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Shattered Nerves: Addressing Induced Seismicity Through the Law of Nuisance

by Lucas Satterlee

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Summary

The number of earthquakes felt in the central and eastern United States has increased dramatically; the scientific consensus is that injection of oil and gas wastewater fluids is the most likely culprit. Regulations and voluntary industry efforts are likely the best mechanisms to mitigate the risks associated with induced seismicity, but the common law remains relevant. This Article explores whether and to what extent a nuisance framework can be applied. Utilizing the law of nuisance to address induced seismicity is a novel concept, but the same basic rules used to assess liability when other human activities cause the earth to vibrate should apply. Proving causation is currently plaintiffs' most challenging obstacle, but as the science becomes more developed, the chances of establishing the requisite link increase. The Article concludes that if reasonable precautions are not taken in the siting and operation of an injection well, companies can be held liable for creating a nuisance in the form of earthquakes.

Imagine sitting in your living room when suddenly the earth shakes, walls crack, and the chimney crashes through the roof and lands in your lap. You are rushed to the emergency room, and your home suffers more than \$100,000 in damages.¹ This is what happened to Sandra Ladra in 2011 following a large earthquake near Prague, Oklahoma, that damaged roads and destroyed at least 14 homes.² The 5.6-magnitude (M) quake was the largest recorded in Oklahoma history, and one of many unprecedented tremors that have hit the region in recent years.³ Scientists concluded that the event was facilitated by the operations of nearby oil and gas wastewater disposal wells, and Ladra sued the two companies believed to be responsible.⁴ The lawsuit has the oil and gas industry worried about an emerging liability issue: induced seismicity.⁵

The development of unconventional sources of oil and gas using horizontal drilling and hydraulic fracturing⁶ has provided the United States with enhanced energy security, boosted the industrial economy, and decreased our imports from more unstable regions of the world.⁷ At the same time, unconventional production has become increasingly controversial as new environmental and social concerns emerge in the wake of shale development.⁸ Induced seismicity is perhaps the "most unexpected phenomenon" of America's energy boom.⁹

The number of earthquakes felt in the central and eastern United States has increased dramatically since around 2009.¹⁰ Myths surrounding the phenomenon abound, but the consensus from the scientific community is that the injection of wastewater fluids is the most likely culprit in

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1. *Ladra v. New Dominion, LLC*, 353 P.3d 529, 46 ELR 20082 (Okla. 2015).
 2. Miguel Bustillo & Daniel Gilbert, *Energy's New Legal Threat: Earthquake Suits*, WALL ST. J., Mar. 30, 2015, available at <http://www.wsj.com/articles/frackings-new-legal-threat-earthquake-suits-1427736148>.
 3. Matthew Weingarten et al., *High-Rate Injection Is Associated With Increase in U.S. Mid-Continent Seismicity*, 348 SCIENCE 1336 (2015) (finding that "high-injection wells (>300,000 barrels per month) are much more likely to be associated with earthquakes than lower-rate wells").
 4. Bustillo & Gilbert, *supra* note 2.
 5. *Id.*
 6. Hydraulic fracturing, or "fracking," is the process of injecting a cocktail of mostly water, sand, and chemicals at high pressure into deep geologic strata to fracture hydrocarbon-bearing source rocks in order to provide permeable pathways to extract the oil and gas. RUSSELL GOLD, THE BOOM 30 (2014).
 7. Bony Osborne & Hillary Snyder, *Overview of Major U.S. Shale Plays: Marcellus/Utica, Niobara, Eagle Ford/Barnett, and Bakken, in Development Issues in Major Shale Plays: What's on the Horizon?* 1-2 (Rocky Mountain Mineral Law Found. Paper No. 1, 2014).
 8. Keith B. Hall, *Recent Developments in Hydraulic Fracturing Regulation and Litigation*, 29 J. LAND USE & ENVTL. L. 29, 30 (2013).
 9. Monika Ehrman, *The Next Great Compromise: A Comprehensive Response to Opposition Against Shale Gas Development Using Hydraulic Fracturing in the United States*, 46 TEX. TECH. L. REV. 423, 460 (2014).
 10. Seismicity in the region has ballooned from an average of approximately 20 per year (1970-2000) to over 100 per year (2010-2013). PETER FOLGER & MARY TIEMANN, CONG. RESEARCH SERV., R43836, HUMAN-INDUCED EARTHQUAKES FROM DEEP-WELL INJECTION: A BRIEF OVERVIEW 4-6 (2015).

the increasing rates in seismicity.¹¹ Hydraulic fracturing itself is unlikely to result in any significant levels of seismicity felt at the surface, but the rapid development of unconventional formations using this technique has contributed to the volume of wastewater that needs to be disposed of.¹² The following analysis is limited to a discussion of induced seismicity resulting from wastewater disposal, not hydraulic fracturing.

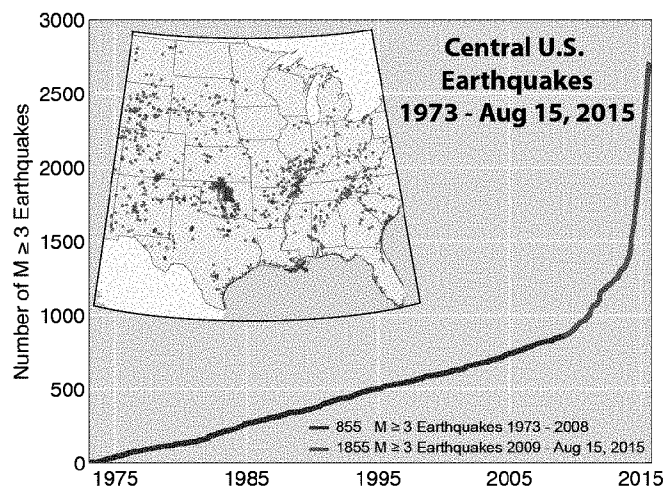
The uptick in interest surrounding induced seismicity has drawn a varied response from lawmakers, regulators, and others. Regulations and voluntary industry efforts are likely the best institutional mechanism to mitigate the risks associated with induced seismicity, but the role of the common law remains relevant.¹³ The common law provides flexibility to address newly recognized harms, particularly where an industry's political clout hamstrings regulators from being more aggressive.¹⁴

Liability for induced seismicity may be found under several existing tort theories, but this Article is limited to a discussion of nuisance law. Section I presents general background information on the phenomenon known as induced seismicity in the context of Class II oil and gas wastewater disposal wells. Sections II-IV analyze the threshold issue of causation and apply existing nuisance law theory to induced seismicity. The Article concludes that in the right circumstances, wastewater well operators can be held liable for creating a nuisance in the form of damaging earthquakes.

I. Induced Seismicity and the Link to Oil and Gas Wastewater Disposal

The central United States has experienced a “dramatic increase” in seismicity over the past six years¹⁵ (see Figure 1). While most of these events are too small to be felt, several damaging earthquakes occurred in areas where historic levels of seismicity were minimal.¹⁶ Nowhere has this

Figure 1
Increasing Rate of Earthquakes
Beginning in 2009



Source: U.S. Geological Service, Induced Earthquakes, <http://earthquake.usgs.gov/research/induced/>.

trend been more evident than in Oklahoma.¹⁷ In 2014, Oklahoma became the most seismically active state in the continental United States, enduring at least 5,415 earthquakes, which is more than it experienced in the previous 30 years combined.¹⁸ The Sooner State is on pace to double that number in 2015,¹⁹ as “the frequency and severity of these earthquakes are both on the rise.”²⁰ The explanation for these events appears to be induced seismicity.²¹

Induced seismicity is defined as earthquakes resulting from anthropogenic activity that “causes a rate of energy release, or seismicity, which would be expected beyond the normal level of historical seismicity.”²² Over the decades, scientists have recognized an array of human activities known to cause earthquakes.²³ The most infa-

11. Justin L. Rubinstein & Alireza B. Mahani, *Myths and Facts on Wastewater Injection, Hydraulic Fracturing, Enhanced Oil Recovery, and Induced Seismicity*, 86:4 SEISMOLOGICAL RES. LETTERS 2-3 (2015).

