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Agricultural Chemical Contamination of Groundwater: An Economic Analysis of Alternative Liability Rules

by

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AGRICULTURAL CHEMICAL CONTAMINATION OF GROUNDWATER: AN ECONOMIC ANALYSIS OF ALTERNATIVE LIABILITY RULES

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The dramatic increase in crop production levels over the past three decades can be attributed in part to the increased application of agricultural pesticides and commercial fertilizers by American farmers. The benefits of these chemicals, however, do not come without risks; some agricultural chemicals can enter groundwater and potentially contaminate drinking water wells. The author of this note analyzes, from an economic perspective, the three major rules of liability that could be applied to agricultural chemical contamination of groundwater: a rule of no liability, a negligence standard, and strict liability. After examining how each of these three rules would induce actions to prevent groundwater contamination, the author suggests that, based on economic theory, strict liability is the best liability rule. The author argues that strict liability will encourage all chemical beneficiaries—chemical manufacturers, retailers, and farmers—to take care to prevent groundwater contamination. However, in reality, the difficulty of proving causation suggests that chemical manufacturers are most likely to be held strictly liable for the damages caused by agricultural chemical contamination of groundwater.

I. INTRODUCTION

American farmers produce an abundance of agricultural commodities for American consumers and for overseas export markets. Total United States agricultural production in 1987 included 6.7 billion bushels of corn, 1.9 billion bushels of wheat, and 1.8 billion bushels of soybeans.[1] Harvested cropland in 1987 totaled 282 million acres, with corn grown on 58.7 million acres, wheat on 53.2 million acres, and soybeans on 55.3 million acres.[2] These production levels are the result, at least in part, of significant changes over the last three decades in the demographics of rural America and the production practices of American farmers. Today, there are at least 1.6 million fewer farms in the United States than there were in 1959.[3] Average farm size has increased from 303 acres in

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1. BUREAU OF THE CENSUS, U.S. DEP'T OF COMMERCE, 1987 CENSUS OF AGRICULTURE 35 (1989) [hereinafter 1987 CENSUS OF AGRICULTURE].
2. *Id.*
3. In 1959, there were 3,710,503 farms in the United States. BUREAU OF THE CENSUS, U.S.

1959[4] to 462 acres in 1987.[5] At the same time, average crop yields for several major crops have increased dramatically.[6]

The application of agricultural pesticides[7] and commercial fertilizers[8] is largely responsible for this dramatic increase in production. Agricultural pesticide use has nearly tripled since 1964.[9] Nitrogen fertilizer use quadrupled between 1960 and 1980.[10] These chemicals have benefited both farmers and consumers by increasing crop production and thereby increasing food supplies. However, these chemicals also have caused potentially serious environmental impacts.

In a five-year survey completed in 1990, the United States Environmental Protection Agency (EPA) detected twelve pesticides and nitrate in drinking water wells across the nation.[11] Numerous instances confirm the fact that agricultural chemicals, both pesticides and nitrate from fertilizers, can enter groundwater and potentially contaminate drinking water wells.[12] Although the results of this contamination still are largely unknown, groundwater contamination does pose documented and suspected health risks.[13]

DEP'T OF COMMERCE, 1959 CENSUS OF AGRICULTURE 53 (1962) [hereinafter 1959 CENSUS OF AGRICULTURE]. In 1987 there were 2,087,759 farms in the United States. 1987 CENSUS OF AGRICULTURE, *supra* note 1, at 1.

4. 1959 CENSUS OF AGRICULTURE, *supra* note 3, at 53.

5. 1987 CENSUS OF AGRICULTURE, *supra* note 1, at 1.

6. Between 1959 and 1987, average per-acre crop yields increased from 52.8 to 114.6 bushels for corn (117%); from 21.3 to 35.5 bushels for wheat (67%); and from 23.4 to 33.2 bushels for soybeans (42%). 1987 CENSUS OF AGRICULTURE, *supra* note 1, at 8 (for all crops and both years, yields calculated by dividing bushels produced by acres harvested).

7. Pesticides are poisonous chemicals used to kill pests. BLACK'S AGRICULTURAL DICTIONARY 272 (2d ed. 1985). Common pests in agricultural crops include fungi, weeds, insects, and animals. *Id.* The pesticides used to control these pests are, respectively, fungicides, herbicides, insecticides, and rodenticides.

Pests interfere with crop growth and reduce yields in different ways. Weeds compete with crops for water, nutrients, and sunlight. Orvin C. Burnside, *Weeds*, *in* INTRODUCTION TO CROP PROTECTION 29 (W. Ennis, Jr. ed., 1979). Insects attack the germinating seed, plant roots, plant foliage, and other plant parts. E.H. Smith, *Insects and Mites*, *in* INTRODUCTION TO CROP PROTECTION 15 (W. Ennis, Jr. ed., 1979).

