural gas storage basins and held that EOR, field unitization, and subsurface hazardous waste injection are all a benefit to the community and in the public interest. Based on this precedent, it would be unlikely for a court to find that storage of CO$_2$ for purposes of combating climate change, one of the country’s most pressing environmental needs, is not a public use if such storage is carried out pursuant to federal or state legislation declaring it a public use and supporting that declaration with the appropriate scientific findings and data.

To the extent the federal government wishes to enlist private CCS operators in implementing large-scale CO$_2$ storage, Congress will need to enact legislation that not only establishes that such storage is a public use but also specifically grants the power of eminent domain to such private actors. One model for granting such authority and regulating its use is the Natural Gas Act (NGA). Under the NGA, a natural gas company that wishes to construct an interstate natural gas pipeline or obtain subsurface property for natural gas storage must obtain a certificate of public convenience and necessity from the Federal Energy Regulatory Commission (FERC). After the company submits an application for a certificate that describes the project and establishes why the project is required and is in the public interest, FERC files a public notice of the application in the Federal Register, solicits public comment, and conducts a public hearing on the application. As part of its evaluation, FERC must, among other things, investigate the environmental consequences of the project and issue an environmental impact statement consistent with the National Environmental Policy Act (NEPA). At the end of the process, FERC issues a certificate if it finds that the proposed project “is or will be required by the present or future public convenience and necessity.”

Once FERC has issued the certificate, the NGA empowers the certificate holder to exercise “the right of eminent domain” over any lands needed for the project if the necessary property interests cannot be obtained through voluntary contractual negotiations. Moreover,
although the NGA itself does not provide for a “quick-take” process whereby the certificate holder can obtain possession of the property prior to the determination of just compensation, numerous courts have authorized certificate holders to obtain such immediate possession through the equitable remedy of a preliminary injunction. As a result, after depositing an amount of money with the court equal to the appraised value of the property (and establishing sufficient financial viability to pay any additional amounts awarded by the court), the certificate holder can begin construction of the pipeline or natural gas storage area while the amount of compensation owed is still being litigated.

This structure under the NGA for reviewing projects and authorizing the right of eminent domain can serve as a partial model for CCS legislation. Congress could enact CCS legislation that creates a comprehensive regulatory, geologic, and environmental review process to determine whether a CCS storage project is in the public interest. This process, which could be conducted by FERC with mandatory input or consultation from EPA and other federal agencies, would be subject to public notice, comment, geologic review, environmental review, and other expert review. A determination that the project is in the public interest would result in FERC or whatever federal agency is granted authority over such review issuing a certificate that indicates the project is in the public interest. The CCS operator holding the certificate would then be authorized to exercise the power of eminent domain to obtain any necessary property interests if it cannot obtain such interests through voluntary contractual negotiations. Congress could also specifically grant “quick-take” authority to the certificate holder so that project implementation may begin before the final determination of just compensation.

As discussed earlier, simply because a private party owns land above a proposed CO\textsubscript{2} storage basin does not mean that private party has a “property interest” in the subsurface that can be acquired only by eminent domain. Instead, unless the surface owner (or mineral owner) can establish actual use of the subsurface, reasonably foreseeable use of the subsurface, or actual damage, the surface owner may have little or no recognizable property interest in the subsurface area and the CCS certificate holder can use that subsurface area without any payment of just compensation. If, however, storage of CO\textsubscript{2} pursuant to the certificate will actually interfere with subsurface uses of the property by surface owners or mineral owners, the CCS operator would be able to exercise the right of eminent domain to obtain these subsurface property rights with payment of just compensation.

\footnote{260 See \textit{East Tenn. Natural Gas Co.}, 361 F.3d at 827 (granting immediate possession to natural gas company after issuance of order recognizing right of eminent domain under NGA but before determination of just compensation and citing other cases granting similar immediate possession); Jim Behnke \& Harold Dondis, \textit{The Sage Approach to Immediate Entry by Private Parties Exercising Federal Eminent Domain Authority Under the Natural Gas Act and the Federal Power Act}, 27 \textit{ENERGY L.J.} 499 (2006).}

\footnote{261 \textit{Id.}}
B. Just Compensation

Just as the Fifth Amendment of the U.S. Constitution does not provide much guidance as to when a taking has occurred, it also does not provide much guidance as to how “just compensation” should be measured. It simply states that private property shall not be taken “without just compensation.” The objective of determining just compensation in takings claims is to put the claimant in the financial position he occupied before the taking. This is intended to be assessed from the perspective of the landowner. As Justice Holmes has stated, the question is, “what has the owner lost?” not, “what has the taker gained?” Assessing the value or worth any particular person places on a specific piece of property, however, can be a difficult enterprise. As a result the Court generally has used a more practical measure in the form of the concept of “fair market value” or, what a willing buyer would pay to a willing seller, “even though this measure does not encompass all values an owner may derive from his property.” Put otherwise, if there is a prevailing market price at the time of the taking, that price is just compensation. Fair market value is also recognized as a means to strike a fair “balance between the public's need and the claimant's loss” in takings cases.

