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Assessing the Challenges of Geologic Carbon Capture and Sequestration:

A California Guide to the Cost of Reducing CO_2 Emissions

by Les Lo Baugh & William L. Troutman***

Introduction

Carbon capture and sequestration ("CCS") is receiving new and intense focus globally, driven by climate change and potential economic benefits. At an energy symposium this past December, the Australian Government announced its $100 million commitment to the Global Carbon Capture and Storage Institute.[1] In so doing, Australia noted that by 2030, global energy demand is estimated to rise by fifty-five percent, with emissions of sixty-two gigatons ("GT") globally, thus emphasizing the need for an increase in CCS efforts worldwide.[2]

Echoing these sentiments, a number of research initiatives have begun in the United States, highlighted by the Regional Carbon Sequestration Partnerships, sponsored by the Department of Energy ("DOE").[3] President Barack Obama has also emphasized the need for CCS, including in his energy plan the intent to "instruct DOE to enter into public-private partnerships to develop 5 'first-of-a-kind' commercial scale coal-fired plants with carbon capture and sequestration."[4] While this research is identifying effective technologies to make CCS a practical reality, it has not yet broached the legal and regulatory challenges associated with large-scale CCS projects to substantively reduce greenhouse gas ("GHG") emissions.

That these questions remained unanswered reveals the complicated legal truths regarding CCS—any project must navigate a complicated web of state and federal property rights issues, address public safety concerns, and develop risk mitigation measures to ensure long-term efficacy. Thus far, no one in the United States has taken the lead to establish a legal and regulatory framework for CCS.

As one of the largest producers of carbon dioxide ("CO_2") emissions in the United States, California is prominently positioned to lead the way in setting CCS precedents on a regional basis. Given California's historical position on the vanguard of environmental issues, it is likely that its involvement in the CCS discussion will also have a formative effect on establishing the national legal and regulatory framework necessary for efficient, effective, and successful geologic CCS ("GCCS").

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Accordingly, this article considers the legal risks inherent in CCS projects through the lens of California law, focusing on GCCS.[5] Because the law of GCCS is undeveloped, many of the considerations discussed are directly applicable to assessing legal risk in other jurisdictions. Ultimately, surveying the many issues that impact such risk may help eliminate barriers to large-scale, commercially viable GCCS projects that are necessary to meaningfully reduce GHG emissions, regionally, nationally, and internationally.

First, the article provides a brief overview of the mechanics of GCCS. Then the article identifies and discusses one of the fundamentals to assessing GCCS risk—ownership. Next, it analyzes potential liabilities confronting any GCCS project in California, drawing on legal principles that are readily analogous to other jurisdictions. Finally, it proposes some mechanisms to manage the risks associated with GCCS.

The Basics of Geologic Carbon Capture and Sequestration

As the name implies, GCCS involves the capture and sequestration of CO_2 for hundreds, if not thousands, of years. Simply put, CO_2 must first be captured, pre-combustion, post-combustion, or by oxy-firing combustion.[6] It then must be stored permanently (in contrast to enhanced oil recovery ("EOR"), in which CO_2 is not sequestered permanently).

Three basic forms of CCS exist: (1) terrestrial sequestration, involving trees, grasses, soils, or algae; (2) deep-sea sequestration, involving containment and dissolving in deep oceans; and (3) geologic CCS. GCCS utilizes underground reservoirs, such as depleted oil and gas fields, saline aquifers, and un-mineable coal seams. Research efforts thus far show that GCCS in saline formations has the greatest near-term potential to reduce GHG emissions, although the legal and regulatory challenges are

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great.[7] However, geologic sequestration is not new. Millions of tons of CO_2 are injected each year. Projects such as Statoil at Sleipner, BP at In Salah, and the EnCana EOR project have been operating for years.

The process of GCCS begins with capturing CO_2 from fossil-fuel power plants, cement plants, petroleum refineries, etc.[8] The gas stream is then scrubbed, resulting in virtually pure CO_2.[9] It is then compressed and cooled to a supercritical state, during which it exhibits characteristics of both liquid and gas.[10] Once supercritical, the CO_2 is transported to the injection site by truck (pipelines are expected once commercial projects get started).[11]

Once at the injection site, the captured, purified, and compressed CO_2 is injected through wells into "pore space" deep below the surface of one or more cap rock formations.[12] Pore space consists of porous sedimentary rock layers, formed from sand, mud, or ancient shells, that allow the passage of fluids.[13] Sedimentary rock occurs in layers, flanked by other layers of impermeable rock, such as mudstone and clay.[14] These impermeable layers trap water, oil, and gas beneath and between them.[15] Depths of between 3,000 and 15,000 feet are generally considered ideal for GCCS because pore space at that depth is often comprised of saline aquifers, containing ancient, trapped saltwater with high levels of dissolved solids.[16] The water in these deep saline reservoirs is considered commercially "useless" because of its depth and contamination.[17] In deep saline formations, it is theorized that supercritical CO_2 will flow as a distinct liquid on top, displacing and compressing the saline water below it.[18] When injection ceases, scientific models predict that the CO_2 will remain hydro-dynamically trapped at the top of the aquifer by the cap rock or other impermeable layer, remaining in place for thousands of years.[19]

Estimates put the geologic storage capacity in saline formations in the United States at a vast 3,300 to 12,000 billion metric tons.[20] In California alone, DOE estimates the storage space in deep saline formations to be between 76 and 303 billion metric tons.[21] To put this in perspective, California emits an estimated 104 million metric tons of CO_2 per year.[22] Thus, the potential impact on reducing these emissions into the atmosphere is great—but not without legal challenges.