12. FOLGER & TIEMANN, *supra* note 10, at 11.

13. Emery G. Richards, *Finding Fault: Induced Earthquake Liability and Regulation*, 40 COLUM. J. ENVTL. L. FIELD REP. 32 (2015).

14. HOLLY DOREMUS ET AL., ENVIRONMENTAL POLICY LAW 40 (6th ed. 2012).

15. Rubinstein & Mahani, *supra* note 11, at 1.

16. In 2011 alone, multiple damaging earthquakes occurred: M5.6 Prague, OK; M3 Trinidad, CO; and M4.7 Guy-Greenbrier, AR. Rubinstein & Mahani, *supra* note 11, at 1. For comparison, the 2015 earthquakes that devastated Nepal (4/25) and Afghanistan (10/26) were 7.8M and 7.5M, respectively, and some of the largest natural earthquakes ever recorded include Chile 1960 (M9.5); Alaska 1964 (9.2); Sumatra 2004 (9.1); and Japan (2011 (9.0); http://earthquake.usgs.gov/earthquakes/eventpage/us10003re5#general_summary; http://www.usgs.gov/blogs/features/usgs_top_story/magnitude-7-8-earthquake-in-nepal/; http://earthquake.usgs.gov/earthquakes/world/10_largest_world.php.

17. Arkansas, Ohio, and Texas have also experienced damaging quakes with suspected links to wastewater from oil and gas operations. Richards, *supra* note 13, at 3.

18. Bustillo & Gilbert, *supra* note 2.

19. Mathew Philips, *Oklahoma Earthquakes Are a National Security Threat*, BLOOMBERG-BNA ENERGY & CLIMATE REP., Oct. 23, 2015, available at <http://www.bloomberg.com/news/articles/2015-10-23/oklahoma-earthquakes-are-a-national-security-threat>.

20. Blake Watson & Catrina Rorke, *Should Oil Firms Be Held Liable in Earthquake Lawsuits?*, WALLST. J., Nov. 15, 2015, available at <http://www.wsj.com/articles/should-oil-firms-be-held-liable-in-earthquake-lawsuits-1447643517>.

21. The U.S. Geological Survey (USGS) began warning in 2012 that the surge in earthquakes in Oklahoma was likely linked to disposal operations. Mike Soraghan, *Sierra Club Threatens to Sue Drillers to Stop Okla. Shaking*, E&E NEWS, Nov. 3, 2015, <http://www.eenews.net/stories/1060027316>.

22. U.S. Dep't of Energy (DOE)-Lawrence Berkeley Nat'l Lab., *What Is Induced Seismicity?*, http://esd1.lbl.gov/research/projects/induced_seismicity/.

23. Human activities known to induce seismic events include impoundment of reservoirs, mining, withdrawal of fluids such as oil and gas, and injection

mous case of injection-induced seismicity involved a series of quakes that struck near Denver in the 1960s.²⁴ The events were eventually linked to the underground injection of hazardous chemical wastes at the Rocky Mountain Arsenal defense plant.²⁵ Prior to the 2011 earthquake that struck near Prague, Oklahoma, an M5.3 seismic event that hit Denver in 1967 was generally considered the largest human-induced earthquake in recorded history.²⁶ There are similarities between the Rocky Mountain Arsenal earthquakes and recent events taking place in the central United States.²⁷

Induced seismicity has been observed in the oil and gas industry since at least the 1930s²⁸ and can be attributed to three types of large-scale fluid injection used by the industry: wastewater disposal, hydraulic fracturing, and enhanced recovery.²⁹ While each of these processes is capable of inducing seismic events,³⁰ wastewater disposal is attributed to the “vast majority” of the recent increase, “including the largest and most damaging quakes.”³¹ For this reason, nuisance claims based on disposal activities are likely to be the most successful.³² The basics of how human activities can cause earthquakes are fairly well-understood,³³ and the primary driving mechanism of an injection-induced earthquake is increased fluid pressure.³⁴

The oil and gas industry injects a large portion of its wastewater into Class II disposal wells.³⁵ Scientists at the

U.S. Geological Survey (USGS) explain that most injection operations “do not appear to induce earthquakes . . . much less damaging ones.”³⁶ Most of the tremors have been aseismic (that is, not causing any appreciable seismic activity for quakes over M3), and most wells are in underground formations that have a “low risk of failure leading to damaging earthquakes” if the injection fluids do not migrate from the intended structure.³⁷ However, induced seismicity associated with wastewater disposal “will become an increasingly important issue” as domestic energy resources continue to be developed.³⁸

If state regulators are slow to address induced seismicity in a meaningful way, some operators may ignore the risk.³⁹ This risk of “inertia against regulation” is particularly high in places like Oklahoma and Texas, where the oil and gas industry makes up a large portion of the economy and has substantial influence over the state’s political agenda.⁴⁰ Ultimately, regulation will probably have a more direct mitigation effect than litigation, but the common law provides supplemental deterrence.⁴¹ Until regulators and insurance markets catch up to the new geologic norm in the central United States, those injured by induced seismicity will rely on the common law for redress.

II. Common-Law Liability and Earthquake Lawsuits

The common law provides flexibility to address newly recognized harms.⁴² It is not subject to the same “political pressures and bureaucratic inertia” encountered in the regulatory process.⁴³ Rather, it can provide an early response to new technologies and “where external forces demand change.”⁴⁴ While causation still presents a difficult barrier for induced seismicity plaintiffs, the preponderance of the evidence standard enables juries to decide issues that may be an area of ongoing scientific uncertainty.⁴⁵ Further, tort liability has an indirect deterrent effect on those causing the nuisance and may provide an incentive to mitigate the problem of induced seismicity where social command lags behind.⁴⁶

of fluids into subsurface formations. FOLGER & TIEMANN, *supra* note 10, at 1. Enhanced Geothermal System (EGS) operations are also associated with induced seismicity. See Ernie Majer et al., *Protocol for Addressing Induced Seismicity Associated With Enhanced Geothermal Systems*, DOE, May 31, 2011, <http://www1.eere.energy.gov/geothermal/pdfs/egs-is-protocol-final-draft-20110531.pdf>.

24. FOLGER & TIEMANN, *supra* note 10, at 4.

25. *Id.*

26. *Id.* However, some scientists speculate that the 7.9M earthquake that ravaged China in 2008 was induced by human activity, and a 7.3M earthquake in Uzbekistan has been linked to natural gas production. Richard Perez-Pena, *U.S. Maps Pinpoint Earthquakes Linked to Quest for Oil and Gas*, N.Y. TIMES, Apr. 23, 2015, available at http://www.nytimes.com/2015/04/24/us-us-maps-areas-of-increased-earthquakes-from-human-activity.html?_r=0; Megan Hart, *Earthquakes Decrease in Southern Kansas, But Data Not Clear on How Long They Could Last*, TOPEKA-CAPITAL J., Sept. 17, 2015, <http://cjonline.com/news/business/2015-09-17/earthquakes-decrease-southern-kansas-data-not-clear-how-long-they-could>.

27. FOLGER & TIEMANN, *supra* note 10, at 4.

28. DOE-Lawrence Berkeley Nat'l Lab., *Induced Seismicity-Oil & Gas*, http://esd1.lbl.gov/research/projects/induced_seismicity/oil&gas/.

