ANTICIPATED HARM, PRECAUTIONARY REGULATION AND HYDRAULIC FRACTURING

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TABLE OF CONTENTS

INTRODUCTION

Advocates of natural gas call it a "bridge fuel" into a clean energy future.[1] Those in favor of expanding its use for energy production point out that it pollutes less than oil or coal when consumed and can potentially generate far more electricity with existing technology than

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1. Joe Kirkland & Climatewire, *Natural Gas Could Serve as 'Bridge' Fuel to Low-Carbon Future*, SCIENTIFIC AMERICAN (June 25, 2010), http://www.scientificamerican.com/article.cfm?id=natural-gas-could-serve-as-bridge-fuel-to-low-carbon-future; *see also* MASS. INST. OF TECH., THE FUTURE OF NATURAL GAS 7, at iii (2011), *available at* http://web.mit.edu/mitei/research/studies/documents/natural-gas-2011/NaturalGas_Report.pdf ("[T]he realization over the last few years that the producible unconventional gas resource in the U.S. is very large has intensified the discussion about natural gas as a 'bridge' to a low-carbon future.").

all the existing renewable energy technologies combined.[2] These qualities assure that natural gas will account for an increasing share of the United States' energy mix over the next several decades, with large unconventional reserves playing a key role. New horizontal drilling techniques coupled with high volume hydraulic fracturing, known as fracking, have made these unconventional reserves viable.[3] Yet accumulating reports of contaminated ground water near fracking sites across the country have spurred intense scrutiny and protests, threatening the future of natural gas in the United States.[4] The Industry has blamed these reported contamination events on improper drilling practices, accidental surface leaks and spills, and natural occurrences.[5] However, as the study and extent of high volume slick water hydraulic fracturing increases, so to does a body of evidence which points to the underground migration of fracking fluid and methane into groundwater as the culprit.[6]

This note will focus on the poorly understood interaction between fracking fluid and underground strata as well as the serious and permanent harm caused by the unintended migration of gases and drilling fluids into aquifers. I will argue that hydraulic fracturing's potential to irreparably contaminate essential groundwater supplies demands a precautionary approach, and therefore preemptive action. This note will focus on the precautionary principle and the common law doctrine of anticipatory nuisance. Together, these two legal mechanisms provide a predictable and rational legal response to an uncertain causal connection between groundwater contamination and

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2. Adam Serchuk & Robert Means, *Natural Gas: A Bridge to a Renewable Energy Future*, RENEWABLE ENERGY POLICY PROJECT 12 (1997), *available at* http://www.repp.org/repp_pubs/pdf/issuebr8.pdf.

3. MASS. INST. OF TECH., THE FUTURE OF NATURAL GAS 7, at iii (2011), *available at* http://web.mit.edu/mitei/research/studies/documents/natural-gas-2011/NaturalGas_Report.pdf; *see also* Reuters, *EPA to Release Results of Fracking Study in 2012*, (Nov. 3, 2011), http://www.reuters.com/article/2011/11/03/us-usa-fracking-epa-idUSTRE7A272220111103 ("'Natural gas plays a key role in our nation's clean energy future, and the Obama administration is committed to ensuring that we continue to leverage this vital resource responsibly,' the EPA said.").

4. Amy Mall, *Incidents Where Hydraulic Fracturing is the Suspected Cause of Drinking Water Contamination*, SWITCHBOARD NAT. RESOURCES DEF. COUNCIL STAFF BLOG (Dec. 19, 2011), http://switchboard.nrdc.org/blogs/amall/incidents_where_hydraulic_frac.html.

5. *Id.*

6. *Id.*; *see also* Abrahm Lustgarten, *EPA: Chemicals Found in Wyo. Drinking Water Might be From Fracking*, PROPUBLICA (Aug. 25, 2009), http://www.propublica.org/article/epa-chemicals-found-in-wyo.-drinking-water-might-be-from-fracking-825 ("'It starts to finger-point stronger and stronger to the source somehow being related to the gas development," said Nathan Wiser, an EPA scientist and hydraulic fracturing expert . . . .").

fracking. I will argue that preemptive action should take the form state and local regulation and should utilize a precautionary framework. I will further argue that the common law doctrine of anticipatory nuisance can facilitate an increased role for the judiciary, and more importantly, refine some of the ambiguities associated with the precautionary principle.

Inevitably, a precautionary approach forces one to evaluate how a legal system measures and values the probability of future harm occurring and what standard of proof is sufficient to trigger action.[7] Part I of this note will provide a technical overview of fracking. Part II will offer an exploration into the precautionary principle and the common law doctrine of anticipatory nuisance in order to illustrate the similarities in rationale and the problems in applying these doctrines. Part III will focus on the arguments among the industry, local communities, environmental groups, and government about the interactions of fracking fluid, methane, and dynamic underground geology. Part IV will apply a precautionary approach through both regulation and common law, in an attempt to prevent permanent environmental harm before it occurs.

I. A TECHNOLOGICAL OVERVIEW OF FRACKING

The Massachusetts Institute of Technology Energy Initiative's study, *The Future of Natural Gas*, asserts that "[a]ssessments of the recoverable volumes of shale gas in the United States have increased dramatically over the last five years."[8] Reserve assessments have grown considerably, driven by the crowning achievement of the oil and gas industry—the technologically advanced drilling technique known as slick water high volume hydraulic fracturing.[9] According to a 2009 study by the Potential Gas Committee, which tracks gas supplies throughout the world, natural gas reserves in the U.S.

7. Stephanie Joan Mead, *The Precautionary Principle: A Discussion of the Principle's Meaning and Status in an Attempt to Further Define and Understand the Principle*, 8 N.Z.J. ENVTL. L. 137, 141–143 (2004) (reviewing the challenges drafters face in the international law context in defining the level of certainty needed to trigger a precautionary approach).

8. MASS. INST. OF TECH., THE FUTURE OF NATURAL GAS 7 (2011), *available at* http://web.mit.edu/mitei/research/studies/documents/natural-gas-2011/NaturalGas_Report.pdf.

9. *Id. see also* Abrahm Lustgarten, *EPA Launches National Study of Hydraulic Fracturing*, PROPUBLICA (Mar. 18, 2010), http://www.propublica.org/article/epa-launches-national-study-of-hydraulic-fracturing ("The fracturing technology . . . made it possible for energy companies to open vast domestic energy reserves across the country and fueled a nationwide boom in drilling activity.").

jumped 35% from 2006 to 2008, partly attributed to the increased use of hydraulic fracturing techniques.[10] Current average projections of recoverable shale gas resources are approximately 650 trillion cubic feet (Tcf), enough to supply the United States for 30 years at the 2009 rate of consumption.[11] Other estimates put these reserves at 90 years of consumption.[12] The Energy Information Administration (EIA) estimated that the U.S. possesses enough shale gas to supply the nation's needs at the 2010 rate of consumption for over 65 years, with a high estimate of 80–100 years.[13] The vast size of these now economically viable reserves has been called a "game changer" in the energy industry, both in where world energy supplies will flow from in the future, and in the billions of dollars that is at stake.[14]

Contrary to popular belief, hydraulic fracturing is not a new technique. Since the early fifties, the basic concept was used to stimulate production in old oil and gas wells.[15] This is done by forcing water, usually mixed with proppants (sand or beads to hold the fractures open) and chemicals (to reduce friction and kill bacteria) down a well bore at extremely high pressure in order to create or expand fractures in order to release gas from the rock formation in which it is trapped.[16] Within the last ten years, advances in horizontal drilling (drilling down, then turning the well bore horizontally and following the vein of shale laterally underground), new chemical

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10. Press Release, Potential Gas Committee, *Potential Gas Committee Reports Unprecedented Increase in Magnitude of U.S. Natural Gas Resource Base* (June 18, 2009), *available at* http://www.aga.org/SiteCollectionDocuments/Newsroom/0906PGCPRESS.PDF.

11. *Id. See also* MASS. INST. OF TECH., THE FUTURE OF NATURAL GAS 7, 30 (2011), *available at* http://web.mit.edu/mitei/research/studies/documents/natural-gas-2011/NaturalGas_Report.pdf (estimating recoverable domestic shale gas totals to be 650 Tcf, which projects to a nearly 30 year supply based on the United States consuming 22.8 Tcf in 2009).

12. Robert J. Samuelson, *Shale Gas: Hope for Our Energy Future*, NEWSWEEK (Aug. 5, 2010), http://www.newsweek.com/2010/08/05/shale-gas-hope-for-our-energy-future.html.

13. *Frequently Asked Questions*, U.S. ENERGY INFO. ADMIN., http://www.eia.gov/tools/faqs/faq.cfm?id=58&t=8 (last visited July 20, 2012).

14. Gerard Wynn & Ben Hirschler, *Shale Gas is U.S. Energy "Game Changer"*, REUTERS (Jan. 28, 2010), http://www.reuters.com/article/2010/01/28/davos-energy-idUSLDE60R1MV20100128. *See, e.g.*, James Boxell, *Total Invests Billions in Shale Gas*, Financial Times (Jan. 6, 2012, 3:50 PM), http://www.ft.com/home/us (search "news" for article title) (identifying several recent investments in United States shale gas ventures).

15. ENERGY IN DEPTH, A LOOK BACK: HF, SDWA, AND RECENT EFFORTS BY STATES TO FIGHT BACK (last visited July 20, 2012), *available at* http://www.energyindepth.org/PDF/timeline.pdf.

16. AMERICAN EXPLORATION AND PRODUCTION COUNCIL, THE REAL FACTS ABOUT FRACTURE STIMULATION: THE TECHNOLOGY BEHIND AMERICA'S NEW NATURAL GAS SUPPLIES 1–2 (2010), *available at* http://energyindepth.org/wp-content/uploads/2011/10/Real-facts-behind-fracture-stimulation-technology.pdf.

additives, the use of higher volumes of water, and stronger pumps have revolutionized hydraulic fracturing, enabling the extraction of natural gas from shale formations previously thought technically and economically infeasible.[17]

The Marcellus Shale Formation is a relatively thin rock layer ranging from 20 to a couple hundred feet thick and stretches from eastern Ohio through West Virginia, Pennsylvania, and New York. Recently, this formation has experienced sharp increases in new well drilling.[18] Pennsylvania is a prominent example of this newfound gas rush. In 2008 alone, at least 4,000 new oil and gas wells were drilled in Pennsylvania, more than any other state except Texas.[19] Furthermore, the pace of drilling on these permits is astounding; in the first nine months of 2010, "2,300 permits had been issued and nearly half of those wells have been drilled."[20]

Fracking is extremely water intensive. Drilling and fracturing a single horizontally drilled gas shale well typically requires a total of two to 7.8 million gallons of fluid (on average 5.6) per frack.[21] The phrase "per frack" describes each time water is pumped down the well bore to release the trapped gas after the borehole is drilled.[22] This can be done multiple times for each well to stimulate the flow of gas back up the well.[23] The fluid injected into a well to fracture the surrounding rock is approximately 99% water and sand, with the remainder comprised of some subset of over 200 chemicals used to

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17. *How Natural Gas Works,* UNION OF CONCERNED SCIENTISTS, http://www.ucsusa.org/clean_energy/technology_and_impacts/energy_technologies/how-natural-gas-works.html (last updated Aug. 31, 2010).