GCCS Ownership Issues

Because of the long-term nature of GCCS, ownership issues regarding real property interests and long-term liability are critical and unique, centered on the question of pore space.[23] In many regions, the law of ownership regarding subsurface mineral and water rights is well developed. However, no clear answers exist as to the ownership of pore space.[24] This issue is slowly being addressed at the state level, as Wyoming, Texas, and Illinois have recently enacted statutory provisions regarding pore space and liability, but only for specific CCS purposes.[25] The application of the concept of the "negative rule of capture," and its associated statutory provisions, are also untested in the GCCS context.[26]

Because of the long-term nature of GCCS, ownership issues regarding real property interests and long-term liability are critical and unique, centered on the question of pore space.

In California, the surface owner generally owns the rights to property below the surface, "to the center of the earth, and above the surface to the heavens."[27] Thus, if the surface and subsurface rights have not been severed, the pore space should remain with the surface owner. However, circumstances exist in which the perceived public interest is substantial and the potential property use is limited by practical considerations. For instance, airplanes enter airspace above property at a safe altitude without it constituting a trespass. Access to navigable water and shorelines is treated similarly. As such, the public interest aspects of GCCS may affect ownership as GCCS becomes a more integral part of climate change solutions.

Similarly, the issue of ownership of pore space for CCS purposes has not been determined by either legislative action or express judicial decisions. The recent report and model rules released by the Interstate Oil & Gas Compact Commission, as well as numerous statements by various parties, including California state entities, have taken the position that the ownership of such pore space, particularly in saline formations as opposed to hydrocarbon formations, is undetermined.[28]

While no California court has explicitly vested pore space ownership in the surface owner of a severed estate for CCS purposes, absent legislative action or "judicial activism," it appears that the better argument is that pore space ownership resides with the surface owner and generally remains so even if mineral rights are severed. A surface owner who has conveyed its mineral rights and severed the estate,

> own[s] nearly all rights in the land except for the exclusive right to drill for and produce oil, gas and other hydrocarbons. The owners of the mineral estate . . . typically hold only the very limited right . . . to drill and capture subsurface oil and gas, and the incidental rights necessary to accomplish this. Thus . . . the lessee generally obtains only a nonpossessory interest in real property to capture such substances, which is in the nature of an easement.[29]

Accordingly, absent express language in the mineral grant, pore space ownership "should" likely remain with the surface owner despite severance; however, the wording of the operative agreements must be evaluated to determine whether or not a broader conveyance occurred than is typical. This conclusion is supported by a number of cases in other jurisdictions addressing ownership of storage space for natural gas.[30] Gas storage cases in Texas, West Virginia, Oklahoma, Louisiana, and Michigan have all stated that the surface owner, and not a mineral rights holder, retains ownership of pore space.[31] Nonetheless, even assuming a court of first instance applied the above logic to GCCS, a risk of tort liability remains on severed estates if the mineral rights are not also acquired prior to injection, as migrating or escaping CO_2 could allegedly interfere with the mineral rights, as discussed below.

Risks of Ownership and Operation of a CCS Project in California

The focus of the experimental and pilot GCCS projects is the validation of the scientific models. While awaiting this validation, however, various risks must be evaluated. The first concern for a developer, for obvious reasons, is what happens if it is alleged that injected CO_2 does not remain sequestered in the manner expected. At the same time, a number of non-release legal risks also exist, even if captured CO_2 behaves as theorized. Whatever the cause, a GCCS project may encounter tort, nuisance, negligence, and/or strict liability claims. The more litigious the culture of the jurisdiction, the more likely such issues will be raised even in circumstances where GCCS performs to optimal expectations.

Liability from Release Events

In most circumstances, these liabilities will likely result if there is unexpected behavior of captured CO_2, such as migration offsite from the saline injection reservoir into a linked adjacent subsurface saline reservoir, where the pore space is located within a larger saline reservoir that extends to other estates. Theoretically, in some circumstances, CO_2 could also migrate through new faults or fractures into an unlinked adjacent subsurface saline reservoir; an adjacent hydrocarbon or mineral formation; groundwater; other adjacent subsurface strata; or onto the surface itself.[32]

If a GCCS site was not selected properly, theoretically, captured CO_2 might also react unexpectedly in the designated property, leading to potential liability if all surface and subsurface rights for the injection area had not been acquired. In those circumstances, CO_2 might migrate into other unacquired saline, hydrocarbon, or other mineral formations under the designated property. CO_2 might also migrate into other subsurface strata or groundwater stores under the designated property, or onto the unacquired surface at or near the injection point.[33]

While all of these possibilities might result in allegations of liability, the area of greatest concern would likely be from allegations of migration into hydrocarbon or other mineral formations, groundwater,[34] and onto the surface,[35] rather than from migration within the deep saline aquifer under adjacent property. This is due to the likely absence of any provable legal damages resulting from a theoretical CO_2 migration, as discussed below.