29. Rubinstein & Mahani, *supra* note 11, at 2.

30. Enhanced oil recovery (EOR) involves production techniques (e.g., water flooding) that sweeps more oil and gas toward wells than would come out on its own. *Id.* at 4.

31. *Id.* at 5.

32. The magnitude of potential harm is greatest with wastewater disposal wells because they can raise fluid pressures “more, over longer periods of time, and over larger areas, than either of the other injection methods.” *Id.* at 6.

33. Earthquakes are induced when: “human perturbation changes the amount of stress in the earth’s crust, and the forces that prevent faults from slipping become unequal.” Injecting wastewater fluids deep into a geologic fault can lubricate the formations and cause them slip (i.e., suddenly release stored energy). FOLGER & TIEMANN, *supra* note 10, at 3.

34. Rubinstein & Mahani, *supra* note 11, at 6.

35. Because the wastewater is hazardous, disposing it deep underground is considered the “environmentally preferred option” for managing produced and other wastewater associated with oil and gas production. FOLGER & TIEMANN, *supra* note 10, at 11.

36. Rubinstein & Mahani, *supra* note 11, at 1. Damaging earthquakes are usually greater than magnitude 5. DOE, *Induced Seismicity-Oil & Gas*, *supra* note 28. See also FOLGER & TIEMANN, *supra* note 10, at 1 (explaining that “only a small fraction of the more than 30,000 US wastewater disposal wells appears to be associated with damaging earthquakes”).

37. FOLGER & TIEMANN, *supra* note 10, at 9.

38. DOE-Lawrence Berkeley Nat'l Lab., *About Induced Seismicity* http://esd1.lbl.gov/research/projects/induced_seismicity/.

39. Richards, *supra* note 13, at 30.

40. *Id.*

41. *Id.* at 32.

42. *Id.* at 40.

43. *Id.* at 94 (noting that plaintiffs have strong incentives for initiating and prosecuting such actions, such as the immediate risk of person harm and potential to recover of compensatory damages).

44. Bruce M. Kramer, *Horizontal Drilling Trespass: A Challenge to the Norms of Property and Tort Law*, 25 COLO. NAT. RESOURCES, ENERGY & ENVTL. L. REV. 291, 338 (2014).

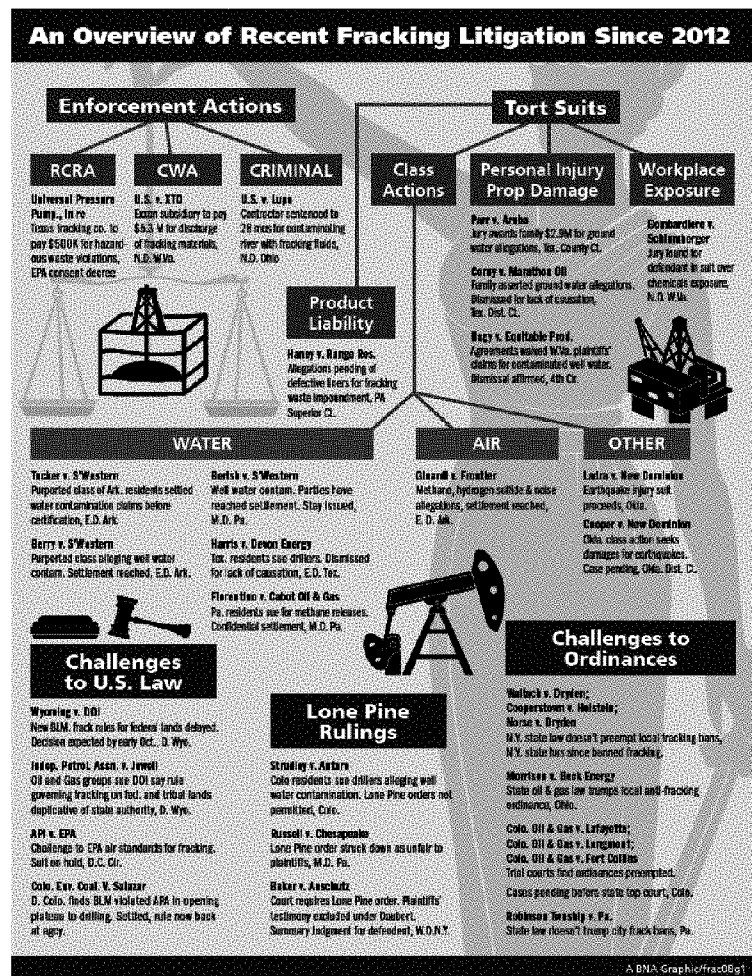
45. DOREMUS, *supra* note 14, at 94.

46. *Id.* at 85.

The battle over unconventional shale development is being fought in the courts on many fronts, and earthquake lawsuits are just beginning to enter the fray (see Figure 2).⁴⁷ Over 20 such lawsuits have been filed since 2011, and more are just on the horizon.⁴⁸ Some of these lawsuits ended quietly in settlement,⁴⁹ but the *Ladra* case has been watched closely by the industry and those immersed in the fracking debate nationwide.⁵⁰ The district court dismissed the case for lack of jurisdiction, reasoning that the Oklahoma Corporation Commission (OCC) has exclusive jurisdiction over cases involving oil and gas operations.⁵¹ However, in June 2015, the Oklahoma Supreme Court reversed, and remanded the case for a determination on the merits.⁵² The court held that “district courts have exclusive jurisdiction over private tort actions when regulated oil and gas operations are at issue.”⁵³

Regardless of the eventual outcome, the Oklahoma Supreme Court’s unanimous decision paves the path for other landowners seeking compensation for injection-induced seismicity in Oklahoma.⁵⁴ Another important case is *Cooper v. New Dominion, LLC*.⁵⁵ The Oklahoma class action lawsuit seeks damages caused by the same defendants and earthquakes at issue in the *Ladra* case.⁵⁶ Allowing these cases to proceed is a huge victory for the plaintiffs and others injured by injection-induced seismicity, but whether any of these landowners will ultimately succeed on the merits is far from clear. Proving causation and developing an appropriate litigation framework is the next step.

Figure 2



Source: Peter Hayes & Steven Sellers, Fracking Boom Likely to Trigger More Litigation, Lawyers Say, BNA BLOOMBERG ENERGY & CLIMATE REPORT (Sept. 17, 2015), <http://www.bna.com/fracking-boom-likely-n17179936215/>.

47. Other fracking related litigation includes claims of state preemption of local fracking bans, federal rulemaking challenges, and fracking tort claims alleging personal injury, property damage, workplace exposure, and product liability. Peter Hayes & Steven M. Sellers, *Fracking Boom Likely to Trigger More Litigation, Lawyers Say*, BLOOMBERG-BNA ENERGY & CLIMATE REP., Sept. 14, 2015, <http://www.bna.com/fracking-boom-likely-n17179936215/>.

48. *Id.*

49. In 2013, Chesapeake Energy and BHP Billiton settled with five Arkansas residents for an undisclosed sum after the Guy-Greenbrier earthquake swarm damaged their homes in 2011. Bustillo & Gilbert, *supra* note 2.

50. Richard A. Oppel, *Oklahoma Court Rules Homeowners Can Sue Oil Companies Over Quakes*, N.Y. TIMES, June 30, 2015, available at <http://www.nytimes.com/2015/07/01/us/oklahoma-court-rules-homeowners-can-sue-oil-companies-over-quakes.html>.

51. *Ladra v. New Dominion, LLC*, 353 P.3d 529, 530, 46 ELR 20082 (Okla. 2015).

52. *Id.*

53. *Id.* at 531-32 (clarifying that the defendants confused “the statutory grant of exclusive jurisdiction to the OCC to regulate oil and gas exploration and production activities . . . with the jurisdiction to afford a remedy to those whose common law rights have been infringed by either the violation of these regulations or otherwise”).