18. Valerie Myers, *Times In-Depth: What is the Marcellus Shale and Why is it so Attractive Now?*, THE ERIE TIMES, Jan. 30, 2011, http://goerie.com/apps/pbcs.dll/article?AID=/20110130/NEWS02/301309829/-1/RSS01.

19. Joaquin Sapien, *With Natural Gas Drilling Boom, Pennsylvania Faces an Onslaught of Wastewater*, PROPUBLICA (Oct. 3, 2009), http://www.propublica.org/article/wastewater-from-gas-drilling-boom-may-threaten-monongahela-river.

20. Genaro C. Armas, *Eyes of the Natural Gas Industry are on Pennsylvania*, MERCURY, Oct. 16, 2010, http://www.pottsmerc.com/article/20101016/NEWS01/310169985/eyes-of-the-natural-gas-industry-are-on-pennsylvania&pager=full_story (reviewing number of permits issued for gas wells in Pennsylvania).

21. LOGAN, DEEP SHALE GAS DRILLING: CONCERNS FOR FARMERS AND RURAL COMMUNITIES, (2011), *available at* http://www.oeffa.org/documents/FrackingpowerpointPDF.pdf?PHPSESSID=021148783e86a62518ed44daa0a73aa0. *See also* ERIK MIELKE ET AL., WATER CONSUMPTION OF ENERGY RESOURCE EXTRACTION, PROCESSING AND CONVERSION (2010), *available at* http://belfercenter.ksg.harvard.edu/files/ETIP-DP-2010-15-final-4.pdf (analyzing water consumption in shale gas production).

22. *Id.*

23. *Id.*

enhance the fracturing process by reducing friction, preventing corrosion, and killing bacteria.[24] The industry stresses the small percentage of chemicals in fracking fluid in an attempt to dispel safety concerns.[25] However, even a small percentage of the millions of gallons of fluid used in one single frack contains hundreds of thousands of pounds of chemical additives, many of them known carcinogens and endocrine system disruptors.[26] These chemicals include but are not limited to benzene, naphthalene, aromatic hydrocarbons, glycol ethers, and hydrochloric acid.[27]

Along with the chemical additives, fracking fluid also picks up naturally occurring radioactive materials (NORMs) such as uranium, and total dissolved solids (TDS), which is a mixture of salt and other minerals that lie deep underground.[28] Ron Bishop, a leading biochemist and professor at SUNY Oneonta stated that "[s]hales, more than any other kind of rock, selectively trap heavy metals such as lead, arsenic, barium, strontium, and chromium."[29] This means that even if no chemicals are used in the fracking fluid, the water that is pumped underground becomes infused with radioactive and toxic elements that had previously been locked safely underground for millions of years. ProPublica reported on a New York Department of Environmental Conservation study that "analyzed 13 samples of wastewater brought thousands of feet to the surface from drilling and found that they contain levels of radium-226, a derivative of uranium, as high as 267 times the established limit safe for discharge into the environment and thousands of times the limit safe for people to drink."[30]

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24. ENERGY IN DEPTH, A FLUID SITUATION: TYPICAL SOLUTION USED IN HYDRAULIC FRACTURING, (last visited July 20, 2012), *available at* http://www.energyindepth.org/frac-fluid.pdf.

25. ENERGY IN DEPTH, A FLUID SITUATION, (last visited July 20, 2012) *available at* http://energyindepth.org/wp-content/uploads/2011/10/frac-fluid.pdf.

26. THEO COLBORN, ET AL., NATURAL GAS OPERATIONS FROM A PUBLIC HEALTH PERSPECTIVE 2–3 (2010), *available at* http://endocrinedisruption.org/files/GasManuscriptPreprintforweb12-5-11.pdf.

27. *Id.* at 4, 19.

28. CCE-PRI MARCELLUS SHALE TEAM, INTRODUCTION TO MARCELLUS SHALE NATURAL GAS DEVELOPMENT, *available at* http://cce.cornell.edu/EnergyClimateChange/NaturalGasDev/Documents/PDFs/CCE_NatGas_Roadshow1a_2010_Final_.pdf.

29. Sue Smith-Heavenrish, *Health Impacts of Gas Drilling Examined*, TOMPKINS WEEKLY (Mar. 1, 2010), http://ithaca.wishingwellmagazine.org/blogs/tompkins-weekly/2010/03/health-impacts-gas-drilling-examined.

30. Abrahm Lustgarten, *Is New York's Marcellus Shale Too Hot to Handle?*, PROPUBLICA (Nov. 9, 2009), http://www.propublica.org/article/is-the-marcellus-shale-too-hot-to-handle-1109.

Disposing of the highly toxic fluid that is recovered from fracking is a serious problem.[31] Of equal concern is what is lost in the process. On average, only 15 to 20% of the fracking fluid is recovered; the rest remains underground.[32] The natural gas industry assumes it will stay put, locked safely away from our drinking water thousands of feet below ground.[33] The Union of Concerned Scientists states that the geological formations targeted for fracking "are typically thousands of feet deeper than freshwater aquifers."[34] However, fracturing a specifically targeted location thousands of feet underground is difficult. As one lawyer working on an underground trespass case involving fracking stated, "[t]he problem is . . . that fracture stimulation isn't a precise science . . . in some ways, cracking the shale [predictably] could be thought of as trying to hammer a dinner plate into equal pieces . . . 'You may plan a fracture that will go 1,000 feet and it might go 2,000 feet or 400 feet.'"[35]

Uncertainty also exists as to whether new or existing geological features such as preexisting faults and joints will allow methane gas and fracking fluid to escape into drinking aquifers.[36] Scientists are also concerned that the hydraulic fracturing process itself could compromise the multiple layers of rock separating the shale formations from aquifers, leading to contaminated groundwater supplies.[37] Furthermore, in shale formations, "once the presence and

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31. *See generally* Joaquin Sapien, *With Natural Gas Drilling Boom, Pennsylvania Faces an Onslaught of Wastewater*, PROPUBLICA (Oct. 3, 2009), http://www.propublica.org/article/wastewater-from-gas-drilling-boom-may-threaten-monongahela-river.

32. Abrahm Lustgarten, *In New Gas Wells, More Drilling Chemicals Remain Underground*, PROPUBLICA (Dec. 27, 2009), http://www.propublica.org/article/new-gas-wells-leave-more-chemicals-in-ground-hydraulic-fracturing.

33. *See Going Deep: Well Stimulation Technology Deployed Thousands of Feet Below the Water Table*, ENERGY IN DEPTH, http://www.energyindepth.org/hydraulic-frac-graphic.jpg (last visited July 20, 2012) (depicting the hydraulic fracturing process graphically).

34. *How Natural Gas Works*, UNION OF CONCERNED SCIENTISTS (Dec. 2010), http://www.ucsusa.org/clean_energy/technology_and_impacts/energy_technologies/how-natural-gas-works.html.

35. *FAQ*, UN-NATURALGAS.ORG, http://unnaturalgas.org/hydraulic_fracturing_a-z.htm (last visited July 20, 2012).

36. *See* James O'Toole, *EPA Sounds Alarm on Fracking in Wyoming*, CNN MONEY, (Dec. 9, 2011), http://money.cnn.com/2011/12/09/news/economy/epa_fracking_wyoming/index.htm ("Given the area's complex geology and the proximity of drinking water wells to ground water contamination, EPA is concerned about the movement of contaminants within the aquifer and the safety of drinking water wells over time."); *see also* Abrahm Lustgarten and Nicholas Kusnetz, *Feds Link Water Contamination to Fracking for the First Time*, PROPUBLICA, (Dec. 8, 2011), http://www.propublica.org/article/feds-link-water-contamination-to-fracking-for-first-time

37. *How Natural Gas Works*, *supra* note 28.

thickness of the formation is established, the drilling companies do not perform further seismic data collection, which would lead to identifying faulting in the area."[38] Compare this practice with vertical wells, which depend on 3D seismic mapping for success, and therefore utilize seismic data collection throughout the process.[39] "[Hydraulic fracturing] may open faults and may increase permeability along laterally and vertically extensive fault planes and fault zones—thereby increasing the risk of contaminant and gas excursions."[40] As one reporter wrote of the fracking fluid injected underground, "[h]ow far it goes and where it ends up, no one really knows."[41] The unique qualities of high volume hydraulic fracturing create scientific uncertainty as to the short and long-term effects of the activity.[42] Consequently, this also creates uncertainty regarding what regulations are needed to protect the health and safety of the environment and those who live above shale gas reserves.

The gas industry vehemently denies that any causation exists between fracking and water contamination. They suggest instead that these reports of contaminated, cloudy, smelly, and flammable drinking water emerging across the country are "anecdotal" at best and that "no science or investigation has ever verified the contamination as true."[43] Yet, as ProPublica's excellent reporting makes clear, by this same reasoning, there are no substantive and thorough studies or evidence that demonstrate hydraulic fracturing is safe either.[44] It is in the context of this truth that the legal framework for hydraulic fracturing must operate, even as drilling continues.

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38. JAMES L. NORTHROP, THE UNIQUE ENVIRONMENTAL IMPACTS OF HORIZONTALLY HYDROFRACKING SHALE 2 (2000), *available at* http://frackingfreeireland.org/wp-content/uploads/2011/08/10aug19_NorthrupEPAcommentsFracking2010.pdf.

39. *Id.*

40. *Id.*

41. Abrahm Lustgarten, *Hydrofracked? One Man's Mystery Leads to a Backlash Against Natural Gas Drilling*, PROPUBLICA (Feb. 25, 2011), http://www.propublica.org/article/hydrofracked-one-mans-mystery-leads-to-a-backlash-against-natural-gas-drill/single.

42. Abrahm Lustgarten and Nicholas Kusnetz, *Feds Link Water Contamination to Fracking for the First Time*, PROPUBLICA, (Dec. 8, 2011), http://www.propublica.org/article/feds-link-water-contamination-to-fracking-for-first-time ("The presence of synthetic compounds such as glycol ethers . . . and the assortment of other organic components is explained as the result of direct mixing of hydraulic fracturing fluids with ground water in the Pavillion gas field," the draft report states. "Alternative explanations were carefully considered.").

43. *Id.*

44. *Id.*

There are a myriad of other environmental problems associated with fracking. These include wastewater treatment and storage, chemical spills and disposal, air and noise pollution, water withdrawal and radioactive waste permitting, monitoring and enforcement of best practices, and the degradation and fragmentation of wildlife habitat.[45] It seems the list could continue indefinitely. Fortunately, all of the aforementioned environmental problems are understood fairly well, even if a solution is not. The problem with hydraulic fracturing is not with these well-understood and visible impacts of gas extraction. Instead, the real danger lies within the poorly understood interaction of fracking fluids, methane, and subsurface geology. This raises the very real possibility that fracking, no matter how stringently regulated, may never be safe, and that hard science supporting this conclusion will only be discovered after it is too late.