If a release of CO_2 from the injection reservoir did occur for whatever reason, this could theoretically expose a GCCS project to allegations for trespass, nuisance, negligence, and strict liability for operation of an ultrahazardous activity. While no California court has addressed these issues for GCCS, analogues exist within other subject areas, as well as in other jurisdictions.

Trespass

Trespass is the "'unauthorized entry' onto the land of another," regardless of motive.[36] A trespass may be permanent or continuing, with a continuing trespass constituting a series of separate injuries that can be discontinued or abated.[37] The classification as one or the other impacts statute of limitations issues, as well as potential damages amounts.[38]

While no California court has addressed subsurface trespass in the GCCS context, when injecting waste fluids, "causing subsurface migration of fluids into a mineral estate without consent constitutes a trespass."[39] However, courts may not hold CO_2 injection directly analogous to waste fluid injection, and migration into a saline aquifer may not be treated the same as a migration into a mineral estate. More importantly, as discussed below, because deep saline aquifers have no value for mineral extraction or groundwater use, courts may find no damages.

In the event damages are found, the general measure is that "which will compensate for all the detriment proximately caused thereby whether it could have been anticipated or not."[40] If a trespass is permanent, all past and future damages are recoverable in one action.[41] In instances of trespass for subsurface migration of fluids into a mineral estate, a normal measure of damages for trespass is the reasonable rental value of the property during the course of the trespass.[42] However, courts have flexibility and award the deterioration in the market value of the mineral estate, the costs of disposing of the substances causing the trespass, and the unjust enrichment enjoyed by the injector.[43]

Nuisance

Under California law, a nuisance is an interference with the use and enjoyment of a property right.[44] This interference must constitute unreasonable conduct that causes substantial harm.[45] As with trespass, a nuisance can be permanent or continuing.[46] If a nuisance is permanent, a party may only bring one action to recover all damages, including anticipated future damages.[47]

A plaintiff may seek either injunctive relief or damages in connection with a nuisance.[48] The measure of damages, like those for trespass, is "the amount which will compensate for all the detriment proximately caused thereby, whether it could have been anticipated or not."[49] A plaintiff may recover damages for annoyance, discomfort, inconvenience, and mental suffering, even absent physical damage.[50] If a nuisance is intentional, a court may award punitive or exemplary damages.[51] Damages may also consider diminution of the property value.[52] If a nuisance is continuing and can be abated, a plaintiff may seek an injunction and damages accruing prior to the abatement. If the nuisance continues, a plaintiff may bring successive actions for additional damages, so long as any prior award of damages did not include anticipated future damages.[53]

Negligence

A party is liable in California for negligence for injuries caused by its failure to exercise reasonable care given the circumstances.[54] Damages can be compensatory to "[restore] the plaintiff as nearly as possible to his or her former position, or [give] some pecuniary equivalent," as well as punitive.[55] Although the reasonable care standard is not judicially developed, it is expected that a court will consider the public benefit of sequestration in imposing a duty, in addition to the traditional negligence considerations of foreseeability, extent of harm, and causation.[56] This consideration will analyze the consequences to the public of the imposed duty, as well as the social utility of the activity.[57] The public policy aspects of CCS are in an evolutionary stage.

Strict Liability

Under California law, strict liability is imposed for ultrahazardous activities ("UHA"), defined as "certain activities [that] create such a serious risk of danger that it is justifiable to place liability for the loss on the person engaging in them, regardless of lack of culpability."[58] Classification of UHAs differs from nuisance activities because UHAs are lawful and cannot be abated.[59] Strict liability for UHAs is limited only to harm within the scope of the abnormal risk created, and applies only to the class of persons exposed to the abnormal risk.[60]

Because of these factors, a court must individually analyze the factual scenario for a claim to determine if the "risk created is so unusual, either because of its magnitude or because of the circumstances . . . as to justify the imposition of strict liability from the harm that results . . . even though it is carried on with all reasonable care."[61] Because strict liability is a theory of tort recovery, compensatory and punitive damages are the appropriate remedies, as applicable.[62]

Thus, the question of GCCS as a UHA is unique to each project. GCCS by its nature does not appear to pose an abnormal risk. However, as is commonly said, "bad facts make bad law." If unfortunate circumstances occurred, potential exists for the law to evolve in an unanticipated manner.