54. Oppel, *supra* note 50.

55. No. CJ-2015-00024 (D. Okla. filed Feb. 10, 2015) (seeking class certification for people whose property was damaged by injection-induced seismicity).

56. New Dominion is a Tulsa-based company that has pioneered a “new breed of high-volume” injection wells. Philip, *supra* note 19.

III. Legal Causation

Is there a relationship between the defendant’s injection activity and the plaintiff’s injuries? Even if the defendant’s injection activities played some role, should the inducer be liable for damage brought about by the tectonic forces of nature? When natural disasters strike, these so-called acts of God fall on a continuum.⁵⁷ At one end of the spectrum are events caused by purely natural forces.⁵⁸ At the other end are damaging forces induced by the “exercise of human will.”⁵⁹ When human enterprise is thought to be responsible for inducing the events, the common law attempts to assess fault through the concept of “causation.”⁶⁰

Induced seismicity is still an area of ongoing research, but the general consensus from the scientific community is that a cause-and-effect relationship exists.⁶¹ Yet establish-

57. Adam F. Scales, *Man, God, and the Serbian Bog: The Evolution of Accidental Death Insurance*, 86 IOWA L. REV. 173, 269-70 (2000).

58. *Id.*

59. *Id.*

60. *Id.* at 270.

61. Weingarten et al., *supra* note 3, at 1336.

ing causation from a legal standpoint is a different matter.⁶² Defendants legally cause harm to the plaintiff if their disposal operations are a substantial factor in bringing about the “time, place, and intensity” of the damaging tremors.⁶³ The fact that an earthquake may eventually occur on its own (tomorrow or a century from now) is irrelevant in the causation analysis.⁶⁴

A. Superseding Cause

The doctrine of superseding cause—an unforeseeable cause of independent origin—is likely to come up in a case of induced seismicity.⁶⁵ The doctrine releases a defendant from liability where an unforeseen intervening force of nature supersedes the defendant’s tortious conduct.⁶⁶ Ample scientific warning, public scrutiny, and the fact that injection-induced earthquakes have been observed since the 1960s suggest that the recent seismic events were foreseeable. An intervening force is not a superseding cause if the defendant’s inducing activity “put the force into motion,” and courts have held companies liable for “releasing or redirecting” a destructive force of nature.⁶⁷ Therefore, because the tectonic force depends on the injection activities to lubricate the faults and produce the injury at the time it occurs, the force is unlikely to be considered a superseding cause that relieves defendants of liability.⁶⁸

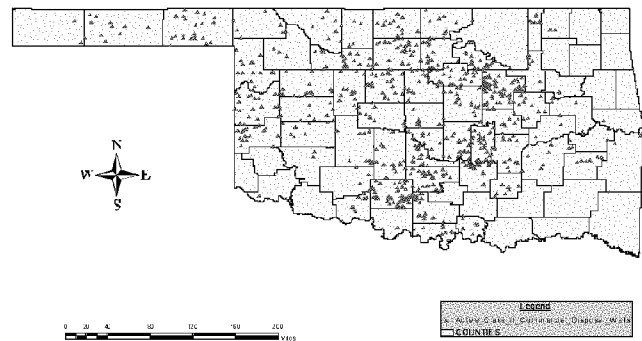
B. General and Specific Causation

Plaintiffs must prove both general and specific causation, and “scientific uncertainty complicates both tasks.”⁶⁹ For general causation, plaintiffs must prove that the type of injection operation used by the defendants is capable of causing the type of damaging tremors suffered by the plaintiffs.⁷⁰ Putting forth evidence of general causation will not be as difficult, since the science supports the notion that wastewater injection can cause, and has caused, damaging earthquakes.⁷¹

Establishing specific causation presents a much more daunting task. Plaintiffs will have to prove that the crack in their ceiling was caused by a specific tremor that can be linked to the defendant’s disposal operations.⁷² The farther the home is from the epicenter of the quakes, the

more difficult it becomes to establish specific causation.⁷³ The construction of the home and other environmental factors further complicate such a task.⁷⁴ Active drilling and disposal sites are extremely clustered (see Figure 3), “making it extraordinarily difficult to differentiate how each well or event contributes to the geologic stresses that cause the earthquakes.”⁷⁵

Figure 3
Oklahoma Class II Commercial Disposal Wells
1/30/2013



Source: Oklahoma Corporate Comm'n, Class II Commercial Disposal Wells, <http://www.occeweb.com/og/Oklahoma%20Class%20II%20Commercial%20Disposal%20Wells.pdf>.

C. Circumstantial Evidence and Expert Testimony

The issue of causation is a question of fact to be determined by a jury, and establishing such a link will rely almost exclusively on circumstantial evidence.⁷⁶ In cases involving property damage from earth vibrations caused by blasting operations, circumstantial evidence based on reasonable inferences is often sufficient to establish causation.⁷⁷ The same probably holds true for injection-induced earthquakes. The corresponding timing of injection, close proximity of disposal wells to the epicenter, and low historic levels of natural seismicity are factors that weigh in favor of a causation finding.⁷⁸

This determination also involves a heavy dose of expert testimony,⁷⁹ and plaintiffs are likely to depend heavily on recent scientific reports to establish a causal link. In both complaints, the plaintiffs in *Ladra* and *Cooper* cite recent

62. Darlene A. Cypser & Scott D. Davis, *Liability for Induced Earthquakes*, 9 J. ENVTL. L. & LITIG. 551, 566 (1994). See also Eric Scheiner & Chen Foley, *Fracking, Earthquakes and Insurance: A Collision Course?*, Ins. J., May 18, 2015, <http://www.insurancejournal.com/magazines/features/2015/05/18/367654.htm>.

63. Cypser & Davis, *supra* note 62 at 566; 74 AM. JUR. 2D TORTS §§26-28.

64. Cypser & Davis, *supra* note 62 at 565-66 (explaining that “large portions of the earth’s crust may exist for centuries at a level of strain near the point of failure,” but the inducer invites “the damage to occur at that point in time”).

65. RESTATEMENT (2D) OF TORTS §440 (1965).

66. *Id.*

67. Cypser & Davis, *supra* note 62, at 560-63.

68. *Id.* at 560-61.

69. DOREMUS, *supra* note 14, at 89.

70. *Id.* at 62.

71. Hayes & Sellers, *supra* note 47.

72. *Id.*

73. *Id.*

74. *Id.*

75. Watson & Rorke, *supra* note 20.

76. Cypser & Davis, *supra* note 62, at 562.

77. *Smith v. Lockheed Propulsion Co.*, 247 Cal. App. 2d 774, 781 (Cal. Ct. App. 1967) (involving seismic vibrations activated by testing of rocket motor).

78. Cypser & Davis, *supra* note 62, at 562. See also U.S. EPA, *Minimizing and Managing Potential Impacts of Injection-Induced Seismicity From Class II Disposal Wells: Practical Approaches* (2015) (noting that the historic absence of seismic activity “may be one indicator of induced seismicity if seismic events occur following activation of an injection well”), <http://www.epa.gov/r5water/uic/techdocs.htm#ntwg>.