II. TWO LEGAL RESPONSES TO AN UNCERTAIN PROBABILITY OF HARM

In an ironic twist, the inherent flaw in many of the legal mechanisms developed to cope with scientific uncertainty is one of vagueness. Specifically, these regimes suffer from an ambiguous level of proof or probability of harm necessary to both trigger regulatory action and allow a proposed activity to proceed. This section lays out the application and criticisms of the precautionary principle and compares its essential features to the common law doctrine of anticipatory nuisance; two legal mechanisms that function to prevent permanent environmental damage before it occurs.

A. The Precautionary Principle

At its most basic level, the precautionary principle calls for regulators to take the position of "better safe than sorry."[46] Specifically, the precautionary approach "requires that where a causal

45. *Hydraulic Fracturing 101*, EARTHWORKS, http://test.earthworksaction.org/index.php/issues/detail/hydraulic_fracturing_101#WASTE (last visited July 20, 2012). *See also* OIL AND GAS ACCOUNTABILITY PROJECT, HYDRAULIC FRACTURING, (2006), *available at* http://www.earthworksaction.org/files/publications/Fracking.pdf.

46. Stephanie Joan Mead, *The Precautionary Principle: A Discussion of the Principle's Meaning and Status in an Attempt to Further Define and Understand the Principle*, 8 N.Z.J. ENVTL. L. 137, 137–38 (2004) (reviewing the history of use of the precautionary principle).

link cannot be shown between the activity or substance introduced and a potential harm, caution must be taken before allowing such an activity."[47] At first glance, this concept sounds straightforward. Yet the true beauty of this principle is two-fold: first, it justifies regulation before full scientific certainty can be established (and before permanent environmental damage occurs), and second, it enables legislators to shift the burden of proof from the traditional structure that requires regulators prove that regulation is necessary to requiring that the industry prove that regulation is unnecessary.[48] Talbot Page, a noted economist, produced the traditional and oft-used reasoning behind this principle in 1978.[49] Page argued that "a false negative could cost lives, while a false positive, such as banning a truly harmless chemical, would have only economic consequences, and probably minor ones at that."[50] While simplistic in its rationale, the continued relevancy of this concept is seen in its adoption throughout the world. The continued relevancy of the precautionary principle is especially true as the development of new technology outpaces our understanding of its effects.

Various formulations of the precautionary principle are written into at least fourteen international documents.[51] The first inclusion of this principle into a formal document was in the Declaration of the Second International North Sea Conference on the Protection of the North Sea in 1987 and stated that "in order to protect the North Sea from possible damaging effects of the most dangerous substances, a precautionary approach is necessary which may require action to control inputs of such substances even before a causal link has been established by absolute clear scientific evidence."[52] The principle became embedded in international law when it was drafted into the 1992 Rio Declaration on the Environment and Development at the United National Conference on Environment and Development.[53] Principle 15 of the Rio Declaration states, "[i]n order to protect the

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47. *Id.* at 148 (defining the basic premise of the precautionary principle).

48. Mead *Supra*, note 43, at 140, 152.

49. Frank B. Cross, *Paradoxical Perils of the Precautionary Principle*, 53 WASH. & LEE L. REV. 851, 852 (1996).

50. *Id.*

51. Cass R. Sunstein, *Beyond the Precautionary Principle,* 151 U. PA. L. REV. 1003, 1006 (2003).

52. *Id.* at 1012 (citing to the Second International Conference on the Protection of the North Sea).

53. *Id.*

environment, the precautionary approach shall be widely applied by States. . . . Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation."[54] While these formulations are non-binding, they provide guidance for the evolution of international environmental law and illustrate the utility of precautionary reasoning.[55]

The European Union (EU) attempted to clarify exactly what the precautionary principle demanded during a European Commission meeting in 2000.[56] Unfortunately, no set definition was agreed upon and it was decided that the precautionary principle "applies only to risk management . . . and is triggered only by risks identified by scientific risk assessment."[57] This interpretation presupposes that a structured approach to risk analysis exists *before* the activity or substance is introduced. Furthermore, the term "scientific risk assessment" implies an orderly process by which scientific experts come to a certain conclusion. Yet in the context of a contentious and high stakes activity such as fracking, a structured approach for studying the effects of an activity and implementing necessary regulations is rarely put in place *before* the activity is underway. A policy statement clarified this risk assessment to mean that a precautionary approach "must follow a scientific evaluation based on enough data to establish a possibility of occurrence."[58] What level of possibility it demands is still an open question. The EU clarification further limits the scope of the precautionary principle by including "the value of 'cost analysis' in the application of the precautionary principle."[59] This interpretation requires that the cost of a precautionary approach be taken into account when deciding the appropriate regulatory action, ensuring a proportionality of

54. United Nations Conference on Environment and Development, Rio de Janiero, Braz., June 3-14, 1992, *Rio Declaration on Environment and Development*, U.N. Doc. A/CONF.151/26/Rev.1 (Vol. I), Annex I (Aug. 12, 1992), *available at* http://www.un.org/documents/ga/conf151/aconf15126-1annex1.htm.

55. Mead *supra* note 38, at 163.

56. Mead, *supra* note 46, at145 (reviewing the attempts of the European Union to determine the definition of the precautionary principle).

57. *Id.*

58. Laurent Bontoux, *The Current EU Precautionary Approach on EMF*, EUROPEAN COMMISSION (Feb. 2009), ec.europa.eu/health/ph_risk/documents/ev_20090211_co01_en.pdf.

59. Mead, *supra* note 46, at 145 (reviewing the controversy of including cost analysis in the application of the precautionary principle).

response.[60] Because of the consideration of cost, this interpretation could fail to prevent a harm of high magnitude but relatively low probability due to prohibitive cost.[61] Stereotypically, Europe is seen as risk-averse, skeptical of science and technology and collectivist in their support for a unified government whereas the U.S. is thought of as risk-taking, technologically optimistic and individualistic.[62] These stereotypes are inaccurate.[63]

The United States has incorporated a precautionary approach into several important domestic statutes, regulating both environmental and public health concerns.[64] A common thread of precaution is evident in environmental regulations based on conservative assumptions.[65] One example is National Primary Ambient Air Quality Standards under the Clean Air Act, which mandates an "adequate margin of safety" when setting emission standards.[66]

The U.S. Food and Drug Administration's (FDA) approach to new drug approval is precautionary as well.[67] "Rather than placing pharmaceuticals with uncertain health risks on the market, the FDA requires that all new drugs be subjected to numerous tests . . . in order to ensure a certain level of safety."[68] The United States also applies precaution in the area of pesticide regulation. As an example, in 1977, "the U.S. government removed the widely used pesticide Dibromochloropropane (DBCP) from the U.S. market even though possible health risks had not been established with scientific certainty."[69] The Environmental Protection Agency (EPA) also took a

60. Mead, *supra* note 46, at 151-152.

61. *Id. See also* O'Riordan.T. & Cameron, J., *Interpreting the Precautionarv Principle*, Earthscan Publications Ltd (1994), http://dieoff.org/page31.htm.

62. Jonathan B. Weiner, Professor of Law, Duke University, Comparing Risk Regulation in the United States and Europe at the Conference on REACH 2 (June 8, 2007), www.ucis.pitt.edu/euce/events/policyconf/07/PDFs/Wiener.pdf.

63. *Id.* at 42.

64. Cross, *supra* note 49, at 852, 855.

65. *See Id.* at 856–58 (describing environmental statutes that utilize conservative assumptions).

66. Clean Air Act, 42 U.S.C. § 7409(b)(1) (2006).

67. Linda O'Neil Coleman, Comment, *The European Union: An Appropriate Model for a Precautionary Approach*, 25 SEATTLE U. L. REV. 609, 626 (2002).

68. *Id.*

69. *Id. See also Pesticides and Breast Cancer Risk: Dibromochloropropane (DBCP)*, SPRECHER INSTITUTE FOR COMPARATIVE CANCER RESEARCH (July 2004), http://envirocancer.cornell.edu/FactSheet/pesticide/fs50.dbcp.cfm ("Currently there is not enough scientific information to determine whether or not DBCP causes breast cancer in people. Very few studies have been done on women who were exposed to DBCP . . . . DBCP was banned by the US Environmental Protection Agency (US EPA) in 1977.").

precautionary approach in the assumption that the dose-response curve of low level toxic agents is linear—that there is no safe threshold for exposure[70]—when they wrote that "EPA continues to believe that the most scientifically valid approach, given the lack of critical data, is to use the linear approach to assessing the mode of action."[71] Even without full scientific certainty, EPA banned *any* exposure to certain chemicals rather than assume that exposure below a certain level would be safe.[72]

Congressional legislation is not the only area where the U.S. takes a precautionary approach. Because most environmental standards are promulgated through administrative agencies, the judiciary frequently reviews agency action. Courts have upheld regulations based on conservative assumptions in the regulation of lead. For example, the District of Columbia Circuit Court held that "Congress directed the Administrator to err on the side of caution . . . . We see no reason why this court should . . . requir[e] the Administrator to show that there is a medical consensus that the effects on which the lead standards were based are '*clearly harmful to health*.'"[73] In the Supreme Court's *Benzene* decision, the Court emphasized that risk assessment for hazardous substances "is free to use conservative assumptions in interpreting the data with respect to carcinogens, risking error on the side of overprotection rather than under-protection."[74] These cases illustrate that there is a window, albeit a narrow one, where an agency can promulgate standards based on precaution without exceeding its delegated power or risk being overturned by a court upon a finding that their action was arbitrary and capricious.

Taking the lead in utilizing a precautionary approach in order to safeguard its citizens, California passed Proposition 65, the Safe Drinking Water and Toxic Enforcement Act.[75] Proposition 65 dispatches the burden of proof a governmental agency must carry

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70. Sunstein, *supra* note 51, at 1026.

71. National Primary Drinking Water Regulations, 66 Fed. Reg. 6976, 6994 (Jan. 22, 2001) (to be codified at 40 C.F.R. pt.9).

72. Sunstein, *supra* note 51, at 1026.

73. Lead Indus. Ass'n v. EPA, 647 F.2d 1130, 1155 (D.C. Cir. 1980).

74. Cross, *supra* note 49, at 856 (quoting Indus. Union Dep't v. Am. Petroleum Inst., 448 U.S. 607, 656 (1980)).

75. Scott La Franchi, *Surveying the Precautionary Principle's Ongoing Global Development: The Evolution of an Emergent Environmental Management Tool*, 32 B. C. ENVTL. AFF. L. REV. 679, 716 (2005) (analyzing the S.F.,CAL., ENVTL. CODE ch.1, § 101 (2003)).

before it can regulate a chemical known to cause cancer or reproductive toxicity.[76] These chemicals are no longer "considered 'innocent' until proven 'guilty'".[77]

The city of San Francisco adopted its own Precautionary Principle Ordinance in 2003. The ordinance states that "[w]here threats or irreversible damage to people or nature exist, lack of full scientific certainty about cause and effect shall not be viewed as sufficient reason for the City to postpone cost effective measures to prevent the degradation of the environment or protect the health of its citizens."[78] It is important to note that in both formulations, a bare suspicion of risk of injury is not enough; "known to cause cancer or reproductive toxicity"[79] and "lack of *full* scientific certainty"[80] show that some evidence is needed to trigger a precautionary action. Yet the question of just how much evidence is required before a preemptive action remains. It is this ambiguity that must be resolved before a consistent and workable precautionary approach can be applied.[81]

Illustrating the issue of what level of evidence is required before legislative action can be taken, several cities overlying or dependant on drinking water originating in the Marcellus Shale formation have passed moratoriums on fracking based on what critics would call minimal evidence.[82] Pittsburgh became the first Pennsylvania city to ban drilling within its boundaries in November of 2010. Soon after, Pittsburgh was joined by Philadelphia, New York City, as well as a number of smaller towns in the northeast, Texas and Colorado.[83] The

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76. *Id.*

77. William S. Pease, *Identifying Chemical Hazards for Regulation: The Scientific Basis and Regulatory Scope of California's Proposition 65 List of Carcinogens and Reproductive Toxicants*, 3 RISK–ISSUES IN HEALTH AND SAFETY 127 (1992) (citing CAL. HEALTH & SAFETY § 25249.5 (West 1986)).