Select Considerations Impacting Liability

Released CO_2: The Question of Damages

Although unexpected migration of CO_2 may technically constitute a tort, an open question exists as to proving damages. While no California court has directly addressed damages in CO_2 sequestration, courts have decided the issue in the context of subsurface injection of fluids, which has analogues in oil, gas, and hazardous waste injection case law, both in California and in other jurisdictions. Accordingly, if no identifiable damage exists, a claim for unauthorized subsurface migration may fail. In the controlling California case on subsurface migration, *Cassinos v. Union Oil Co. of California*, injected waste water ultimately migrated into plaintiff's mineral estate, resulting in "widespread damage throughout a large oil, gas and mineral field."[63] Because this injection interfered with plaintiff's right to extract commodities, the court of appeals affirmed the trial court's award of rental value for the trespass—the market price for the cost of wastewater injection.[64]

If courts adopt this reasoning, which seems most appropriate, no damages should exist absent interference with another's mineral rights. Given that GCCS injects CO_2 into deep saline reservoirs, presumed to be devoid of any extractable minerals of value, the resulting encroachment within the saline reservoir on an adjoining estate should fail for lack of damages. Similarly, if the injected CO_2 migrates into unacquired strata on the acquired property containing no commodities, no damage should result.

These conclusions are consistent with the Ohio case *Chance v. BP Chemicals, Inc.*,[65] which establishes the precedent oft cited by GCCS prognosticators that no damage exists for subsurface migration of materials into adjacent landowners property absent a reasonable and foreseeable use of the subsurface by the adjacent landowner.[66]

GCCS Permitting Probably Will Not Yield a Permit Shield Defense

Currently, the injection of CO_2 will require a permit under regulations promulgated pursuant to the Safe Drinking Water Act ("SDWA").[67] The U.S. Environmental Protection Agency ("EPA") has recently proposed a new class of well under SDWA (Class VI) and minimum technical criteria for injection of CO_2.[68] This new permit would require adherence to a number of regulations aimed at preventing CO_2-related contamination of underground drinking water.[69] This begs the question of whether permitting of GCCS projects will protect an operator from liability in the event of a release with a "permit shield."[70] An examination of SDWA reveals that operators should expect no such defense, as SDWA does not contain the required specific language providing for a permit shield defense. Even if such a defense was clearly articulated in the statute, courts generally interpret permit shields to protect a permittee only from civil and criminal penalties assessed through a citizen suit or government action, and not common law claims such as trespass and nuisance.[71]

Liabilities for Non-Release Events

Unlike the risks of release of CO_2, these liabilities represent possible costs to a GCCS project before initiation and/or even if captured CO_2 remains sequestered as expected.

Environmental Permitting Challenges

In efforts to obtain appropriate permits and regulatory clearance on the state and federal level, a GCCS project may face significant and costly litigation before getting off of the ground. These costs most likely will come by way of challenges to permits required for compliance with SDWA and the National Environmental Policy Act ("NEPA") on the federal level, the California Environmental Quality Action ("CEQA") on the state level, and other local regulations.

It is difficult to predict the form of a challenge to a GCCS project's SDWA permitting, as EPA issued proposed rules for GCCS that have not yet been finalized (discussed above). In the interim, a challenge to a GCCS permit could come pursuant to a formal EPA guidance document issued to EPA staff and all EPA Regions covering issuance of permits for geologic sequestration under the existing SDWA regulations for underground injection.[72] While it is arguable that noncompliance with such a document could support some action by EPA, it is unlikely that a private party could avail itself of noncompliance with the guidance documents.[73]

The more likely challenge to a CO_2 injection permit would come directly from NEPA claims in federal court and CEQA claims in state court. This is a particularly perilous aspect of the process, as the analysis of the environmental impact of the injection plan will come under public scrutiny for the first time when the Environmental Impact Statement ("EIS"), under NEPA, or the Environmental Impact Report ("EIR"), under CEQA, is prepared. Given the developing nature of GCCS, a project may be particularly vulnerable, especially in litigious jurisdictions, during the EIS/EIR process in the event that a litigious private party or environmental group desires to slow or prevent the development of GCCS technology and projects.[74] These costs and/or delays are certainly possible even if an operator meticulously adheres to NEPA or CEQA requirements, such as the adequate discussion of alternatives and cumulative impacts, and avoidance of project segmentation.

> *A GCCS project may encounter tort, nuisance, negligence, and/or strict liability claims.*

Similarly, it is not unusual for the construction of a well to require a permit pursuant to county or city ordinances. For instance, under the Police Powers provisions of the California State Constitution and in other jurisdictions, local agencies may require permit conditions that have a reasonable relationship to the purpose of the permit.[75] Thus, methods of construction, as long as they are consistent with the requirements of the State Department of Gas, Oil & Geothermal Resources, may be part of the local permit. A challenge to these permits would also likely come under CEQA.

Geologic Sequestration and Injection Versus Allegedly Induced Seismic Activity

A number of reported instances of seismic activity induced by large scale human activities exist, such as underground nuclear explosions and construction projects.[76] Allegations of geothermal plant activity resulting in seismic activity during the 1990s in California did not apparently result in any financial awards to potential plaintiffs. In addition, in the 1960s some believed injected waste fluid triggered seismic activity in the Rocky Mountains, although this was not substantiated. However, this should not be viewed as a shield to such allegations in the future.