79. Cypser & Davis, *supra* note 62, at 562.

USGS studies for causation theories.⁸⁰ USGS is the federal agency responsible for studying and monitoring earthquake activity in the United States, and it has established an ongoing project looking into hazards from induced seismicity.⁸¹ In April 2015, USGS issued a comprehensive assessment of induced seismicity, mapping out regions where such quakes have occurred and linking the recent seismic activity in the central United States to oil and gas wastewater disposal operations.⁸² The report specifically references the 2011 M5.6 earthquake in Prague, Oklahoma, and explains that deep injection of wastewater in the region “could trigger earthquakes with enough strength to damage nearby structures.”⁸³ Other studies have reached similar findings and may be relied on by plaintiffs searching for evidence of legal causation.⁸⁴

Although the barriers are formidable, in the right circumstances—where scientific studies positively link seismicity to the defendant’s disposal wells—plaintiffs can prevail on causation. The scientific understanding of induced seismicity is still an area of great uncertainty and ongoing research,⁸⁵ but as scientists continue to establish a more definite link and regulators require more active monitoring, the task will become easier.

IV. Nuisance Liability Framework

After proving causation, the next step is to develop an appropriate liability framework for induced seismicity. The potential field of candidates includes tort theories based on nuisance, negligence, trespass, and strict liability. All these theories might be applicable to induced seismicity, and the determination is a matter of state

law.⁸⁶ This Article is limited to a discussion of nuisance; however, since elements of negligence and strict liability inform modern nuisance law, it discusses those theories within the nuisance framework. Nuisance allegations have been among the most common actions brought against oil and gas companies in the wake of the domestic energy boom, but a court has not yet applied nuisance theory to induced seismicity.⁸⁷ The contours of such a framework are not entirely clear, but looking to familiar concepts of tort liability involving concussion or vibration damage provides a useful aid.

The common law has assessed liability for damaging induced vibrations in the context of “rocket engine tests, pile driving, explosives, oil wells,” and other industrial activities that shake the earth.⁸⁸ Although these tremors originate at the surface and are more easily attributed to anthropogenic activities than induced seismicity, the same basic legal principles apply.⁸⁹ The damages to persons and property are “similar to those caused by explosives or machine vibrations.”⁹⁰ In fact, in one case, the dynamite blasting vibrations complained of might have actually been small induced earthquakes.⁹¹ Most states recognize the right of a plaintiff to recover damages caused by vibrations under a nuisance theory.⁹² Such actions have been pursued against oil and gas operations.⁹³ Compensatory damages are the primary remedy in a vibration nuisance case, but injunctive relief may also be awarded in certain circumstances.⁹⁴ There are two distinct but similar causes of action for a nuisance: private nuisance and public nuisance.⁹⁵

80. Barclay R. Nicholson, *Induced Seismicity Legal Issues Break New Ground*, Law360, May 15, 2015, <http://www.law360.com/articles/654837/induced-seismicity-legal-issues-break-new-ground>.

81. USGS-Earthquake Hazard Program, *Induced Earthquakes*, <http://earthquake.usgs.gov/research/induced/>.

82. Mark Petersen et al., *Incorporating Induced Seismicity in the 2014 United States National Seismic Hazard Model: Results of 2014 Workshop and Sensitivity Studies*, USGS (2015), <http://pubs.usgs.gov/of/2015/1070/pdf/ofr2015-1070.pdf>.

83. *Id.* at 3.

84. Daniel D. McNamara et al., *Efforts to Monitor and Characterize the Recent Increasing Seismicity in Central Oklahoma*, 34:6 LEADING EDGE 628 (2015); Petersen et al., *supra* note 82; Matthew Weingarten et al., *High-Rate Injection Is Associated With Increase in U.S. Mid-Continent Seismicity*, 348 SCIENCE 1336 (2015) (finding that the entire increase in earthquake rate is associated with fluid injection); Mark Zoback & F. Rall Walsh III, *Oklahoma’s Recent Earthquakes and Saltwater Disposal*, SCIENCE ADVANCES, June 18, 2015; Katie M. Keranen et al., *Potentially Induced Earthquakes in Oklahoma, USA: Links Between Wastewater Injection and the 2011 Mw 5.7 Earthquake Sequence*, GEOLOGY, G34045.1 (2013) (concluding the Prague, OK, sequence was related to two nearby disposal wells); Daniel McNamara et al., *Reactivated Faulting Near Cushing Oklahoma: Increased Potential for a Triggered Earthquake in an Area of United States Strategic Infrastructure*, 42 GEOPHYSICAL RES. LETTERS, 8328 (2015). See also FOLGER & TIEMANN, *supra* note 10, at 7 (describing several studies linking wastewater injection to quakes in Arkansas, Ohio, and Texas).

85. The relationship between earthquake activity and the timing of injection, the amount and rate of fluid injected, and other factors are current research topics that require additional study. FOLGER & TIEMANN, *supra* note 10, at 1. See also Nicholson, *supra* note 80 (emphasizing that the USGS report acknowledges the difficulty of pinpointing how seismicity is induced).

86. Plaintiffs may recover under a strict liability theory in Colorado and Ohio. By contrast, Oklahoma and Texas do not recognize strict liability for concussion damage. Richards, *supra* note 13, at 32-33.

87. Michael Goldman, *A Survey of Typical Claims and Key Defenses Asserted in Recent Hydraulic Fracturing Litigation*, 1 TEX. A&M L. REV. 305, 310 (2013).

88. Cypser & Davis, *supra* note 62, at 553.

89. *Id.*

90. *Id.* at 583 (citing cases involving vibrations from heavy equipment, quarrying, mining, and storage of explosives).

91. In the 1970s, seismologists determined that earthquakes occurring in Dutchess County, NY, “were probably triggered by” the operation of a quarry, and “smaller quakes might have been mistaken for dynamite blasts.” *Id.* at 585-86.

92. In the 19th century, damages were awarded for private nuisance actions involving vibrations from railroad operations. Courts also determined that vibrations stemming from “pile drivers, pneumatic drills, wrecking balls, and other construction and wrecking equipment constituted a private nuisance.” Randy Sutton, *Vibrations Not Accompanied by Blasting or Explosions as Constituting Nuisance*, 103 A.L.R. 5th 157, §2(a) (2002).

93. See *Transcontinental Gas Pile Line Corp. v. Gault*, 198 F.2d 196 (4th Cir. 1952) (holding operator of gas compressor station liable for causing annoying vibrations in nearby area). In one case alleging nuisance for vibrations caused by nearby oil and gas operations, the defendants were unsuccessful in their attempts to overturn the judgment because jurors revealed they entertained the idea of induced earthquakes during deliberations, which were not part of the trial evidence. *Hiser v. XTO Energy, Inc.*, No. 13-3443 (8th Cir. Oct. 3, 2014).

94. Traditionally, a plaintiff was entitled injunctive relief, but since the industrial revolution, courts have been more reluctant to enjoin “economically valuable” activities. Modern courts sometimes appoint a special master and use an equity-balancing analysis to determine if injunctive relief is warranted. DOREMUS, *supra* note 14, at 56. Putative damages may also be awarded if the conduct is sufficiently wrongful. *Id.* at 57.

95. DOREMUS, *supra* note 14, at 41 (noting that the “vast majority of such cases are for private nuisance, but a few actions have been brought as public nuisance cases”).

A. Private Nuisance—Balancing of Utilities Doctrine

A private nuisance involves an unreasonable and substantial interference with another's use and enjoyment of land.⁹⁶ Under the *Restatement (Second) of Torts*, the defendant's actions must be: (a) intentional and unreasonable, or (b) unintentional and otherwise actionable under rules controlling liability for negligent or reckless conduct, or for abnormally dangerous conditions or activities.⁹⁷ The acts leading to the invasion of another's interest are deemed intentional "if they are substantially certain to produce harm, whether or not the actor desires the harm."⁹⁸ Since the great majority of injection wells do not cause seismic events, much less damaging ones, it is unlikely such actions are "substantially certain" to produce a damaging earthquake. However, induced seismicity can still be an unreasonable or negligent invasion.