78. La Franchi, *supra* note 75 at 716 (citing S.F.,CAL., ENVTL. CODE ch.1, § 101 (2003)).

79. CAL. HEALTH & SAFETY CODE § 25249.5 (2006).

80. S.F., CAL., ENVTL. CODE ch. 1 § 101 (2003) (emphasis added), *available at* http://www6.sfgov.org/index.aspx?page=4 (follow link for municipal codes).

81. Mead *supra* note 46, at 145.

82. Marie C. Baca, *Pittsburgh Bans Natural Gas Drilling*, PROPUBLICA (Nov. 16, 2010), http://www.propublica.org/article/pittsburgh-bans-natural-gas-drilling; *see also* Nicholas Kusnetz, *In Symbolic Move, Philadelphia Calls for Gas Drilling Ban*, PROPUBLICA (Jan. 28, 2011), http://www.propublica.org/article/in-symbolic-move-philadelphia-calls-for-gas-drilling-ban (citing "uncertainty around the environmental and economic impact of hydraulic fracturing . . . to argue for a cautious approach to drilling" in a report issued by the city of Philadelphia); *Buffalo Bans Fracking in Groundbreaking Vote*, FRACK ACTION, http://frackaction.com/buffaloban (last visited July 20, 2012).

83. *Id.*

city of Quebec has also "halted most new natural gas exploration and development following an environmental assessment of shale-gas extraction that called for further studies."[84] The men and women sitting on the councils and commissions that voted for these moratoriums have seen the same anecdotal evidence that has been circulating around the country and seem to have decided: first, there is something more than coincidence linking fracking with drinking water contamination, and second, the potential harm, should it occur, would be irreparable.

Most of the criticism surrounding a precautionary approach to potentially harmful activity has focused on this issue of what level of proof is sufficient for both triggering preemptive action as well as demonstrating that an activity is safe.[85] Other concerns include the possibility of unfairly burdening a party that has not conclusively caused damage or has yet to act, as well as the possibility that the principle could restrict technological and economic benefits.[86] The precautionary principle's vagueness lies in the amount of certainty needed both before an activity is allowed and what probability of harm is needed to trigger a precautionary approach.[87] According to one scholar, "for a term so widely applied with such a strong following among nations, lawyers, environmentalists, scientists and academics alike, there is little agreed upon about this principle."[88] As an example of the amorphousness of this concept, the Rio Declaration's precautionary principle can be seen as too ambiguous to be workable.[89] "In interpreting the meaning of the precautionary principle from this definition one could reach the conclusion that the directive would be, if taken literally, 'don't do anything.' This is due to the uncertainty attached to the words 'adverse effects . . . not fully understood.'"[90] The need to clearly explicate the probability of harm necessary before preemptive action is justified is vital in ensuring that a precautionary approach does not freeze technological

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84. Chip Cummins & Ed Welsch, *Quebec Halts Most Shale-Gas Activity After Inconclusive Environmental Assessment*, FIRST ENERCAST FINANCIAL (Mar. 09, 2011), http://www.firstenercastfinancial.com/e_news.php?cont=42130.

85. Mead, *supra* note 46, at138 (reviewing the criticism of the precautionary principle).

86. Cross, *supra* note 49, at 860.

87. Mead, *supra* note 38, at 143–45.

88. Mead, *supra* note 46, at 138 (considering the ambiguity surrounding the use of the precautionary principle).

89. Mead *supra* note 46, at 143, 145.

90. *Id.* at 142.

innovation and economic growth as well as fail to prevent environmental harm.[91]

The lack of a concrete, easily applied definition can lead to arbitrary application of the principle with no beneficial effect.[92] However, the term "principle" itself implies that the precautionary approach is a guiding perspective when crafting legislation, not a rigid rule that would demand a specific regulatory approach.[93] "The precautionary principle is more about the direction of the decision and how the decision is adopted than about the exact content of the decision."[94] This sentiment is similar to the EU's approach, which interprets the precautionary principle as providing an overarching framework for risk assessment.[95] Regardless of the vagueness associated with the principle, and the multitude of definitions, scholars have found common elements that all formulations of the precautionary principle share.[96] They are "threat of harm," "lack of scientific certainty or evidence," "cause and effect relationship is not yet proven," and "necessity or duty to act."[97]

Strong and weak versions of the principle exist because of flexibility both in defining and applying the principle's core characteristics.[98] Four different versions are evident.[99] The first is the *Non-preclusion Precautionary Principle* that states, "[r]egulation should not be precluded by the absence of scientific uncertainty about activities that pose a risk of substantial harm."[100] This is the weakest formulation.[101] A lack of evidence should not be a justification for inaction, but nothing more is required and no real direction is given to regulators faced with a potentially dangerous activity.[102]

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91. Sunstein, *supra* note 51, at 1019-1029

92. *Id.* at 145.

93. Mead *supra* note 46, at 160.

94. Alessandra Acruri, *The Case for a Procedural Version of the Precautionary Principle Erring on the Side of Environmental Preservation*, *in* FRONTIERS IN THE ECONOMICS OF ENVIRONMENTAL REGULATION AND LIABILITY 37 (Marcel Boyer et al. eds., 2006).

95. Bontoux, *supra* note 58.

96. Mead, *supra* note 46, at 150 (consolidating elements common in the various formulations of the precautionary principle).

97. *Id.*

98. Sunstein, *supra* note 51, at 1014.

99. Sunstein, *supra* note 51, at 1014.

100. *Id.*

101. *Id.*

102. Sunstein, *supra* note 51, at 1012, 1014.

The second formulation, *Margin of Safety Precautionary Principle* dictates that "[r]egulation should include a margin of safety, limiting activities below the level at which adverse affects have not been found or predicted."[103] This formulation is stronger because of its requirement that conservative estimates below what is considered safe should be used in crafting regulation. Margin of safety regulations are comparable to the EPA Clean Air standards mentioned earlier. Unfortunately, this formulation still suffers from an unspecified level of evidence required before a margin of safety regulation is passed.[104] The phrase "found or predicted" allows an analysis that overlooks the magnitude or impact of the harm and could result in burdensome and potentially overcautious and rigid laws.[105] Furthermore, this formulation is rooted in the belief that an activity or substance actually has a margin of safety at which it is safe, an assumption that can cause serious problems if later found to be wrong.

Best Available Technology Precautionary Principle is similar in strength to the previous formulation. It demands that "[b]est available technology requirements should be imposed on activities that pose an uncertain potential to create substantial harm, unless those in favor of the activities can show that they present no appreciable risk."[106] Once again, the words "uncertain potential," "substantial harm," and "no appreciable risk" are overly ambiguous and could lead to overly burdensome regulation or dangerously unregulated activities.[107] In addition, while technology is a powerful tool in the prevention of environmental harm, a false sense of security can result. This has the potential to produce decision-making, which in hindsight appears flawed, even arrogant.

The last and strongest formulation is *Prohibitory Precautionary Principle,* which states "[p]rohibitions should be imposed on activities that have an uncertain potential to impose substantial harm, unless those in favor of the activities can show that they present no appreciable risk."[108] This formulation suffers from the same problem of vagueness as to the level of potential harm needed before action

103. *Id.*
104. Sunstein, *supra* note 51, at 1031.
105. *Id.* at 1024.
106. *Id.*
107. *Id.*
108. *Id.*

can be taken. Critics argue that no activity can be proven completely safe and that a prohibitory approach would stifle economic growth and technological innovation.[109] It is even suggested that the unintended consequences of banning an activity or substance could be worse than the potential harm itself.[110]

In its current adopted formulations, the precautionary principle operates as a guiding framework for legislatures and policy makers to face an unproven causal connection and decide whether to act preemptively.[111] However, as discussed above, the vagueness and ambiguities found in these formulations, the cementing of a cost-benefit analysis into a precautionary analysis and political and economic realities have left a precautionary approach relatively ineffective thus far.[112] By looking at a common law mechanism that struggles with the same problems of certainty of harm and preemptive action, a clearer formulation of a workable precautionary approach may be found.

B. Anticipatory Nuisance

Tort law generally requires one to suffer injury prior to asserting an action for damages or injunctive relief.[113] The justification for this is twofold; an adequate remedy at law is assumed to exist after the harm occurs, and if an anticipated harm is uncertain or contingent, it is unfair to assume that defendants will conduct their businesses or activities so as to create injury.[114] However, the common law doctrine of anticipatory nuisance enables courts of equity to prevent permanent harm in circumstances where it may be difficult or even impossible to restore the damage.[115]

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109. Mead, *supra* note 46, at 141 (presenting the opposing arguments about the effect of uncertainty in the application of the precautionary principle).

110. Cross, *supra* note 49, at 860–61.

111. Mead, *supra* note 46, at 160.

112. *Id. See also* Sunstein, *supra* note 51, at 1054–1058; Mead, *supra* note 46, at 176.

113. Andrew H. Sharp, *An Ounce of Prevention: Rehabilitating the Anticipatory Nuisance Doctrine*, 15 B.C. Envtl. Aff. L. Rev. 627, 637–638; (citing to RESTATEMENT (SECOND) OF TORTS: PRIVATE NUISANCE § 827 (1979) (discussing how courts generally only enjoin nuisances that have already occurred)).

114. *Id.* at 637–38.

115. *Id.* at 629.

The anticipatory nuisance doctrine focuses a court's analysis on "whether or not injury should be prevented before it occurs."[116] A private nuisance is defined as any activity on the part of a defendant that creates a substantial and unreasonable interference with a plaintiff's use and enjoyment of his or her own land.[117] Aggrieved plaintiffs can use an anticipatory nuisance cause of action to prevent what is perceived to be a nuisance before it interferes with the use and enjoyment of his or her own land.[118] The first hurdle a plaintiff must clear is proving that injury will occur.[119] In cases that utilize the anticipatory nuisance doctrine as a cause of action, courts focus their analysis on the probability of future harm actually occurring and have generally "required a high probability (although not an absolute certainty) of injury before enjoining the threatening activity."[120] Similar to the precautionary principle, the application of this doctrine throughout the United States has been inconsistent regarding the level of certainty required before a court can act.[121]

Courts applying the most rigid version of the anticipatory nuisance doctrine have only taken action against a potentially harmful activity if the activity itself can be categorized as a nuisance per se.[122] Although some courts end their inquiry at this point, many others continue their analysis a

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116. *See* Charles J. Doane, *Beyond Fear: Articulating a Modern Doctrine in Anticipatory Nuisance for Enjoining Improbable Threats of Catastrophic Harm*, 17 B.C. Envtl. Aff. L. Rev. 441, 453–454 (1990) (citing to Ryan Teel, Comment, *Not in My Neighborhood: The Fight Against Large-Scale Animal Feeding Operations in Rural Iowa, Preemptive Tactics, and the Doctrine of Anticipatory Nuisance*, 55 DRAKE L. REV. 497, 524 (2007)).