Although the depth of the target saline aquifer is generally substantially below the level of any seismic activity associated with the circumstances above, litigation risk exists because California is subject to notable seismic activities and no nexus need be proven before litigation is commenced. While the frequency of seismic activity in California could provide opportunities for plaintiffs to allege a nexus between GCCS activities and any specific seismicity, the historic background of recurrent seismic activity in California may make it difficult for a plaintiff to establish causation. If litigated, the general concepts of tort liability discussed above would apply.

Looking Forward: The Need for Certainty

At a minimum, this survey of California law shows that given the unknowns, the question of litigation over a project is one of "when" and "on what grounds." However, many potential GCCS operators may not view themselves as pioneers. While prudent contracting and operations, along with adequate insurance, typically reduce risk exposure, the long time horizon of sequestration poses unique liabilities and responsibilities that industry and current legal systems appear ill-equipped to address. But the chorus of government, industry, and environmental voices emphasizing GCCS as a climate change solution seems to argue that allowing a protracted period for courts to the develop the applicable law is inconsistent with the public interest. Notably, the recently proposed Emergency Economic Stabilization Act, which contains the Energy Improvement and Extension Act, began forcing these issues by providing GCCS tax incentives and requiring the Secretary of the Treasury, in conjunction with EPA, to establish regulations setting security measures to ensure CO_2 remains sequestered.[77] This first step hopefully will evolve into a substantial and expeditious resolution of these issues. Nevertheless, a number of precedents may provide a conceptual basis to address the unique issues of sequestration including post-operational issues.

Programs like the Acute Orphan Well Account, the Hazardous and Idle-Deserted Well Abatement Fund, and the Methane Gas Hazards Reduction Assistance programs may prove as stepping stones to addressing GCCS liability over the expected timeline, but they do not provide a shared solution when the injector, operator, or owner of the stored substance is financially viable.[78] These programs also only involve discovery of releases during the operational life of a project. Further, they do not cut off an operator's liability after well closure.

Other precedents may serve as more useful models, including the Price Anderson Nuclear Industries Indemnity Act and the National Flood Insurance Program. The former is similar to an industry liability pooling plan.[79] On the other hand, the latter guarantees insurance to at-risk communities.[80] Similarly, many GCCS commentators have called for government assumption of monitoring and liability after a reasonable time, such as 10 years following the end of injections.[81]

Another important matter for consideration is granting operators some form of eminent domain, similar to grants by the Federal Energy Regulatory Commission or state public utility commissions for gas pipelines.[82] This would presumably require new federal or state legislation, but would greatly reduce liability risks, project costs, and expedite development of GCCS (the lack of such power when it comes to alternative energy power lines is an analogous failure of the legal system to adapt to changing needs). Of course, much of the concern would dissipate if the migration of CO_2 is treated similarly to the state's basis for water regulation and air traffic—that is, absent some reasonable expectation of use or actual damage, no claim lies for a property owner.

Conclusion

In light of the enormous potential for GCCS to be a useful tool in the battle against climate change, thoughtful but expeditious resolution of these issues is clearly in the public interest, both nationally and internationally. Unfortunately, legislative gridlock and political partisanship have too often been part of recent legislative processes. However, the generally accepted need to aggressively address the continued massive infusion of CO_2 into our atmosphere should provide focus and incentives to our leaders. Given the need to address GCCS and its associated legal obstacles, one can only hope lawmakers move faster than hydro-dynamically trapped CO_2.

Endnotes: Assessing the Challenges of Geologic Carbon Capture and Sequestration

1 *See generally* Michael Sheldrick, Global Carbon Capture and Storage Institute, Australian Government, Remarks at the IEF-IFP Symposium on the Role of Technology in the Petroleum Sector in Enhancing Global Energy Security (Dec. 15, 2008), *available at* http://www2.iefs.org.sa/Events/Documents/Michael%20Sheldrick.pdf (last visited Feb. 21, 2009).

2 *Id.*

3 *E.g.*, Office of Fossil Energy Nat'l Energy Tech. Lab., U.S. Dep't of Energy, Carbon Sequestration Atlas of the United States and Canada (2008), *available at* http://www.netl.doe.gov/technologies/carbon_seq/refshelf/atlasII/atlasII.pdf (last visited Feb. 21, 2009).

4 Obama Biden, Barack Obama and Joe Biden: New Energy for America 6, *available at* http://www.barackobama.com/pdf/factsheet_energy_speech_080308.pdf (last visited Feb. 21, 2009).

5 As set forth in this discussion, this article focuses on GCCS because of the vast storage reservoirs in the United States.

6 D.J. Dillon et al., The Babcock & Wilcox Co., Oxy-Combustion Process for CO2 Capture From Advanced Supercritical PF and NGSS Power Plant 1 (2005), http://uregina.ca/ghgt7/PDF/papers/peer/145.pdf (oxy-firing combustion, or simply oxy-combustion, is the process by which a fossil fuel is combusted with near pure oxygen and recycled flue gas, CO_2, or water/steam to produce a flue gas consisting essentially of CO_2 and water. This flue gas is seen a potential means of disposing of combustion related CO_2 because the flue gas is not diluted with nitrogen, as when conventional air is used for firing, and therefore can be disposed of with less downstream processing).