8. Fertilizer normally consists of inorganic chemicals added to the soil to provide plant nutrients for crop growth. BLACK'S AGRICULTURAL DICTIONARY 152 (2d ed. 1985). The major plant nutrients are nitrogen, phosphorous, and potassium. *Id.* Nitrogen fertilizers include ammonium nitrate, anhydrous ammonia, urea, and ammonium phosphate. *Id.* Excess fertilizer not taken up by plant roots or absorbed by soil particles may leach through the soil into the groundwater. *Id.*

9. ELIZABETH G. NIELSEN & LINDA K. LEE, U.S. DEP'T OF AGRIC., THE MAGNITUDE AND COSTS OF GROUNDWATER CONTAMINATION FROM AGRICULTURAL CHEMICALS 2 (1987) (Agricultural Economic Report No. 576). In 1987, farmers applied herbicides on 171 million acres, insecticides on 69 million acres, fungicides on 10 million acres, and nematicides on six million acres. *See* 1987 CENSUS OF AGRICULTURE, *supra* note 1, at 19.

10. NIELSEN & LEE, *supra* note 9, at 2. In 1987, farmers applied commercial fertilizer on 211 million acres. *See* 1987 CENSUS OF AGRICULTURE, *supra* note 1, at 19.

11. OFFICE OF WATER, U.S. ENVTL. PROTECTION AGENCY, NATIONAL PESTICIDE SURVEY: SUMMARY RESULTS OF EPA'S NATIONAL SURVEY OF PESTICIDES IN DRINKING WATER WELLS (1990) [hereinafter NPS SUMMARY] (16-page fact sheet issued in fall 1990, in advance of the full survey results).

12. *See infra* text accompanying notes 35-64.

13. *See infra* text accompanying notes 65-71.

This note analyzes, from an economic perspective, the three major rules of liability that could be applied to agricultural chemical contamination of groundwater: a rule of no liability, a negligence standard, and strict liability. In Part II, the note reviews the importance of groundwater and the available data on groundwater contamination,[14] and examines the known and suspected health risks of pesticides and nitrate in drinking water.[15] Part II also summarizes the policy options available to prevent or reduce groundwater contamination, including the theories of liability that courts have applied in cases of groundwater contamination from various sources and in analogous cases of chemicals drifting through the air to damage nontarget property.[16] The final sections of Part II review the statutory exemptions from liability for groundwater contamination that Congress and some of the states have enacted or considered.[17] In Part III, based largely on Professor Steven Shavell's application of economic analysis to accident law,[18] the note demonstrates that, in theory, a rule of strict liability should be applied in cases of agricultural chemical contamination of groundwater.[19] Part IV briefly examines some of the issues that would be raised by actually imposing strict liability, including what steps chemical beneficiaries can take to reduce the risk of groundwater contamination, the problem of multiple injurers, and the contamination victim's daunting problem of proving causation.[20] Part V concludes that, in theory, all chemical beneficiaries—manufacturers, retailers, and farmers—should be held strictly liable for the damages caused by agricultural chemical contamination of groundwater. In actual practice, a contamination victim-plaintiff is most likely to recover against the chemical manufacturer, who then may have a right of contribution from jointly responsible retailers and farmers.[21]

II. GROUNDWATER CONTAMINATION ISSUES

A. *The Importance of Groundwater*

Groundwater is water that exists in aquifers beneath the surface of the earth.[22] Aquifers are geologic formations that can yield usable amounts of water to natural springs and drilled wells.[23] Usable aquifers underlie most of the land of the United States and hold an immense volume of water.[24]

14. *See infra* text accompanying notes 22-64.
15. *See infra* text accompanying notes 65-71.
16. *See infra* text accompanying notes 72-100.
17. *See infra* text accompanying notes 101-32.
18. *See* STEVEN SHAVELL, ECONOMIC ANALYSIS OF ACCIDENT LAW (1987).
19. *See infra* text accompanying notes 133-220.
20. *See infra* text accompanying notes 221-35.
21. *See infra* text accompanying notes 236-39.
22. U.S. ENVTL. PROTECTION AGENCY, GROUND-WATER PROTECTION STRATEGY 10 (1984) [hereinafter GROUND-WATER PROTECTION STRATEGY].
23. *Id.*
24. *Id.*

In 1980, 89 billion gallons per day of groundwater were used for agricultural irrigation, domestic drinking water, and industrial purposes.[25] Approximately 117 million people, over half the population of the United States, rely on groundwater for their drinking water.[26] Groundwater is tapped by approximately 12 million individual wells, 160,000 noncommunity public water supplies, and 48,000 community public water supplies.[27] In rural areas, groundwater often is the exclusive source of drinking water.[28]

B. Sources and Extent of Groundwater Contamination

EPA has identified three categories of groundwater contamination sources: waste disposal,[29] nondisposal use of chemicals on the surface of the land (including normal agricultural chemical application),[30] and saltwater encroachment in response to groundwater usage.[31] Although all of these sources of contamination are potentially serious, this note focuses on groundwater contamination caused by the application of agricultural chemicals.