117. RESTATEMENT (SECOND) OF TORTS § 822 (1979).

118. Andrew H. Sharp, *An Ounce of Prevention: Rehabilitating the Anticipatory Nuisance Doctrine*, 15 B.C. Envtl. L. Rev. 627, 628–629 (1988).

119. *See* Doane, *supra* note 116 at 453–54 (analyzing various anticipatory nuisance approaches taken by courts to show harm will occur).

120. Doane, *supra* note 116 at 443; *see also* W. PAGE KEETON ET AL., PROSSER AND KEETON ON THE LAW OF TORTS § 89, at 640–41 (5th ed. 1984) (citing Hamilton Corp. v. Julian, 101 A. 558, 560 (Md. 1917)); *see also* Purcell v. Davis, 50 P.2d 255, 258 (Mont. 1935) (refusing to enjoin proposed oil refinery in residential neighborhood due to uncertainty of threatened noxious fumes, explosions, and fire).

121. Doane, *supra* note 116, at 453 ("Courts have failed, however, to arrive at a single, clearly articulated definition of how imminently a defendant's conduct must threaten injury to a plaintiff before it can be enjoined.").

122. Serena M. Williams, *The Anticipatory Nuisance Doctrine: One Common Law Theory For Use in Environmental Justice Cases*, 19 WM. & MARY ENVTL. L. & POL'Y REV. 223, 242 (1994–1995) ("A nuisance per se is an act, instrument or structure which is a nuisance at all times and under any circumstances, regardless of location or surroundings. Nuisances per se have included prostitution and gambling . . . ."); *see also* Doane, *supra* note 116, at 453 ("The strictest courts will only grant prospective injunctions against defendants whose conduct can be categorized as nuisance per se.").

step further and focus on the defendant's actions and whether this conduct "necessarily results" in a nuisance to the plaintiff..[123] Like the language used in various formulations of the precautionary principle, the "necessarily results" language is difficult to interpret because of its vagueness. Furthermore, this amorphous language would result in inaction if the link between an activity and the potential injury is seen as inconclusive or attenuated.[124] Other courts have used the terms "beyond all ground of fair questioning" and "conclusive evidence."[125] Regardless of the formulation, the result appears to be the same; the burden of proof a plaintiff must show in order to prove an injury will occur is high.[126]

Still another standard that has been applied in these cases is one of "reasonable certainty."[127] This approach has been called "more probabilistic."[128] Reasonable certainty analysis allows courts the flexibility to analyze not just whether the activity itself, isolated from the context in which it occurs, necessarily results in a nuisance, but allows courts to take into account the facts of each case.[129] Another example of the variety of language used by courts to define the required probability of harm is "clear and convincing evidence" as found in *O'Laughlin v. City of Fort Gibson.*[130] In *O'Laughlin*, the Oklahoma Supreme Court applied "a rule requiring clear and convincing evidence of a reasonable probability of injury for an injunction to issue against a threatened nuisance." Other similar

123. Doane, *supra* note 116, at 453 ("In *Purcell v. Davis*, for example, the Montana Supreme Court held that the proposed construction of an oil refinery in a residential neighborhood would not constitute a nuisance per se. Nevertheless, the court held that the defendant's activity could also be enjoined if it necessarily resulted in a nuisance.").

124. Williams, *supra* note 122, at 243–44 ("In *Village of Goodfield v. Jamison*, plaintiff sought to enjoin the construction of a hog transfer station, fearing possible offensive odors and increased traffic, noise, flies and pests. However, the plaintiff presented no evidence of traffic, and the defendant countered the plaintiff's evidence as to the odor reaching the village due to prevailing winds and as to the noise from the loading and unloading of animals; all evidence concerning the flies and pests indicated that proper operation of the station would limit any problems. Thus, the court found the plaintiff's fears speculative.").

125. *Id.* at 243–44.

126. Doane, *supra* note 116, at 454.

127. Williams, *supra* note 122, at 244–45.

128. Doane, *supra* note 116, at 454.

129. Williams, *supra* note 122, at 244 ("In one instance, the Texas Court of Appeals upheld the award of an injunction for the threatened nuisance of a parking lot and emphasized that a nuisance is to be determined by considering all the circumstances, not merely the thing itself. The court stated that 'every case must stand on its own footing. The plaintiffs introduced sufficient evidence that the location, time, and manner of use of the proposed parking lot would constitute a nuisance.'").

130. O'LaughlinO''Laughlin v. City of Ft. Gibson, 389 P.2d 506, 509 (Okla. 1964); Doane, *supra* note 116, at 454.

variations of this language include certainty of harm, the definiteness of injury, clear and satisfactory evidence, sufficient evidence, and the immediacy of danger.[131]

Georgia and Alabama have both codified the anticipatory nuisance doctrine, using "reasonable certainty" language.[132] The Alabama statute states: "Where the consequences of a nuisance about to be erected or commenced will be irreparable in damages and such consequences are not merely possible but to a reasonable degree certain, a court may interfere to arrest a nuisance before it is completed."[133] The Georgia statute is similar and requires that the injury be irreparable and "not merely possible but to a reasonable degree certain."[134] However, confusion over what exactly constitutes "reasonably certain" harm has allowed similar cases with similar facts to reach different results because of this variability.[135] This illustrates that, regardless of how the standard is phrased, courts struggle to determine just what level of certainty or probability of harm is required.[136] Furthermore, while courts' application of the reasonable certainty standard has been inconsistent, it generally requires a high probability of injury.[137] The high burden of proof a plaintiff must show to prove injury and the inconsistency in the application of this doctrine have discouraged plaintiffs from utilizing this cause of action.[138] A reasonable analysis must include a focus on the probability of future injury. A more quantitative and effective analysis exists, which maintains its focus on the probability of future injury but allows for flexibility in its application.

In *Village of Wilsonville*, residents brought a nuisance action to enjoin the building of a hazardous waste landfill over an abandoned coalmine.[139] The residents of Wilsonville argued that there was a substantial risk of toxic waste release, explosions, and fumes.[140] The

131. Doane, *supra* note 116, at 454; *see also* Sharp, *supra* note 113 (presenting a historical look at the doctrine's use in state and federal courts).

132. Doane, *supra* note 116, at 454 (citing to ALA. CODE § 6-5-125 (2005), GA. CODE ANN. § 41-2-4 (West 2011)).

133. *Id.*

134. Doane, *supra* note 116, at 454 (citing to GA. CODE ANN. § 41-2-4 (West 2011)).

135. Sharp, *supra* note 113, at 646.

136. *Id.*

137. George P. Smith, *Re-Validating* the *Doctrine of Anticipatory Nuisance*, 29 VT. L. REV. 687, 688 (2005).

138. Doane, *supra* note 116, at 455.

139. *Id.* (citing to Vill. of Wilsonville v. SCA Servs., Inc., 426 N.E.2d 824, 827 (Ill. 1981)).

140. *Id.* (analyzing Vill. of Wilsonville v. SCA Servs., Inc., 426 N.E.2d at 829–30).

Illinois Supreme Court granted injunctive relief finding there was a high probability that operating a toxic waste landfill would create a nuisance and necessarily result in substantial injury.[141] The majority opinion was in line with past cases that applied the anticipatory nuisance doctrine.[142] Both "high probability" and "reasonable certainty" were used to define the potential for injury and according to the court, were met.[143] However, Justice Howard C. Ryan's concurrence stated that the court established too high a threshold for a plaintiff to overcome and argued the balancing test should weigh *both* the probability and magnitude of an injury.[144] Justice Ryan wrote:

> "[i]f the harm that may result is severe, a lesser possibility of its occurring should be required to support injunctive relief. Conversely, if the potential harm is less severe, a greater possibility that it will happen should be required.... This balancing test allows the court to consider a wider range of factors and avoids the anomalous result possible under a more restrictive alternative where a person engaged in an ultra-hazardous activity with potentially catastrophic results would be allowed to continue until he has driven an entire community to the brink of certain disaster. A court of equity need not wait so long to provide relief."[145]

This is an inverse balancing test: as the magnitude of the harm increases, the lesser the probability required for an injunction.[146] Conversely, as the probability increases, a lesser magnitude of harm will justify injunctive relief. Shifting the analysis from an exclusive focus on the probability of harm, and analyzing the magnitude of harm as well, provides a rational, consistent, and flexible standard

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141. *Id.*

142. *Id.*

143. *Id.*

144. Smith, *supra* note 137, at 713; *see also* Doane, *supra* note 116, at 455.

145. Doane, *supra* note 116, at 455 (analyzing Vill. of Wilsonville v. SCA Servs., Inc., 426 N.E.2d at 842).

146. Doane, *supra* note 116, at 443 (analyzing Vill. of Wilsonville v. SCA Servs., Inc., 426 N.E.2d at 842).

that alleviates much of the ambiguity associated with the anticipatory nuisance doctrine.[147]

C. Common Ground

The precautionary principle is a legislative tool that allows lawmakers to grapple with an uncertain causal connection within a guiding framework.[148] The anticipatory nuisance doctrine offers a cause of action to abate or enjoin a future nuisance.[149] The rationale underlying both of these legal instruments is the prevention of significant harm before it occurs. Both have varying degrees of strength in the different levels of probability and certainty required before action can be taken, and both allow for flexible outcomes whether it is an equitable remedy or a technology based regulation. Furthermore, both have the ability to augment the burden of proof a prospective victim of a proposed activity must meet before action can be taken.

The fundamental flaw of both the precautionary principle and the doctrine of anticipatory nuisance is the struggle to pin down just how much certainty is needed before legal action can be taken. Justice Ryan's concurrence in *Village of Wilsonville* simply states that the more severe the potential harm, the less certain it must be to occur in order to issue injunctive relief. Contrariwise, if the harm is not very severe, then a much higher likelihood of occurrence should be required before a preliminary injunction will lie.[150] This inverse balancing test would ensure a more predictable and usable anticipatory nuisance doctrine than the inconsistent, neglected, and inconsistently applied doctrine that now exists.

Furthermore, it is possible that this test could be adopted in a precautionary approach in order to erase much of the ambiguity inherent in explicating just what standard of proof is sufficient to trigger preemptive action. Justice Ryan's test would provide a much clearer definition of what level of certainty is necessary before implementing a regulation. This test would also influence the choice of regulatory tool or strength of precaution taken in a given situation

147. Williams, *supra* note 122, at 247.

148. Mead, *supra* note 46, at 138, 150 (reviewing the use of the common elements of the precautionary principle by legislators).