In the nuisance context, the invasion is "unreasonable if the gravity of the harm outweighs the utility of the conduct or the harm is serious and the economic burden of compensation would not make the conduct infeasible."⁹⁹ Factors to consider in this analysis include the extent and character of the harm; social value of the plaintiff's use of land and defendant's conduct; suitability of each to the character of the locality; and the burdens on each party of avoiding the harm.¹⁰⁰

I. Gravity of Harm—Extent and Character of the Harm

Nuisance law does not involve the protection of "slight inconvenience or 'petty annoyance.'"¹⁰¹ The harm must be significant and implicate "something that is definitely offensive, seriously annoying or intolerable."¹⁰² Numerous courts have found that induced vibrations were not of a sufficient degree to support an action for nuisance.¹⁰³ In most instances of induced seismicity, the gravity of harm is probably low since most of these earthquakes are aseismic.¹⁰⁴ However, where the quakes result in serious property damage or personal injury, the analysis becomes more complicated.¹⁰⁵ Several earthquakes have caused significant property damage and, in the *Ladra* case, personal injury too.

Even without physical damage to real or personal property, vibrations have been found to constitute a nuisance

in the absence of physical damage.¹⁰⁶ Induced seismicity has the potential to shatter plenty of nerves if it is sufficiently annoying, inconvenient, or results in a loss of business or property value.¹⁰⁷ The seismicity may be particularly disconcerting if it occurs frequently or in swarms.¹⁰⁸ An isolated seismic event may not be significant enough to warrant liability, but injection-induced earthquakes typically occur over a period of time, and "duration or recurrence of the interference" is a factor that weighs in favor of finding a nuisance.¹⁰⁹ So far, none of the quakes have been catastrophic or involved fatalities,¹¹⁰ but that does not necessarily mean individual property owners should bear the externalized costs of the inducer's operations. Therefore, where the seismicity results in significant personal or property damage, or occurs in swarms, the gravity of harm may be sufficient for nuisance liability.

2. Social Value of Disposal Well Operations

The situation in Oklahoma provides an interesting case study when it comes to balancing the gravity of harm against the social utility of the conduct. The Sooner State has experienced the greatest uptick in seismic activity and some of the most damaging quakes. At the same time, "Oil is *the* Oklahoma business,"¹¹¹ a source of pride for many, and the state's largest employer.¹¹² Imposing the seismic externalities on individual property owners may seem like an "unjust way of forcing public investment in industrial growth."¹¹³ However, because the industry is so intrinsically intertwined with the identity of the state, the significant benefit of engaging in oil and gas production (and the ancillary need to dispose of waste fluids) might support a finding of no nuisance.¹¹⁴ In states like Colorado or Ohio, where the economy is more diverse and less dependent on hydrocarbon extraction, the chances of overcoming the social utility factor are considerably greater.

3. Character of the Locality

Often expressed as "a pig in the parlor," an activity might be a nuisance if its location is inconsistent with the character of the surrounding community.¹¹⁵ Sometimes, the industrial character of the area prevents a defendant's operation

96. *Id.*

97. RESTATEMENT (2D) OF TORTS §822 (1979).

98. DOREMUS, *supra* note 14, at 41 (citing RESTATEMENT §825).

99. *Id.*

100. *Id.* (citing §§827-28).

101. Kamuck v. Shell Energy Holdings GP, LLC, 2012 WL 1463594 (M.D. Pa. 2012).

102. Kembel v. Schlegel, 329 Pa. Super. 478 A.2d 11, 14-15 (Pa. Super. Ct. 1984).

103. See Sutton, *supra* note 92, at §2(a).

104. FOLGER & TIEMANN, *supra* note 10, at 9.

105. John Shampton & David Ritter, *Making The Earth Move: Liability for Earthquake Damage Associated With Oil & Gas Production Activities*, 21 S.L.J. 91, 95 (2011).

106. Sutton, *supra* note 92.

107. Darlene A. Cypser, *Colorado Law and Induced Seismicity* 47 (1996) (unpublished manuscript) (on file with author), http://www.researchgate.net/publication/273789334_Colorado_Law_and_Induced_Seismicity (noting that vibrations can cause various physical and psychological reactions). See also GOLD, *supra* note 6, at 31 (explaining that even when the earthquakes are not large, they become unsettling to residents "who are growing accustomed to feeling small rumbles under their feet").

108. Cypser, *supra* note 107, at 47.

109. Cypser & Davis, *supra* note 62, at 585.

110. Rubinstein & Mahani, *supra* note 11, at 1.

111. GOLD, *supra* note 6, at 170.

112. Richards, *supra* note 13, at 30. One in five jobs in OK are tied to the oil and gas industry. Oklahoma Energy Res. Bd. (OERB), *Industry Statistics*, <http://www.oerb.com/industry/impact/stats>.

113. DOREMUS, *supra* note 14, at 42.

114. Shampton & Ritter, *supra* note 105, at 95.

115. DOREMUS, *supra* note 14, at 89.

from being considered a nuisance, and a plaintiff can only expect the “degree of quiet consistent with the standard of comfort prevailing in the locality of his dwelling.”¹¹⁶ Blasting operations conducted without proper precautions in a populated area may constitute a nuisance,¹¹⁷ and the site selection of an oil and gas well may be a nuisance if located out of place for its environment.¹¹⁸ Perhaps the site selection of an injection well can be considered a nuisance if precautionary seismic evaluations are not undertaken, or it induces earthquakes near sprawling suburbs. Colorado is undergoing a significant boom in population growth and urban sprawl, and shale development is increasingly encroaching on these communities.¹¹⁹ Where these conditions exist, disposal operations may not fit the character of the locality.

Further, a nuisance may exist even where the defendant’s operation occupied the area before the residences.¹²⁰ For example, in *State v. H. Samuels Co.*, the defendant operated a salvage business for nearly 50 years, but after the operation expanded to include additional products and capacity for storage, the Wisconsin Supreme Court held that it became a nuisance.¹²¹ Similarly, an injection well may have been disposing waste in the area for years without seismic problems until the recent boom in production increased the intake of wastewater capacity to the point where it now constitutes a nuisance.

4. Respective Burden of Avoiding Harm and Infeasibility of Paying Compensation

The ability of avoiding the harm lies primarily with the injection well operators. There is little that surrounding residents can do to abate the risk of induced seismicity. In places like Oklahoma, where there has been relatively little seismic activity in the past, most homeowners do not have earthquake insurance.¹²² Most of the negative effects associated with seismicity fall on the surrounding community, whereas damage to the well operator’s equipment and facilities is “minimal, or has not significantly impacted” operating costs.¹²³

As far as the financial burden for avoiding the harm caused by induced seismicity, experience thus far shows that mitigating the risk “can be handled in a cost-effective

manner.”¹²⁴ However, to reduce their injection volumes, companies must cut production or spend money to ship waste further away for disposal.¹²⁵ This might be particularly burdensome for smaller companies already struggling to survive since the price of oil fell dramatically in 2014.¹²⁶

Companies have also expressed concern that the economic burden of paying compensation will make their operations infeasible.¹²⁷ Defendants in the *Ladra* case told the court that allowing juries to decide liability “would invite economic catastrophe” by turning their injection wells into “legal liability pariahs.”¹²⁸ However, a nuisance claim is only likely to succeed in rare circumstances, and companies should probably assume the risk of paying out compensation when it is warranted. As with all the factors used to determine unreasonableness, assessing the burden of avoiding harm and infeasibility of paying compensation depends on the situation of the particular defendant-company. The defendant will also be liable for a nuisance if its actions are considered abnormally dangerous or constitute a negligent invasion.