For many years researchers believed that the degradation of agricultural chemicals and the physical barriers between the soil surface and underlying aquifers would prevent the movement of agricultural chemicals into groundwater.[32] However, scientists now know that this is not true for some chemicals.[33] In fact, the four most widely applied agricultural herbicides—alachlor, atrazine, butylate, and metolachlor—have a moderate to high potential to leach into groundwater.[34]

1. The National Pesticide Survey

For the national pesticide survey, conducted from 1988 to 1990, EPA sampled approximately 1300 community water system and rural domestic wells.[35] The survey statistically represents approximately

25. *Id.*

26. *Id.* at 11.

27. *Id.*

28. *Id.*

29. Waste disposal sources include hazardous waste sites, solid waste landfills, and septic tank systems. *Id.* at 12-15.

30. This category includes agricultural chemical applications, highway de-icing materials, leaking underground storage tanks, and abandoned wells. *Id.*

31. *Id.*

32. *See* Rachel J. Sater, *EPA's Pesticides in Groundwater Strategy: Agency Action in the Face of Congressional Inaction*, 17 ECOLOGY L.Q. 143, 143 (1980) (citing GROUND-WATER PROTECTION STRATEGY, *supra* note 22).

33. *See, e.g.*, NPS SUMMARY, *supra* note 11.

34. NIELSEN & LEE, *supra* note 9, at 4 n.2. Farmers annually apply 85 million pounds of alachlor, 77 million pounds of atrazine, 55 million pounds of butylate, and 38 million pounds of metolachlor. *Id.* at 5. In EPA's national pesticide survey, atrazine was the second most frequently detected pesticide or pesticide degradate. NPS SUMMARY, *supra* note 11, at 2.

35. NPS SUMMARY, *supra* note 11, at 1; *see also* OFFICE OF WATER, ENVTL. PROTECTION AGENCY, NATIONAL PESTICIDE SURVEY: GLOSSARY 1 (1990) [hereinafter NPS GLOSSARY] (defining community water system as a piped drinking water system serving at least 15 connections or at

94,600 community water system wells and 10.5 million rural domestic wells.[36] EPA tested for a total of 126 pesticides and pesticide degradates, and also for nitrate.[37]

Nitrate was the most frequently detected contaminant in the drinking water wells sampled.[38] EPA estimates that nitrate is present in over fifty percent of both community water system wells and rural domestic wells nationwide at levels at or above the analytical minimum reporting limit of 0.15 parts per million.[39] In terms of numbers of wells, EPA estimates that about 49,300 community water system wells and almost 6 million rural domestic wells nationwide contain detectable amounts of nitrate.[40]

EPA detected pesticides in drinking water wells much less frequently than nitrate. Only twelve of the 126 pesticides and pesticide degradates tested for were detected at levels above the minimum reporting limits.[41] EPA estimates that 10.4% of community water system wells and 4.2% of rural domestic wells contain one or more pesticides or pesticide degradates at or above the survey's minimum reporting limits.[42] Nationwide, EPA estimates that approximately 9850 community water system wells and 446,000 rural domestic wells are contaminated with one or more pesticides or pesticide degradates.[43]

Whether the results of the national pesticide survey will intensify or alleviate the concern over agricultural chemical contamination of groundwater is unclear. On the one hand, the survey is the most comprehensive effort to date to quantify the extent of pesticide contamination, and the results confirm the presence of a number of agricultural chemicals in groundwater. On the other hand, EPA points out that a large number of tested-for pesticides were not detected at levels above minimum reporting limits.[44] For chemicals with established or proposed lifetime health advisory levels (HALs)[45] or maximum contaminant levels

least 25 permanent residents with at least one operable well); *id.* at 5 (defining rural domestic well as a well used for human consumption that supplies an occupied private household in rural area not on government reservation).

36. NPS SUMMARY, *supra* note 11, at 1.

37. *Id.*

38. *Id.*

39. *Id.*; *see also* NPS GLOSSARY, *supra* note 35, at 3 (defining milligrams per liter as equivalent to parts per million).

40. NPS SUMMARY, *supra* note 11, at 1.

41. *Id.* at 1-2. The 12 detected pesticides and pesticide degradates were DCPA acid metabolites, atrazine, dibromochloropropane (DBCP), dinoseb, hexachlorobenzene, prometon, simazine, alachlor, bentazon, ethylene dibromide (EDB), ethylene thiourea, and gamma-HCH (lindane). *Id.* at 2.

42. *Id.*

43. *Id.*

44. *Id.* at 3.