149. Doane, *supra* note 116, at 443.

150. Vill. of Wilsonville v. SCA Servs., 426 N.E.2d at 842.

as well as ensure a proportionality of response to a given threat. The result would be a workable and flexible regulatory legal mechanism that would expand the focus of lawmakers and judges to prevent current and future harms while mitigating the negative effects that could arise from an overcautious approach. A regulatory framework complements a strong judicial role. Together, these legal mechanisms can ensure a consistent and rational approach to how our legal system deals with uncertain probabilities of harm.

III. UNCERTAINTY UNDERGROUND

High-volume hydraulic fracturing injects two to 7.8 million gallons of fluid per frack (on average 5.6), and it is possible that wells may be fracked multiple times over their life spans.[151] Thus, high-volume hydraulic fracturing requires 70 to 300 times more fluid than the older, more traditional fracking techniques.[152] Typically, chemical additives comprise two percent or less of fracturing fluid (i.e. .44% of Fayettesville Shale fracturing fluid is made up of chemicals).[153] As noted earlier, roughly 15% of the fracking fluid comes back up the wellhead; what happens to the fluid left underground is unknown.[154] The industry claims that the fluid will be locked underground for all time and that there has never been a proven drinking water contamination case in 60 years of fracking.[155] This statement is misleading. In the 60 or so years that fracking has been used commercially, companies have been drilling vertical wells using smaller amounts of fracking fluid with a smaller

151. Logan, *supra* note 21; *see also* Erik Mielke et al., *supra* note 19 (analyzing issues affecting water consumption during shale gas production including use of additional hydraulic fracturing).

152. Logan, *supra* note 21.

153. The typical percentage of chemicals in hydraulic fracturing solutions for the Fayetteville Shale is reported as 0.44% by weight (NY SGEIS, Section 5.4.3, p. 5–44). 0.44% by weight of 5.6 million gallons is 205,000 lbs. (water weighs 8.34 lb./gallon). The NY SGEIS also states that chemical additives typically comprise two percent or less of the fracturing fluid (Section 5.4, p. 5–33). Two percent by weight of 5.6 million gallons is 935,000 lbs. New York State Department of Environmental Conservation Division of Mineral Resources, Supplement Generic Environmental Impact Statement On the Oil, Gas and Solution Mining Regulatory Program 5-33, 5-44 (2009), *available at* ftp://ftp.dec.state.ny.us/dmn/download/OGdSGEISFull.pdf.

154. Abrahm Lustgarten, *In New Gas Wells, More Drilling Chemicals Remain Underground*, PROPUBLICA (Dec. 27, 2009), http://www.propublica.org/article/new-gas-wells-leave-more-chemicals-in-ground-hydraulic-fracturing.

155. *Just the Facts*, ENERGY IN DEPTH, http://www.energyindepth.org/just-the-facts/#groundwater-contamination (last visited July 20, 2012).

number of chemicals injected at lower pressures in rock formations different than the Marcellus shale formation.[156] High volume slick water hydraulic fracturing employs up to 16 horizontal leads from each vertical shaft, uses millions of gallons of water per well, and has only been used for about ten years.[157] This technique has never been used in as dense a matrix of water supplies and population as in the Marcellus Shale Play.[158]

Think of the act of fracking as the setting off of a pipe bomb underground. While drillers do their best to control where the fractures will develop, the immense pressures and unpredictability inherent in the process means that fracturing fluids and natural gas can move in unexpected directions, even ending up in aquifers and water wells.[159] "Even more disturbing, at least two hydrogeologists wrote to the EPA expressing concern that as groundwater tables rise (post oil or gas development), the groundwater could mobilize these stranded fluids."[160] Geologist Richard Young, a leading authority in the field, spoke about the complex and dynamic geology of upstate New York, and the probability that hydraulic fracturing will contaminate aquifers that millions of people on the eastern seaboard depend on.[161] "Deep fracture systems—including faults and joints—

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156. Matt Treida and Chris Poole, *The Evolution of Hydraulic Fracturing and its Effect on Frac Pump Technology*, UPSTREAM PUMPING SOLUTIONS (Spring 2010), http://www.upstreampumping.com/article/well-completion-stimulation/evolution-hydraulic-fracturing-and-its-effect-frac-pump-technolo; *see also* CARL T. MONTGOMERY AND MICHAEL SMITH, HYDRAULIC FRACTURING: HISTORY OF AN ENDURING TECHNOLOGY 27 (2010), *available at* http://www.spe.org/jpt/print/archives/2010/12/10Hydraulic.pdf.

157. *Id.*

158. *Id.* at 32.

159. Sandy Podulka & Bill Podulka, *Gas Drilling In the Finger Lakes Region: How Will It Affect Us?*, MARCELLUS ACCOUNTABILITY PROJECT FOR TOMPKINS COUNTY (May 29, 2010), http://www.tcgasmap.org/media/Greenstar%20Article.pdf.

160. OIL AND GAS ACCOUNTABILITY PROJECT, OUR DRINKING WATER AT RISK: WHAT EPA AND THE OIL AND GAS INDUSTRY DON'T WANT US TO KNOW ABOUT HYDRAULIC FRACTURING vii (2005), *available at* http://www.earthworksaction.org/files/publications/DrinkingWaterAtRisk.pdf?pubs/DrinkingWaterAtRisk.pdf.

161. *Complex Geology and Fracking*, SPECTRA ENERGY WATCH (Sept. 29, 2010), http://www.spectraenergywatch.com/blog/?p=800; *see also* Lustgarten, *supra* note 31 ("Between Pennsylvania's Delaware and Susquehanna River basins and the Catskill watershed in New York—an area that lies in the heart of the eagerly sought Marcellus Shale gas deposits—drinking water is supplied to New York City , Philadelphia, Baltimore, and Trenton, NJ, another 5 percent of the U.S. population. Add those segments together, and a significant percentage of the U.S. water supply—not to mention at least 15 percent of the country's agriculture—could potentially be affected if it turns out that drilling for natural gas leads to significant pollution over a long period of time.").

are complex and the details are seldom known with accuracy. The two acting together—faults and joints—can carry fluids a long distance. The interaction of these rock structures becomes the problem in terms of groundwater flow."[162] Young summarized his view when he stated, "[f]racking can be an irresponsible and unwarranted environmental experiment with uncertain and potentially dangerous effects."[163]

At the very least, the question of whether fracking fluid and methane can migrate into aquifers is very much open for debate. "'This is a field where there is almost no research,' said Geoffrey Thyne, a geologist and former professor at the Colorado School of Mines and an environmental engineering consultant."[164] Thyne has found methane and drilling wastewater in dozens of domestic wells in Colorado and thinks it could have traveled through underground fractures.[165] "It is very much an emerging problem," he says.[166] Dennis Coleman, an expert on tracking underground migration, states:

> [M]ore data must be collected before anyone can say for sure that drilling contaminants have made their way to water or that fracturing is to blame.[167] But Coleman also says there's no reason to think it can't happen. He says he has seen methane gas seep underground for more than seven miles from its source. If the methane can seep, the theory goes, so can the fluids.[168]

The EPA has found fracking fluid in drinking wells in Pavillion, Wyoming. Residents of Dimock, Pennsylvania claim fracking fluid has contaminated their wells.[169] Natural Resources Defense Council

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162. *Complex Geology and Fracking*, *supra* note 161.
163. *Id.*
164. Lustgarten, *supra* note 41.
165. *Id.*
166. *Id.*
167. *Id.*
168. *Id.*
169. Abrahm Lustgarten, *Feds Warn Residents Near Wyoming Gas Drilling Sites Not to Drink Their Water*, PROPUBLICA (Sept. 1, 2010), http://www.propublica.org/article/feds-warn-residents-near-wyoming-gas-drilling-sites-not-to-drink-their-wate; Michael Rubinkam & Mary Esch, *Lawsuit: Gas Drilling Fluid Ruined Pennsylvania Water Wells*, MOTHER NATURE NETWORK (Sept. 15, 2010, 6:11 PM), http://www.mnn.com/earth-matters/energy/stories/lawsuit-gas-drilling-fluid-ruined-pennsylavania-water-wells.

has compiled a list of incidents from across the country where fracking was the suspected cause of water contamination.[170] In Colorado, methane showed up frequently in water wells. Researchers thought it might be originating from the same gas reservoirs being drilled deep underground.[171] In Ohio, gas seepage from a natural gas well blew up a house.[172] "In Pennsylvania, a vast underground gas injection cave, where gas is put for long-term storage, had somehow leaked into water supplies over 50 square miles."[173]

The first EPA study on fracking was completed in 2004 and found that fracturing may release potentially hazardous chemicals into aquifers and drinking wells, but concluded that there was no reason to study it further.[174] The 2004 study determined that fracturing posed "little or no threat" because most of the fracking fluid is pumped back up and disposed of, and the chemicals left underground would be "diluted or biodegrade on their own."[175] These assertions have been the subject of vigorous debate.[176] Soon after the report was published, an EPA whistleblower named Weston Wilson claimed that the study's findings were "unsupportable."[177] He further alleged that evidence showing that benzene and other toxic chemicals in fracking fluid could migrate into groundwater had been suppressed in the final report, and that five of the seven reviewers on the panel had conflicts of interest.[178] Wilson wrote "EPA's failure to regulate the injection of fluids for hydraulic fracturing of coal bed methane reservoirs appears to be improper under the Safe Drinking Water Act and may result in danger to public health and safety."[179] According to Wilson, EPA found that toxic and carcinogenic fluids were injected underground where the groundwater was used to supply drinking water.[180] EPA

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170. Mall, *supra* note 4.

171. *Id.*

172. *Id.*

173. Lustgarten, *supra* note 41.

174. Mike Soraghan, *Controversial Candidates On Short List for EPA Fracking Panel*, N.Y. TIMES, Sept. 20, 2011, http://www.nytimes.com/gwire/2010/09/20/20greenwire-controversial-candidates-on-short-list-for-epa-78157.html.

175. *Id.*

176. *Id.*

177. Letter from Weston Wilson, EPA Employee, to U.S. Senators Wayne Allard and Ben Nighthorse Campbell and U.S. Representative Diana DeGette (Oct. 8, 2004), *available at* http://www.earthworksaction.org/pubs/Weston.pdf.