7 As discussed *infra*, the United States has an estimated 3,300 to 12,000 billion metric tons of deep saline storage space, in contrast to an estimated 138,000 million metric tons of oil and gas reservoir storage space and 177,000 million metric tons of coal seam storage space. *See* Office of Fossil Energy Nat'l Energy Tech. Lab., *supra* note 3, at 139.

8 *See*, *e.g.*, Jeffrey W. Moore, *The Potential Law of On-Shore Geologic Sequestration of CO_2 Captured from Coal-Fired Power Plants*, 28 Energy L.J. 443, 447 (2007); National Energy Technology Laboratory, U.S. Dep't of Energy, What is Carbon Capture?, http://www.netl.doe.gov/technologies/carbon_seq/FAQs/carbon-capture.html (last visited Feb. 21, 2009).

9 Moore, *supra* note 8, at 452.

10 *Id.*

11 *Id.* at 447.

12 *Id.* at 452-53.

13 *Id.* at 452.

14 *Id.* at 452-53.

15 Moore, *supra* note 8, at 453.

16 *Id.* at 452-53.

17 *Id.* at 453.

18 *Id.* at 454.

19 *Id.*

20 Office of Fossil Energy Nat'l Energy Tech. Lab., *supra* note 3, at 20.

21 *Id.* at 138.

22 *Id.* at 139.

23 Additional surface rights are necessary for the implementation of the project, including easements for pipelines, exploration, injection and other wells, utilities, and road access to the site.

24 In some states, water is a "public resource," and it could be argued that the associated "pore space" is as well. However, case law in California focuses on the beneficial use of state waters—not saline containing dissolved solids in deep pore space that is unusable as water.

25 *See* H.R. 89, 59th Leg., (Wyo. 2008) (vesting ownership of "all pore space in all strata below the surface lands and waters" of the state in the "owners of the surface above the strata"); *see also* S. 1461, 80th Leg. (Tex. 2007) (shielding a clean coal GCCS project from liability if properly permitted); S. 1704, 95th Leg. (Ill. 2007) (declaring that the state assumes all liability for GCCS, but only in relation to the FutureGen experimental clean coal project).

26 Under this principle, similar to a party's right in some states to capture oil and gas migrating under her property from another's, one may by right inject substances that migrate under the property of others, even if it displaces other materials. *See*, *e.g.*, Bruce M. Kramer & Owen L. Anderson, *The Rule of Capture – An Oil and Gas Perspective*, 35 Envtl. L. 899, 934-35 (2005).

27 Cal. Civ. Code §§ 659, 829 (1872); Hinman v. Pac. Air Lines Transport Corp., 84 F.2d 755 (1936), *cert. denied*, 300 U.S. 654 (1937) (stating that a land owner's rights above and below land can be figuratively described as reaching the sky and the center of the earth; this analogy has no legal weight).

28 *See generally* Task Force on Carbon Capture and Geologic Storage, U.S. Dep't of Energy Interstate Oil and Gas Compact Comm'n, *Storage of Carbon Dioxide in Geologic Structures: A Legal and Regulatory Guide for States and Provinces* (Sept. 25, 2007) [hereinafter Task Force], *available at* http://iogcc.publishpath.com/Websites/iogcc/PDFS/2008-CO2-Storage-Legal-and-Regulatory-Guide-for-States-Full-Report.pdf (last visited Jan. 28, 2009).

29 Cassinos v. Union Oil Co. of Cal., 18 Cal. Rptr. 2d 574, 581 (Cal. Ct. App. 1993).

Endnotes: Assessing the Challenges of Geologic Carbon Capture and Sequestration *continued on page 67*

[30] *See*, *e.g.*, Tate v. United Fuel Gas Co., 71 S.E.2d 65 (1952); *see also* Dept. of Transp. v. Goike, 560 N.W.2d 365, 366 (1996) (holding that "a surface owner possesses the right to the storage space created after the evacuation of underground minerals or gas. . . . Only the surface owner . . . possesses the right to use the cavern for storage of foreign minerals or gas. . . .").

[31] Two caveats to relying on these decisions are that first, it is not clear if gas storage law is apposite to GCCS, and second, in each case, the language of the mineral rights grant impacted the respective court's analysis.

[32] *See generally* Mark Anthony de Figueiredo, The Liability of Carbon Dioxide Storage (Jan. 12, 2007) (Ph.D. dissertation, MIT), *available at* http://sequestration.mit.edu/pdf/Mark_de_Figueiredo_PhD_Dissertation.pdf.

[33] *See generally id*.

[34] If CO_2 migrated into groundwater and was deemed a contaminant, liability might arise for remediation of the groundwater by way of private litigation, the Comprehensive Environmental Response, Compensation, and Liability Act, the Clean Water Act ("CWA"), the California Porter-Cologne Water Quality Control Act, or the California state superfund statute. Specific facts are necessary to quantify potential costs.