B. Private Nuisance Based on Negligent or Abnormally Dangerous Invasion

Nuisance law recognizes liability for acts that are unintentional but nonetheless actionable under a negligence or strict liability theory for abnormally dangerous activities.¹²⁹ Strict liability only requires that the plaintiff prove causation, whereas negligence dictates that a standard of care was also breached by the defendant.¹³⁰ Most jurisdictions where seismicity has been observed recognize vibration liability based on negligence, but only a few allow a defendant to be found guilty under a strict liability theory.¹³¹

I. Strict Liability—Abnormally Dangerous Conditions or Activities

Some jurisdictions consider blasting an abnormally dangerous activity and recognize liability for vibration damages without requiring any showing of fault.¹³² However, unlike blasting, which directly results in an explosion, the act of injecting wastewater merely induces tectonic forces that rarely cause damaging vibrations. The presence of a “clear, inherent threat of harm” associated with the concept of strict liability may be lacking since the

116. Sutton, *supra* note 92, at §2(a).

117. 31A AM. JUR. 2D, EXPLOSIONS AND EXPLOSIVES §76.

118. See *Crowder v. Chesapeake Operating, Inc.*, No. 2011-008169-3 (Tex. Cnty. Ct. Nov. 26, 2013) (holding that the defendant created a nuisance with its well site, and the facility was out of place for its location). See also Frank Leone & Mark Miller, *Hydraulic Fracturing: New Science and New Developments in Environmental & Toxics Litigation*, BLOOMBERG-BNA ENERGY & CLIMATE REP., Apr. 14, 2015.

119. Don C. Smith & Jessica M. Richards, *Social License to Operate: Hydraulic Fracturing-Related Challenges Facing the Oil & Gas Industry*, 1:2 OIL & GAS, NAT. RESOURCES, & ENERGY J. 81 (2015).

120. Sutton, *supra* note 92, at §3.

121. 211 N.W.2d 417 (Wis. 1973).

122. Bustillo & Gilbert, *supra* note 2 (explaining that 15-23% of Oklahomans have earthquake insurance, “up from about 2% in 2011”).

123. DOE, *Induced Seismicity-Oil & Gas*, *supra* note 28 (explaining that “effects, such as well failure due to subsidence well bore damage and damage of surface facilities, are minimal”).

124. *Id.*

125. Mike Soraghan, *Okla. Officials May Lack Authority on Seismicity Issues*, E&E NEWS, Oct. 9, 2015, <http://www.eenews.net/stories/1060026113>.

126. The energy boom ended abruptly in mid-2014 when the price of oil in America dropped from \$100 to \$43. *Fractured Finances*, ECONOMIST, July 4, 2015.

127. Lawyers representing one of the defendants in the *Ladra* case told a court that allowing the case to proceed would make the legal risk “uninsurable.” Bustillo & Gilbert, *supra* note 2.

128. Oppel, *supra* note 50.

129. RESTATEMENT (2D) OF TORTS §822.

130. Richards, *supra* note 13, at 32.

131. *Id.*

132. Of the states experiencing increased levels of induced seismicity, only Colorado and Ohio allow recovery under a strict liability theory. *Id.*

occurrence of injection-induced seismicity is infrequent and often unpredictable.¹³³

Courts are usually hesitant to apply strict liability to a new phenomenon, and this judicial reluctance is another reason why strict liability may not be the most viable theory.¹³⁴ Therefore, even though the primary source of damage (that is, shock or vibration) is the same as with blasting, it is probably a stretch to consider wastewater injection an abnormally dangerous activity. Negligence provides a more viable avenue to establish nuisance liability and also helps the industry develop a standard of care to reduce the risk of induced seismicity.¹³⁵

2. Negligent Invasions Constituting Nuisance

In nuisance cases for vibration or concussion damages, some courts have required a showing of negligence, or at least considered it a critical factor in assessing liability.¹³⁶ The degree of care required for conducting blasting operations is usually “reasonable care and skill with regard to the nature of the work and local conditions.”¹³⁷ Therefore, well operators may be negligent in their site selection or injection activities if they knew or should have known of the potential to induce seismic activity.¹³⁸ The standard of care might involve a “duty to take precautions against triggering damaging earthquakes.”¹³⁹ Fulfilling such a duty would involve making sure the company has taken steps to mitigate the risks by conducting thorough site investigations and monitoring of seismic activity.¹⁴⁰ If a company fails to conduct a reasonable investigation or acts in disregard of a known seismic risk, then it has breached its duty of care.

Even if long-held industry customs or standards do not require rigorous seismic evaluation and analysis, “conformity to such standards or customs is not a substitute for due care.”¹⁴¹ The industry may be reluctant to adopt new standards that cost additional time, effort, and money.¹⁴² Failure to adopt such measures in the face of increasing scientific evidence and warnings may warrant a finding of negligence.¹⁴³

Rather than acknowledge the link and take affirmative actions to address seismicity, some companies continue to

assert that more study needs to be done to prove that they are contributing to the problem.¹⁴⁴ There is evidence that oil companies pressured seismologists at the Oklahoma Geological Survey not to make any connection between the increase in seismicity and fracking-related wastewater injection wells.¹⁴⁵ If these seismologists had been employed by the companies to conduct a study and were restrained from making a thorough investigation, the employer-operator might be liable for negligence under the doctrine of respondeat superior.¹⁴⁶

Like industry customs, state laws and regulations governing injection well disposal “set only minimum standards,” and are not conclusive regarding the proper standard of care.¹⁴⁷ Regulators in states experiencing induced seismicity are starting to require seismic evaluations in the permitting process, and have implemented procedures to slow or shut down injection activities if seismicity is observed.¹⁴⁸ Compliance with these requirements might be evidence that the company is acting reasonably or operating within the expected standard of care, but compliance is not an automatic bar to a finding of negligence.¹⁴⁹

Therefore, the fact that defendants are operating within the requirements of state-issued permits may not be enough to avoid liability. By contrast, a violation of state regulatory requirements might automatically subject the operator to liability based on its negligence, constituting a “nuisance per se.”¹⁵⁰ In sum, wastewater injection is unlikely to be considered an abnormally dangerous activity, but well operations may constitute a nuisance under a negligence theory if the defendant failed to take proper precautions and ignored the risk.

C. Public Nuisance

Liability for injection-induced seismicity might also be found under a public nuisance theory if the invasion interferes “with the interests of the community or rights of the general public.”¹⁵¹ Although the basic analysis is the same as private nuisance, a public nuisance typically can only be brought by public authorities, or sometimes by a citizen who has suffered an injury “different in kind” from that endured by the public at large.¹⁵² If damaging seismic events are frequent and widespread over an entire community or threaten the viability of critical infrastructure, public nuisance theory may apply.

Beginning in September 2015, a series of earthquakes have struck within several miles of Cushing, Oklahoma,

133. Shampton & Ritter, *supra* note 105, at 95.

134. Richards, *supra* note 13, at 19-20; Shampton & Ritter, *supra* note 105, at 95.

135. Richards, *supra* note 13, at 33. See also Joe Schremmer, *Avoidable “Fracturing”: An Argument Against Strict Liability for Hydraulic Fracturing*, 60 U. KAN. L. REV. 1215, 1254-55 (arguing that “negligence tempers the temptation . . . to drag deep-pocketed oil and companies into court with less-than-meritorious claims”).

136. Sutton, *supra* note 92 at §2(a). Most courts hold that a nuisance in the form of blasting requires a showing of negligence. 31A AM. JUR. 2D, EXPLOSIONS AND EXPLOSIVES §76.

137. 31A AM. JUR. 2D, EXPLOSIONS AND EXPLOSIVES §73.

138. Darlene A. Cypser & Scott D. Davis, *Induced Seismicity and the Potential for Liability Under U.S. Law*, 289 TECTONOPHYSICS 239 (1998).