178. *Id.*

179. *Id.*

180. *Id.*

further discovered that some, but not all, of the fracking fluids would be pumped out and assumed that the remainder would be diluted to some unspecified degree.[181] EPA's Quality Assurance Plan, the scientific basis for the 2004 study, specified that EPA would continue to study the matter and obtain data, yet EPA had no data on the amount of toxic fluids injected, what percentage of fluid remained in the ground after extraction, whether the water will still be usable for drinking, and what the potential health risks are.[182]

According to Wilson, EPA's conclusion that hydraulic fracturing poses little or no threat to drinking water sources is unsupportable and scientifically unsound.[183] As for the seven member peer review team, Wilson wrote that "[i]t's a hand-picked, conflicted small group, who failed to even read the final report and met only once. This is not peer review—this is a mockery of what is supposed to be an independent and balanced review. This is the thin veneer cover to a scientifically unsound study while the scientific process of peer review was abandoned."[184] On a very related note, the scientific peer review system has been held out as an effective substitution for a precautionary approach by those who disagree with the precautionary principle's effectiveness. A strident critic of the precautionary principle and former administrator of the Office of Information and Regulatory Affairs argued that third party peer review of agency actions is superior to a precautionary approach.[185] Criticizing this point of view, one scholar wrote "the peer review system is vulnerable to abuse and misuse. . . . An abusive peer review system can result in the suppression of evidence and the approval of decisions with serious environmental consequences."[186] A precautionary approach would create a more transparent investigation into a proposed activity; one where industry, community, and

181. *Id.*

182. Soraghan, *supra* note 171.

183. *Id. See also* Tom Kane, *Local Agencies Allow Gas Drilling Exemption*, THE RIVER REPORTER (March 26, 2008), http://riverreporter.com/issues/08-03-20/head1-gas.html ("With the help of Cheney, Halliburton and the other major gas producing companies have successfully gotten the EPA to declare the patented formula for the fluids as 'proprietary' and therefore private.").

184. JOSH FOX, AFFIRMING GASLAND 33 (2010), *available at* http://1trickpony.cachefly.net/gas/pdf/Affirming_Gasland_Sept_2010.pdf.

185. La Franchi, *supra* note 75, at 707–09; *see also* JOHN D. GRAHAM, THE PERILS OF THE PRECAUTIONARY PRINCIPLE: LESSONS FROM THE AMERICAN AND EUROPEAN EXPERIENCE 4 (2004), *available at* http://s3.amazonaws.com/thf_media/2004/pdf/hl818.pdf (warning of the dangers of an extreme approach to precaution).

186. La Franchi, *supra* note 75.

government work together in gathering and reviewing scientific data before deciding the appropriate course of action.[187]

Wilson is not the only critic of the 2004 study. EPA spokeswoman, Enesta Jones, wrote that, "[t]he use of hydraulic fracturing has significantly increased well beyond the scope of the 2004 study."[188] The 2004 report addressed only coal bed methane (geologically different than shale), and failed to study the new practice of drilling and hydraulically fracturing horizontally for up to a mile underground (which requires about five times more chemical-laden fluids than vertical drilling).[189] A close analysis of the 2004 report "shows that the body of the study contains damaging information that wasn't mentioned in the conclusion. In fact, the study foreshadowed many of the problems now being reported across the country."[190] The 424-page report states "fluids migrated unpredictably through different rock layers, and to greater distances than previously thought—in as many as half the cases studied in the United States."[191] Jeffrey Jollie, a hydrogeologist working for the EPA, stated that the 2004 report "was never intended to be a broad, sweeping study."[192] Yet, even with all of these criticisms of the 2004 study, mounting evidence of groundwater contamination caused by fracking throughout the country, and another EPA study underway and predicted to be completed by the end of 2012, the gas rush has continued in and around watersheds that supply millions of people with drinking water.[193]

EPA has conceded "there are serious concerns from citizens and their representatives about hydraulic fracturing's potential impact on drinking water, human health and the environment, which demands further study."[194] EPA's Office of Research and Development (ORD)

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187. *Id* at 720; *see also* Mead, *supra* note 46, at 156 (illustrating how the precautionary principle can be used to increase transparency).

188. Lustgarten, *supra* note 9.

189. *Id.*

190. Abrahm Lustgarten, *Buried Secrets: Is Natural Gas Endangering U.S. Water Supplies?*, PROPUBLICA (Nov. 13, 2008), http://www.propublica.org/article/buried-secrets-is-natural-gas-drilling-endangering-us-water-supplies-1113.

191. *Id.*

192. *Id.*

193. *Natural Gas Extraction—Hydraulic Fracturing*, EPA, http://water.epa.gov/type/groundwater/uic/class2/hydraulicfracturing/index.cfm (last visited July 20, 2012).

194. *What is Hydraulic Fracturing?*, WATER IS LIFE. KEEP IT CLEAN., http://marcellus-wv.com/impacts/fracking (last visited July 20, 2012).

is currently conducting a scientific study aimed at investigating any potential relationship between hydraulic fracturing and groundwater contamination.[195] Disclosure of the specific chemical ingredients and amounts used in fracking fluid is finally underway by both the Bureau of Land Management and EPA.[196] The Delaware River Basin Commission has already allowed several exploratory wells in the area and just recently published rules for gas development in the region.[197] These regulations have opened the door for gas development in the 13,539 square-mile watersheds that covers portions of all four member states.[198] Therefore, while the potential dangers of fracking are known, the process continues, albeit with a heightened anxiety over potential health and safety concerns.

IV. PRECAUTION APPLIED

The precautionary principle dictates that where there is scientific uncertainty concerning a proposed action, the proponent of such action should carry the burden of proving that the activity will not be harmful.[199] Ideally, the principle should be incorporated early in the process of regime development.[200] In the case of fracking, the precautionary principle dictates studying potential impacts to

195. *Natural Gas Extraction—Hydraulic Fracturing*, *supra* note 193. *See also* EPA, PLAN TO STUDY THE POTENTIAL IMPACTS OF HYDRAULIC FRACTURING ON DRINKING WATER RESOURCES, at x (2011), *available at* http://water.epa.gov/type/groundwater/uic/class2/hydraulicfracturing/upload/hf_study_plan_110211_final_508.pdf ("A first report of research results will be completed in 2012. This first report will contain a synthesis of EPA's analysis of existing data, available results from retrospective cases studies, and initial results from scenario evaluations, laboratory studies, and toxicological assessments. Certain portions of the work described here, including prospective case studies and laboratory studies, are long-term projects that are not likely to be finished at that time. An additional report in 2014 will synthesize the results of those long-term projects along with the information released in 2012.").

196. *U.S. Interior Dept. to Consider New Hydraulic Fracturing Policy*, WALL STREET JOURNAL, Nov. 30, 2010, *available at* http://online.wsj.com/article/BT-CO-20101130-712465.html (examining the chemical disclosure policy for hydraulic fracturing).

197. Laura Legere, *Basin Commission Releases Draft Gas-Well Rules*, SCRANTON TIMES TRIBUNE, Dec. 10, 2010, http://thetimes-tribune.com/news/gas-drilling/basin-commission-releases-draft-gas-well-rules-1.1075005#axzz17ehajQPJ.

198. Mike Soraghan, *Northeast Regulator Eases Proposed Drilling Curbs*, GREENWIRE (Dec. 9, 2010), http://www.eenews.net/Greenwire/2010/12/09/3.

199. Mead, *supra* note 46, at 152 (suggesting reversing the burden of proof for the precautionary principle).

200. Jorge E. Vinuales, *Legal Techniques for Dealing with Scientific Uncertainty in Environmental Law*, 43 VAND. J. TRANSNAT'L. L. 437, 447 (2010).

drinking water *before* employing the technology on a grand scale. Judging from the inaction of lawmakers and the continued use of fracking in critical watersheds and aquifers, the precautionary principle seems to have missed its chance at halting the gas rush until more is known of its effects. However, a precautionary approach can still be taken.

The principle can continue to serve as guidance for the evaluation of information and the crafting of future regulations. "[P]recautionary reasoning operates not only to gather momentum for the negotiation of a regime but also as an argument guiding decisions at later stages of regime development, including when it comes to evaluating state responsibility for preventing environmental damage."[201] In the context of fracking, a precautionary approach would demand a thorough and transparent review of the scientific data and spur the development of rules and policy choices necessary to prevent potential harms. This approach can influence regulatory decision-making in the short-term purgatory created by EPA as it continues to study the effects of fracking on drinking water, and into the future as the substance of the EPA report is analyzed and put into action.[202] At what level of government this framework should be implemented is the question.

Scott La Franchi writes, "[w]ith the U.S. judiciary beholden to a system of deference, and the administrative state bound to risk assessment and cost-benefit analysis, the future of the precautionary principle currently rests entirely with the legislative branch of government."[203] In the short term, regulation at the state level is the most feasible course of action. Former Pennsylvania Department of Environmental Protection Chief John Hanger agrees, citing the federal government's failure to prevent the Deepwater Horizon drilling disaster and the problem of agency capture.[204] While agency

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201. *Id.* at 447–48.

202. *See* La Franchi, *supra* note 75, at 710 (arguing that a precautionary framework must be fleshed out with more specific regulations in order to be effective).

203. *Id.*

204. Nicholas Kusnetz, *John Hanger, PA's Former Environmental Chief, Talks About Challenges of Keeping Gas Drilling Safe*, PROPUBLICA (Feb. 11, 2010), http://www.propublica.org/article/john-hanger-pas-former-environmental-chief-talks-about-challenges-of-keepin ("I laugh when people ask that question because, basically, if the BP oil spill showed anything, it's that you can't rely on the federal government to regulate the oil and gas industry. The Minerals Management Service was completely captured by the industry. There's no guarantee that doesn't happen at the state level either, but I think local people have much more ability to impact their governor. They pick their governor, they elect their

capture can occur at the state level as well, there is a closer relationship between regulators and citizens and therefore a stronger level of accountability exists.[205] Furthermore, regulation must reflect the distinct geological and hydrological qualities of each state. The next step in applying a precautionary framework is drafting.

Due to the inherent ambiguities associated with the precautionary principle, drafting a rule of law can be extremely difficult. There are those that argue a precautionary principle is merely a "general guiding policy" that should not function as a binding, legal rule.[206] Still others argue that the effectiveness of the precautionary principle depends on its evolution into a "legally binding rule."[207] A middle ground between the two also seems to exist, as state lawmakers can pass legislation that incorporates the precautionary principle explicitly or uses it to justify legislation specifically focused on groundwater contamination from the underground migration of fracking fluids and methane. By narrowing the focus of the precautionary principle's application to an identifiable and scientifically uncertain phenomenon, and clearly defining the margin of safety that is being sought, the legislation will mirror that of other U.S. environmental laws that utilize precautionary reasoning.[208]

Any adoption of a precautionary approach must recognize that "there is no such thing as no risk in a dynamic and changing environment."[209] A workable precautionary principle would accept this fact by clearly explicating the probability of harm necessary to trigger preemptive action. As stated earlier, Justice Ryan's inverse balancing test for an anticipatory nuisance, where the probability *and* magnitude of harm are assessed when determining whether an activity creates a reasonably certain injury, would flesh out a precautionary approach considerably. This balancing test provides a clearer and more easily applied principle that would allow flexibility as well as consistency. Justice Ryan's test incorporated into a

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state legislature. I think generally it's better to have these questions decided close to home. It's Pennsylvania's water, it's Pennsylvania's air, it's Pennsylvania's land.").

205. *Id.*

206. Mead, *supra* note 46, at 162–63 (addressing the differing opinions about the use of the precautionary principle).

207. *Id.* at 163.

208. *See supra* notes 64–74 (cataloging several domestic statutes which base regulations off of conservative assumptions that utilize a margin of safety).

209. Boyden Somerville, Q.C., *FW Guest Memorial Lecture 2001: A Public Law Response to Environmental Risk*, 10 OTAGO L. REV. 143, 152 (2002).

precautionary principle would guide legislators in anticipating harm, determining what burden of proof should fall on those promoting fracking, and ensure an open, informed, and participatory decision-making process.