[35] Because CCS law is undeveloped, this issue poses complex questions with no clear answers, as at least one scenario relates to alleged surface releases with claims of destruction of surface vegetation. *See* Michael L. Sorey et al., U.S. Geological Survey, *Invisible CO_2 Gas Killing Trees at Mammoth Mountain, California* (June 20, 2001), *available at* http://pubs.usgs.gov/fs/fs172-96 (last visited Jan. 29, 2009). More difficult questions exist regarding wholesale failure of GCCS, including impact on the use and trading of emissions credits.

[36] Cassinos v. Union Oil Co. of Cal., 18 Cal. Rptr. 2d 574, 578; Miller v. Nat'l Broad. Co., 232 Cal. Rptr. 668, 677 (Ct. App. 1986); 5 Witkin, Summary of Cal. Law Torts § 693(1)(a) (10th ed. 2005).

[37] Starrh & Starrh Cotton Growers v. Aera Energy LLC, 63 Cal. Rptr. 3d 165, 170-71 (Ct. App. 2007); Beck Dev. Co. v. S. Pac. Transp. Co., 52 Cal. Rptr. 2d 518, 557-60 (Ct. App. 1996).

[38] *Starrh*, 63 Cal. Rptr. at 170-71.

[39] *Cassinos,* 18 Cal. Rptr. 2d at 578.

[40] CAL. CIV. CODE § 3333 (1872); *Cassinos*, 18 Cal. Rptr. 2d at 582.

[41] Rankin v. DeBare, 271 P. 1050, 1050 (Cal. 1928).

[42] *Cassinos*, 18 Cal. Rptr. 2d at 582.

[43] *Id.* at 582-83.

[44] CAL. CIV. CODE §§ 3480-3481 (1872).

[45] Hutcherson v. Alexander, 70 Cal. Rptr. 366, 369 (Ct. App. 1968).

[46] Mangini v. Aerojet-Gen. Corp., 281 Cal. Rptr. 827, 840 (Ct. App. 1991); Phillips v. City of Pasadena, 162 P.2d 625, 626 (Cal. 1945).

[47] A permanent nuisance is a nuisance where "by one act a permanent injury is done, [and] damages are assessed once for all." Williams v. S. Pac. R.R. Co. 89 P. 599, 599 (Cal. 1907) (quoting Beronio v. S. Pac. R.R. Co., 24 P. 1093, 1094 (Cal. 1890)).

[48] CAL. CIV. PROC. CODE § 731 (1872).

[49] CAL. CIV. CODE § 3333 (1872).

[50] Acadia, Cal., Ltd. v. Herbert, 353 P.2d 294, 299 (Cal. 1960).

[51] Stoiber v. Honeychuck, 162 Cal. Rptr. 194, 202 (Ct. App. 1980).

[52] Ingram v. City of Gridley, 224 P.2d 798, 802 (Cal. Ct. App. 1950).

[53] Spaulding v. Cameron, 239 P.2d 625, 627-28 (Cal. 1952).

[54] Rowland v. Christian, 443 P.2d 561, 563-64 (Cal. 1968).

[55] CAL. CIV. CODE § 3333 (1872); 6 Witkin, Summary of Cal. Law Torts § 1548 (10th ed. 2005).

[56] Parsons v. Crown Disposal Co., 936 P.2d 70, 80 (Cal. 1997).

[57] *Id.*

[58] 6 Witkin, Summary of Cal. Law Torts § 1414 (10th ed. 2005). In determining whether an activity is a UHA, California courts consider: (a) the "degree of risk of some harm to the person, land or chattels of others;" (b) likelihood that resulting harm will be great; (c) inability to eliminate the risk through reasonable care; (d) commonness of the activity; (e) inappropriateness of location; and (f) value to the community weighed against the danger. SKF Farms v. Superior Ct., 200 Cal. Rptr. 497, 499 (Ct. App. 1984) (citing RESTATEMENT (SECOND) OF TORTS § 520).

[59] 6 Witkin, Summary of Cal. Law Torts § 1414 (10th ed. 2005).

[60] Goodwin v. Reilley, 221 Cal. Rptr. 374, 376 (Ct. App. 1985).

[61] Travelers Indem. Co. of Ill. v. City of Redondo Beach, 34 Cal. Rptr. 2d 337, 344 (Ct. App. 1994).

[62] Restatement (Second) of Torts § 519 (1979) (stating that a person that carries on an abnormally dangerous activity is subject to strict liability for harm caused by that activity).

[63] Cassinos v. Union Oil Co. of Cal., 18 Cal. Rptr. 2d 574, 584.

[64] *Id.* In reaching this conclusion, the *Cassinos* court considered two similar Oklahoma cases. In those cases, waste water migrated into space devoid of oil or gas, causing the courts to find no damages. *See* W. Edmond Salt Water Disposal Ass'n v. Rosecrans, 226 P.2d 965, 969 (Okla. 1950) (stating that "if . . . disposal of salt water is forbidden unless oil producers first obtain the consent of all persons under whose lands it may migrate . . . , underground disposal would be practically prohibited); Sunray Oil Co. v. Cortez Oil Co., 112 P.2d 792, 794-96 (Okla. 1941).