139. Cypser & Davis, *supra* note 62 at 577-78 (arguing that companies will not be allowed to set their “own uncontrolled standards by adopting careless methods merely to save time, effort, or money”).

140. Cypser, *supra* note 107, at 43.

141. Cypser & Davis, *supra* note 62 at 577-78.

142. *Id.*

143. *Id.* at 580-81.

144. Opper, *supra* note 50.

145. Philips, *supra* note 19.

146. Cypser, *supra* note 107, at 46-47.

147. Cypser & Davis, *supra* note 62 at 577-78.

148. Richards, *supra* note 13, at 6.

149. DOREMUS, *supra* note 14, at 89; Village of Wilson v. SCA Servs., 426 N.E.2d 824 (Ill.1981) (enjoining operation of hazardous waste disposal as nuisance despite issuance of permit).

150. DOREMUS, *supra* note 14, at 68 (citing Gill v. LDI, 19 F. Supp. 2d 1188, 1198-99 (W.D. Wash. 1998)).

151. *Id.* at 42.

152. *Id.*

where one of the largest crude oil storage hubs in the world is located.¹⁵³ The massive storage complex, known as the Cushing Hub, is often considered “ground zero” for the world price of oil and is critical to the country’s economy and energy supply.¹⁵⁴ The largest quake (M4.5) hit within a few miles of town and rattled the complex’s massive tanks.¹⁵⁵

The threat of earthquakes raises new security concerns surrounding the Cushing Hub.¹⁵⁶ After 9/11, U.S. government officials highlighted Cushing as a potential terrorist target, but a more domestic threat lurks just beneath the surface.¹⁵⁷ Scientists predict the faults near Cushing could produce a large earthquake similar to the one that hit Prague in 2011 and has the potential to cause significant damage “to national strategic infrastructure” and the surrounding community.¹⁵⁸ If such an event were to damage the hub’s network of pipelines and storage tanks, it could result in serious environmental damage, a temporary spike in oil prices, safety hazards such as fires, and disrupt the supply of oil to refineries across the country.¹⁵⁹

When it comes to protecting America’s energy security, experience demonstrates that “threats to reliability and security of supply can come in unexpected ways.”¹⁶⁰ The common law is known for its adaptability, and the public nuisance doctrine has been invoked to protect “public health, safety, and even morality.”¹⁶¹ Allowing the government to abate a hazard with national security implications also seems appropriate. Courts recognize the importance of oil and gas storage facilities and the public interest they serve, and in doing so have held companies liable for a public nuisance when continued operation of nearby wells threatens the viability of such critical infrastructure.¹⁶² Companies that own tank capacity in Cushing have not yet taken steps to address earthquakes in their emergency or disaster plans.¹⁶³ If they continue ignoring warnings

from scientists and national security officials, these companies and others that operate nearby disposal wells may find themselves liable for a public nuisance.

V. Conclusion

Utilizing the law of nuisance to address induced seismicity is a novel concept, but the same basic rules used to assess liability when other human activities cause the earth to vibrate should apply.¹⁶⁴ If reasonable precautions are not taken in the siting and operation of an injection well, operators can be held accountable to those injured under a nuisance theory.¹⁶⁵ Proving causation might be the most challenging obstacle for induced seismicity plaintiffs, but as the science becomes more developed, the chances of establishing the requisite link increase.¹⁶⁶ If unabated, the magnitude and frequency of induced earthquakes may also increase, making it easier for plaintiffs to show the gravity of the harm outweighs the utility of the conduct.

In the 19th century, an illness sometimes described as “shattered nerves” was the focus of extensive debate among medical professionals trying to assess the cause and apply the proper remedy.¹⁶⁷ Solving the problem of induced seismicity presents a similar challenge. Liability can fall under several tort theories, and this Article does not suggest that nuisance law is the best apparatus to address the problem. The law of nuisance “is a clumsy tool” and won’t provide a comprehensive solution to address the problem.¹⁶⁸

However, the deterrent effect of common-law liability should not be underestimated.¹⁶⁹ Until regulatory efforts catch up and are adequate to address induced seismicity, litigation may fill the gap and catalyze the industry to engage in proactive mitigation measures.¹⁷⁰ Even if these lawsuits are ultimately unsuccessful on the merits, “[b]ad press, public outcry, and fear from further liability all serve to prod industry self-improvement.”¹⁷¹ Domestic energy production provides great benefits to our economy and is critical to maintaining our modern way of life, but if humans are powerful enough to “mimic the wrath of God,” those responsible should also “mimic the mercy of God” by providing compensation to others who are injured by their industrial activities.¹⁷²

153. Philips, *supra* note 19.

154. Cushing is the “gathering point for light, sweet crude known as West Texas Intermediate (WTI)” that serves as the reference point for futures traded on the New York Mercantile Exchange. DANIEL YERGIN, *THE QUEST* 161 (2012).

155. Philips, *supra* note 19.

156. Michael Wines, *New Concern Over Quakes in Oklahoma Near a Hub of U.S. Oil*, N.Y. TIMES, Oct. 14, 2015, available at <http://www.nytimes.com/2015/10/15/us/new-concern-over-quakes-in-oklahoma-near-a-hub-of-us-oil.html>.

157. Philips, *supra* note 19 (arguing that the threat of earthquakes could present a scenario “no less dangerous than a potential terrorist attack.”).

158. Daniel McNamara et al., *Reactivated Faulting Near Cushing Oklahoma: Increased Potential for a Triggered Earthquake in an Area of United States Strategic Infrastructure*, 42 GEOPHYSICAL RES. LETTERS 8328 (Oct. 2015); Philips, *supra* note 19 (explaining the potential of even larger quakes in the future); Wines, *supra* note 156 (explaining that “the Department of Homeland Security has gauged potential earthquake dangers to the hub and concluded that a quake equivalent to the record M 5.7 could significantly damage the tanks”).

159. Wines, *supra* note 156 (noting that the federal government has designated the hub “a critical national infrastructure”); Philips, *supra* note 19 (arguing that “if even a couple of Cushing’s tanks had to shut down, or a pipeline were damaged, the impact could ripple through the market”).

160. See YERGIN, *supra* note 154, at 719 (explaining that when “economies and technologies change, security concerns take new forms”).

161. DOREMUS, *supra* note 14, at 42.

162. Northern Natural Gas Co. v. L.D. Drilling, Inc., 759 F. Supp. 2d 1282, 1299 (D. Kan. 2010).

163. Philips, *supra* note 19.

164. Cypser, *supra* note 107, at 40.

165. *Id.* at 50.

166. FOLGER & TIEMANN, *supra* note 10, at 20.

167. JANET OPPENHEIM, *SHATTERED NERVES: DOCTOR’S, PATIENTS, AND DEPRESSION IN VICTORIAN ENGLAND* (1991) (discussing how doctors disagreed on whether the nervous breakdown was a physiological disorder or a moral weakness).

168. Justin Pidot, *The Applicability of Nuisance Law to Invasive Plants: Can Common Law Liability Inspire Government Action?*, 24 VA. ENVTL. L.J. 183, 218-19 (explaining that the common law is “inherently reactive, even when used in an anticipatory posture. It requires resource-intensive monitoring, detection, and litigation.”).

169. Richards, *supra* note 13, at 32-33.

170. Pidot, *supra* note 168, at 219.

171. Sean Rigby, *Earthquake Litigation Shaking Up the Fracking Industry*, GEO. INT’L ENVTL. L. REV., Feb. 27, 2015, <http://gei.org/2015/02/27/earthquake-litigation-shaking-up-the-fracking-industry-georgetown-international-environmental-law-review/>.

172. WILLIAM H. RODGERS, *RODGERS’ ENVIRONMENTAL LAW* §2:18 (2015).