The contamination of an entire fresh water aquifer would be catastrophic both environmentally and economically. The probability of this injury occurring varies widely depending on whom you believe. A legislature must weigh the flaws in the 2004 EPA report, an EPA study currently underway, recent moratoriums passed in cities throughout the Northeast, and thousands of reports of contaminated water. One must also look at the magnitude of harm when determining the threshold for taking regulatory action and the burden of proof on those in favor of an activity. After reviewing the mounting evidence linking fracking and groundwater contamination, one could easily reach the conclusion that this evidence reaches a reasonable certainty standard. Furthermore, if Justice Ryan's test were adopted, the magnitude of harm that would result from fracking would ensure that current evidence of injury would meet the probability requirement. There are those that completely disagree.[210] Others admit that risks do exist but are negligible.[211]

The hard realities of a faltering economy, the influence of special interest groups, forward momentum of the gas industry, and the economic interests at stake seem to point to the inevitability that a completely prohibitory precautionary principle is infeasible at this point. However, a prohibitory method may be narrowed in scope and imposed selectively. Firstly, an immediate ban should be imposed on fracking in primary watershed areas and critical water supplies, both surface waters and underground. Secondly, a prohibition should be imposed on the use of carcinogenic, mutagenic, and toxic chemicals in fracking fluid, regardless of location, until there is a high probability that groundwater is NOT in danger of contamination,

210. *Hydraulic Fracturing*, PERMIAN BASIN PETROLEUM ASSOCIATION (2011), http://pbpa.info/regulation/hydraulic-fracturing/. ("Hydraulic fracturing is a safe, well-regulated, environmentally sound practice that has been employed over one million times without a single incidence of drinking water contamination. Hydraulic fracturing's record of safety and impressive ability to help make the most of our domestic energy resources designate it as one of the most important tools in our nation's effort to achieve energy independence.").

211. Kusnetz, *supra* note 204 ("Yes, it's safe in this respect. Is the risk zero? No. But is it as safe as mining and producing and burning coal? It's actually much safer . . . . Is it as safe or safer than drilling, producing and burning oil? It is actually much safer . . . . None of our risks in energy production are zero.").

whether through underground migration, surface spills, or otherwise. The reduction or complete elimination of the chemicals used in the fracking fluid would be relatively easy to achieve, as there are safer alternatives to the dangerous chemicals used in fracking fluids already available.[212] These prohibitions would allow fracking to continue, albeit in a more limited and environmentally sensitive capacity, until the risk of harm can be ascertained. These prohibitions can be complimented with the application of margin of safety regulations.

Margin of safety precautionary principle dictates that "regulation should include a margin of safety, limiting activities below the level at which adverse affects have not been found or predicted."[213] In this context, margin of safety regulations should focus on several issues. Firstly, well spacing and density must be regulated to a level where the risk of fractures interacting with each other and naturally occurring faults and joints is minimal.[214] Intensive geological review of the underground strata should be required before drilling starts and monitoring should continue throughout the entirety of the drilling process to ensure safety. Set back requirements already exist for how close wells can be to a surface water source intended to prevent surface water contamination from spills.[215] These should be strengthened and incorporated into the state-wide planning regulations. Furthermore, the location of underground aquifers and critical watersheds should be avoided at all costs; at least until it can be demonstrated that fracking will pose no risk to these waters. Lastly, an intensive geological survey should be undertaken to ascertain the locations of likely pathways of migration for fracking fluid and methane, such as naturally occurring faults and joints as well as abandoned oil and gas wells from decades past. A margin of safety precautionary approach is generally more accepted as administrative agencies such as OSHA and EPA have promulgated

212. *Industry Insider Explains "Green" Fracking Technology*, OIL AND GAS INVESTMENT BULLETIN (April 8, 2010), http://oilandgas-investments.com/2010/natural-gas/industry-insider-explains-green-fracking-technology/.

213. Sunstein, *supra* note 51, at 1014.

214. NEW YORK STATE DEPT. OF ENVTL. CONSERVATION, DRAFT GENERIC ENVIRONMENTAL IMPACT STATEMENT ON THE OIL, GAS AND SOLUTION MINING REGULATORY PROGRAM (GEIS) 8-4 (1988), *available at* http://www.dec.ny.gov/docs/materials_minerals_pdf/dgeisv1ch8.pdf ("Most wells must be spaced according to the statewide 40 acre spacing rule unless they are in a field subject to a spacing order or other spacing regulations.").

215. *Id.* at 8-15.

regulations based on this approach and have survived judicial scrutiny.[216]

Similar to margin of safety precaution, a best available technology standard should be required. This would encourage technological innovation. Together, these regulations would work to create a culture of safety, which is desperately needed in the mining industry. A serious concern relating to these types of regulation is one of enforcement. In order to effectively implement these regulations, monitoring and enforcement must be properly funded. Many states are already short-staffed as it is and as the pace of drilling increases, the strain on federal, state and local governments will likely get worse.[217] This issue requires its own focus as, time and again, environmental regulations have been proven only as effective as the body responsible for oversight and enforcement.[218]

Shifting the burden of proof onto the proponents of fracking would facilitate "public disclosure and the independent review of testing procedures and results."[219] This would ensure the accuracy and transparency of the peer review process, and create a cooperative process, where industry and government can align their interests and work together towards gaining an understanding of the activity's effects before they occur. While there is concern that the interactions of water, gas, and strata thousands of feet below ground will never be known with certainty, the benefits of shifting the burden of proof, especially during the scientific evaluation stage, outweigh the possibility that the industry will never be able to carry this burden. Action taken on the basis of uncertainty is tentative and must always be revisited again and again as new evidence surfaces.[220] This ensures that there is continued re-visitation of the evidence used to justify regulation. "Whatever the EPA does, its environmental research is

216. *See supra* notes 64–74 (these domestic regulations have been upheld even while they rely on conservative assumptions as to what is "safe.").

217. *See* Ian Urbina, *Regulation Lax as Gas Wells' Tainted Water Hits Rivers*, N.Y. TIMES, Feb. 26, 2011, http://www.nytimes.com/2011/02/27/us/27gas.html?pagewanted=1 ("Part of the problem is that industry has outpaced regulators. 'We simply can't keep up,' said one inspector with the Pennsylvania Department of Environmental Protection who was not authorized to speak to reporters.").

218. *See, e.g.*, Office of Public Affairs, Bureau of Ocean Mgmt., Regulation and Enforcement, *Deepwater Horizon Joint Investigative Team Releases Final Report*, THE BUREAU OF OCEAN MGMT., REGULATION AND ENFORCEMENT (Sept. 14, 2011), http://boemre.gov/ooc/press/2011/press0914.htm.

219. Mead, *supra* note 46, at 156 (explaining how reversing the burden of proof and public disclosure would reduce the risks of potentially harmful activities).

220. *Id.* (suggesting use of risk assessment and testing methods that would address the uncertainty of evaluating the benefits of a new technology).

guaranteed to go slower than the pace of drilling development."[221] Reversal of the burden of proof thus ensures that a precautionary approach can continue to affect decision-making. However, this provides little comfort to those who live in the middle of the gas rush.

The anticipatory nuisance doctrine would provide private landowners with a cause of action that could prevent permanent harm to their land before fracking commences. Two recent Pennsylvania lawsuits, filed separately against Southwest Energy Co. and Chesapeake Energy Corp., claim that their gas drilling has contaminated local water supplies and harmed the related property values.[222] The first claim of contaminated water supply is the issue garnering the most attention. However, it is uncertain whether there is enough evidence to prove causation, not to mention whether the plaintiffs have enough time, money, and resilience to maintain such a suit. A diminution in property values claim avoids drawn out litigation solely on the causation of water contamination. Generally, litigation of environmental claims under any theory is expensive and time consuming because expert testimony is usually required to prove causation and the extent of harm. However, plaintiffs alleging an actual nuisance can seek injunctive relief for the more easily shown presence of odors, flies, noise and increased traffic beyond a tolerable and safe level.[223]

An anticipatory nuisance claim can avoid the causation issues associated with a contaminated water claim by focusing on the damage to property values. However, the plaintiff must still carry the burden of proving that a fracking operation next door poses a substantial and unreasonable interference with the use and enjoyment of their land. This burden is theoretically less difficult and expensive because it does not rely entirely on technical and scientific evidence. A favorable precedent could be established as a model for the thousands of other landowners who seek to prevent fracking from destroying the value of their property, and perhaps give scientists and

221. Lustgarten, *supra* note 41 ("In 2010, another 14,324 new gas wells were drilled in the United States, including in Wyoming.").

222. Press Release, Parker Waichman Alonso LLP, Parker Waichman Alonso LLP and its partner law firms continue to investigate water and other contamination associated with hydraulic fracturing and other natural gas drilling operations (Nov. 17, 2010), *available at* http://www.webwire.com/ViewPressRel.asp?aId=126888.

223. Williams, *supra* note 122, at 250.

decision makers slightly more time to uncover evidence and make the right decisions.

CONCLUSION

It is impossible to contemplate all of the effects of a given activity, or prove that an activity is completely harmless. Critics of a precautionary approach wrongly believe that it rigidly demands a contemplation of all possible effects before any action can be taken. The precautionary principle is a flexible concept that can be applied throughout the entire lifespan of a project and in differing levels of rigidity or strength. The ambiguity inherent in assessing when a probability of harm becomes enough to act on can be greatly reduced by borrowing from the case law and legal rationale underlying anticipatory nuisance and incorporating Justice Ryan's balancing test. In this way, a clearer and more workable principle can be adopted and continue the evolution of the precautionary principle from a guiding concept to a legally binding rule of law.

Although the continued use of hydraulic fracturing seems like a foregone conclusion, the precautionary principle can still contribute as a justification for stricter regulation. Specifically, it would focus on groundwater contamination and prohibitions in critical watershed and geologically unstable areas. A precautionary approach also has the potential to be a valuable guide for future regulations as our understanding of fracking fluid's interaction with geology over time improves.

Scholars in favor of an increased judicial role question whether administrative agencies are sensitive enough to the public interest in regulating risks such as: fracking, whether the scientists and engineers that develop these drilling technologies are capable of objectively assessing the risks they create, and whether legislatures are capable of responding quickly enough to the dangers posed by such activities. An active judicial role in the regulation of modern technological risk is essential. Common law tort remedies can coexist with administrative remedies. In this context, the anticipatory nuisance doctrine can compliment a regulatory regime, ensuring that private landowners are not beholden to an irresponsive legislature.

The EPA is currently involved in an intensive study of groundwater contamination and fracking. Therefore drillers, landowners, and regulators are playing a dangerous game; betting against mounting evidence that fracking will not have serious and irreversible environmental consequences. There are numerous reports from across the country that point to fracking as the culprit in groundwater contamination, not from surface spills and leaks in the equipment, but the inherently unpredictable method of gas extraction. The anticipatory nuisance doctrine compliments the adoption of a precautionary principle. These legal mechanisms, if properly implemented, can expand the focus of lawmakers and judges from present to future effects. In that way, these mechanisms may prevent permanent environmental damage before it occurs.