The Court, however, has refused to designate market value as the sole measure of just compensation, and even in cases where there is an established market there is not necessarily a fixed method for determining the market value. Although the best evidence of market value may be recent sales, courts also have found that any “fair and non-discriminatory” method of determining a “fair and realistic value” is acceptable. While the fair market value measure becomes somewhat problematic when there is no willing seller in a takings case, it becomes even more problematic in the situation where there is not only no willing seller but also no established market at all. Thus, the Court has recognized that in

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262 U.S. CONST. amend. V.
263 See United States v. Toronto, Hamilton & Buffalo Nav. Co. 338 U.S. 396, 404 (1949) (“We take it that in the valuation of readily salable articles, price at the market nearest the taking is, at least in the usual case, a practical rule of thumb, and one that is most likely to place the claimant in the pecuniary position he occupied before the taking.”).
264 Boston Chamber of Commerce v. City of Boston, 217 U.S. 189, 195 (1910).
266 Olson v. U.S., 292 U.S. 246, 255 (1934) (“That equivalent is the market value of the property at the time of the taking contemporaneously paid in money”); see also Yancey v. U.S., 915 F.2d 1534, 1543 (Fed. Cir. 1990) (“Fair market value under the Fifth Amendment is normally ascertained at the date the governmental restrictions are imposed, which is the date of the taking”).
268 564.54 Acres of Land, 441 U.S. at 512.
269 Id.
270 Id. (“The ultimate purpose of valuation, whether in eminent domain or tax certiorari proceedings, is to arrive at a fair and realistic value of the property involved so that all property owners contribute equitably to the public fisc. Any fair and nondiscriminating method that will achieve that result is acceptable.”).
271 Id. (Frankfurter, J. concurring) (“Resort to the conventional formulas for ascertaining just compensation for the taking of property rarely bought and
some circumstances, it simply may be impossible to determine a market value, particularly in cases where there have been too few sales to credibly predict a future price.\(^{273}\)

Turning once again to eminent domain actions brought under the Natural Gas Act, determining just compensation in those cases is often difficult because subsurface gas storage rights are not commonly traded on the public market in the same way as surface rights. As a result, comparative sales and other valuation methods are difficult to determine. In one Ohio case, *Columbia Gas Transmission Corp. v. an Exclusive Gas Storage Easement*,\(^{274}\) the U.S. Court of Appeals for the Sixth Circuit held that state law governing just compensation should apply to federal condemnation of natural gas storage easements. When the issue of just compensation was certified to the Ohio Supreme Court, the state court adopted the federal district court’s instructions to the condemnation commission regarding the factors to be taken into account in setting just compensation. These factors were: (1) comparable sales (if available);\(^{275}\) (2) any probable revenues to the landowner associated with commercially-recoverable natural gas under the property; (3) the fair market value of the storage easement based upon a capitalization of retail income from the right to store gas; (4) depreciation in the fair market value of the condemned tract as a whole by reason of the taking of the storage easement; (5) the existence of any mineral leases on the property; and (6) the value of the property from the landowner’s perspective (not the value of the storage easement to the natural gas company).\(^{276}\)

The judicial principles governing just compensation in general and just compensation for subsurface natural gas storage in particular could guide any valuation of CO\(_2\) storage areas in potential eminent domain actions for owners with a protectable property interest. If evidence of comparable sales or rental payments are not easy to identify, as is likely with regard to the right to store CO\(_2\) hundreds or thousands of meters underground, parties will look to other factors to establish just compensation. For instance, a landowner who can establish the existence of commercially recoverable resources may attempt to calculate the probable revenues and costs of extracting the resource to determine just compensation,\(^{277}\) although this approach is somewhat controversial as future revenues often are thought to be too


\(^{274}\) 962 F.2d 1192 (6th Cir. 1992).

\(^{275}\) It was reported that in 1993, Columbia routinely paid four dollars per acre per year for the right to store gas beneath a property while the East Ohio Gas Company paid five dollars per acre per year. See McGrew, *supra* note 178, at 153-54. These transactions are rentals and thus must be converted and reduced to present value in cases where the gas company wishes to obtain a permanent easement. Moreover, because there is no real market for this property other than gas storage, the gas company essentially has a monopoly, which casts doubt on these amounts as fair market value. *Id.*


\(^{277}\) *Id.* at 49 (noting that the full amount must also be reduced by the interest enjoyed by a one-time payment).
speculative. Parties also may show a depreciation or loss in the whole property value due to the taking at issue, a measure commonly used in partial takings cases. For instance, in general, the ultimate measure of the permanent damages sustained by an owner from the establishment of a pipeline easement across his or her land is the difference between the fair market value of the whole premises immediately before the taking and the fair market value thereof immediately afterward. Thus, just as in the natural gas storage cases, parties and courts will need to be creative in determining just compensation for any actions to take subsurface property for purposes of CO₂ storage.

CONCLUSION

This Article explores the role of property rights in current efforts to develop the technology to transport, inject, and store underground hundreds of million of tons of CO₂ per year as a means to address climate change. Ultimately, we conclude that while most surface and mineral owners do not have a protectable property interest in subsurface pore space, those surface and mineral owners that make actual or reasonably-foreseeable use of the pore space in which the CO₂ would be stored may have protectable property interests. With regard to those owners, there is the possibility that injection and storage of CO₂ may result in a physical taking or, under very limited circumstances, a regulatory taking. At issue for these owners is whether the government has the right to take the porespace by eminent domain consistent with the Fifth Amendment. We conclude storage of CO₂ will likely be found to be a “public use” under the Fifth Amendment because of its potentially important role in combating climate change, and thus an eminent domain action would be lawful. We propose a regulatory framework for such eminent domain actions modeled on the Natural Gas Act. Ultimately, CCS is a promising technology that may play a major role in efforts to address climate change. Before it can be implemented on a grand scale, however, policymakers and courts must identify, analyze, and begin to resolve these important property rights issues, and this Article attempts to aid in those efforts.

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278 See McGrew, supra note 178, at 156.
279 Id. at 159.
280 American Louisiana Pipe Line Co. v. Kennerk, 144 N.E.2d 660, 665 (Ohio App.1957) (recognizing that in Ohio there is a distinction between damages and compensation).