[65] In *Chance*, defendant BP injected waste water containing dissolved salts and other organics, into saline pore space 2,500 feet below the surface using deep well technology. 670 N.E.2d 985, 986-87 (Ohio 1996). Plaintiffs brought a class action for subsurface trespass, nuisance, negligence, ultrahazardous activity, fraud, and negligent infliction of emotional distress, alleging extensive migration. *See id.* at 987-89. In affirming the trial court's finding that no damages existed for trespass, the Ohio Supreme Court held that plaintiffs failed to "to prove some physical damages or interference with use proximately caused by the deepwells . . . [such] that the injectate interfered with the reasonable and foreseeable use of their properties." *Id.* at 993. In addition, because of the number of variables in determining the existence and extent of migration, including the permeability, porosity, and thickness of the injection strata, the diffusion of the waste into the saline, and the degradation of the substances over time, plaintiffs could not prove a property invasion as a factual matter. *Id.* at 994.

[66] *See*, *e.g.*, Elizabeth J. Wilson & Mark A. de Figueiredo, *Geologic Carbon Dioxide Sequestration: An Analysis of Subsurface Property Law*, 36 Envtl. Law Rep. 10114 (2006). *See generally* Moore, *supra* note 8.

[67] 42 U.S.C. §§ 300f-j (1996).

[68] Federal Requirements Under the Underground Injection Control Program for Carbon Dioxide Geologic Sequestration Wells, 73 Fed. Reg. 43,492 (July 25, 2008) (to be codified at 40 C.F.R. pts. 144 & 146).

[69] *Id.* The proposed measures include mapping nearby underground drinking water and ensuring injection, confinement, and containment zones; periodic review, modification and corrective action; deep-well construction procedures accounting for nature of CO_2; testing and monitoring of groundwater quality and CO_2 plume; 50-year post-injection site care and closure plans; and demonstrated financial assurances.

[70] Statutes such as the CWA, the Resource Conservation and Recovery Act, and the Clean Air Act contain permit shield language, which protect permittees from certain types of liability. For example, CWA Section 402(k) states that "[c]ompliance with a permit issued pursuant to this section shall be deemed [to be] compliance." 33 U.S.C.A. § 1342(k) (West 2008). If a permit holder discharges pollutants in compliance with its permit, it will be shielded from CWA civil or criminal liability. Several courts have addressed the scope of the permit shield. *See generally*, *e.g.*, Piney Run Pres. Ass'n v. County Comm'rs of Carroll County, Md., 268 F.3d 255 (4th Cir. 2001); *see also* Atl. States Legal Found., Inc. v. Eastman Kodak Co., 12 F.3d 353, 357 (2nd Cir. 1993).

[71] *See generally*, *e.g.*, *Piney Run Pres. Ass'n*, 268 F.3d 255; *see also* Chance v. BP Chems., Inc., 670 N.E.2d 985, 986-87 (Ohio 1996).

[72] *See* Letter from Cynthia C. Dougherty, Director, Office of Ground Water and Drinking Water, and Brian McLean, Director, Office of Atmospheric Programs, to Water Management Division Directors, Air Division Directors, & EPA Regions I to X (Mar. 1, 2007), *available at* http://www.epa.gov/safewater/uic/pdfs/guide_uic_carbonsequestration_final-03-07.pdf (last visited Jan. 2, 2009).

[73] The possibility of classification of CO_2 as a pollutant under the Clean Air Act or any other statute should be irrelevant to the permitting process itself, as compliance with a SDWA permit is a distinct issue.

[74] For example, Greenpeace has made its opposition to GCCS clear. *See generally* Emily Rochon et al., Greenpeace Int'l, False Hope: Why Carbon Capture and Storage Won't Save the Climate (2008), *available at* http://www.greenpeace.org/usa/press-center/reports4/false-hope-why-carbon-capture (last visited Feb. 21, 2009).

[75] *See generally* Cal. Const. art. XI.

[76] Vitaly V. Adushkin et al., *Seismicity in the Oil Field*, Oilfield Rev. (Summer 2000), *available at* http://www.slb.com/media/services/resources/oilfieldreview/ors00/sum00/p2_17.pdf.

[77] H.R. 6049, 110th Cong. (2008).

[78] Cal. Pub. Res. Code § 3261 (2006); Cal. Pub. Res. Code § 3251 (2001); Cal. Pub. Res. Code § 3862 (2001).

[79] Three levels of coverage exist: First, nuclear plant operators must maintain individual insurance at mandated levels; second, each operator contributes up to the industry statutory cap; and third, the federal treasury provides coverage beyond the sum of the individual and industry combined levels. 42 U.S.C.A. § 2210 (West 2006).

[80] 42 U.S.C.A. § 4001 (West 2006).

[81] *See*, *e.g.*, Task Force, *supra* note 28.

[82] *See*, *e.g.*, 15 U.S.C.A. § 717f (West 2009).