45. *See* NPS GLOSSARY, *supra* note 35, at 3 (defining HAL as "[t]he maximum concentration of a contaminant in water that may safely be consumed over a specific time period").

(MCLs),[46] most observed detections "were at levels well below these standards."[47]

2. *Earlier National Studies*

Even prior to the 1990 results from the national pesticide survey, a number of studies had confirmed the presence of agricultural chemicals in groundwater. Results of nonrandom sampling by EPA released in 1987 confirmed the presence of agricultural chemicals in groundwater samples from twenty-four states.[48] A 1987 report by United States Department of Agriculture (USDA) researchers,[49] using then-available data on regional groundwater contamination vulnerability and county-level pesticide use,[50] identified regions with a high potential for pesticide contamination[51] or nitrate contamination.[52]

3. *State Surveys of Contamination*

A statewide survey of 686 wells in Iowa conducted in 1988 and 1989 detected nitrate and sixteen pesticides or pesticide metabolites in rural water wells.[53] Nitrate levels in 18.3% of Iowa rural water wells exceeded the EPA's recommended health advisory levels.[54] The study estimates that approximately 130,000 Iowans are consuming drinking water with unacceptably high levels of nitrate.[55] The detected pesticides and metabolites were generally at concentrations of less than one part per billion.[56] Atrazine was the most commonly detected pesticide.[57] Statewide, the study estimates that 1.2% of private, rural water wells in Iowa are contaminated with pesticides at levels exceeding recommended health advi-

46. *See id.* (defining MCL as "[t]he maximum permissible level of a contaminant in water that is delivered to any user of a public water system").

47. NPS SUMMARY, *supra* note 11, at 3.

48. U.S. ENVTL. PROTECTION AGENCY, AGRICULTURAL CHEMICALS IN GROUND WATER: PROPOSED PESTICIDE STRATEGY (1987).

49. NIELSEN & LEE, *supra* note 9.

50. *See id.* at 4 (describing USDA's "DRASTIC" index of area hydrogeologic characteristics and a database on county-level pesticide use developed by the private research organization Resources for the Future).

51. High pesticide contamination potential areas are the southern coastal plain (including Florida), the central Atlantic region, the Mississippi Delta, the northern Corn Belt of the Midwest, western Kentucky, and the central valleys of California. *Id.* at 7.

52. High nitrate contamination potential areas are the Corn Belt, eastern Pennsylvania, and California. *Id.* at 11.

53. UNIVERSITY OF IOWA & IOWA DEP'T OF NATURAL RESOURCES, IOWA STATE-WIDE RURAL WELL-WATER SURVEY: SUMMARY OF STATE-WIDE RESULTS AND STUDY DESIGN (n.d.) [hereinafter IOWA SURVEY SUMMARY] (four-page fact sheet designated SWRL H-1).

54. *Id.* at 1. The Iowa report stressed the importance of well depth for nitrate contamination. Nitrate levels are reported separately for shallow wells (less than 50 feet deep) and deep wells (over 50 feet deep). Statewide, nitrate levels exceeded health advisory levels in 35.1% of shallow wells but in only 12.8% of deep wells. *Id.*

55. *Id.*

56. *Id.* at 3.

57. *Id.* Fifteen other pesticides and pesticide metabolites also were detected, while sixteen other pesticides were tested for but not detected. *Id.*

sory levels.[58]

Several other states have tested for and detected agricultural chemicals in groundwater.[59] Additional data on groundwater contamination will become available in the future as other states test for the presence of chemicals in groundwater used for drinking water.[60]

4. *Other Evidence of Contamination*

In addition to the national and state surveys of contamination, numerous studies have examined groundwater contamination by specific chemicals.[61] Researchers have extensively studied groundwater contamination by the insecticide and nematicide aldicarb,[62] fertilizer nitrate,[63]

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58. *Id.*

59. *See* Hsiu-Hsiung Chen & A. Douglas Druliner, *Agricultural Chemical Contamination of Ground Water in Six Areas of the High Plains Aquifer, Nebraska*, *in* U.S. GEOLOGICAL SURVEY, NATIONAL WATER SUMMARY 1986—HYDROLOGIC EVENTS AND GROUNDWATER QUALITY: WATER-SUPPLY PAPER 2325 103 (1988) (discussing fertilizer and pesticide usage over aquifer used for irrigation; finding nitrate and triazine herbicide contamination); PATRICK W. HOLDEN, PESTICIDES AND GROUNDWATER QUALITY (1986) (discussing monitoring and other actions taken by California, New York, Wisconsin, and Florida); *Water Well Monitoring Finds Residues of 10 Pesticides in Ground Water Sources*, 19 ENV'T REP. (BNA) 1916 (1989) (California testing of 43,056 samples from 2977 wells detected 10 chemicals; nematicide DBCP most commonly detected).

60. *See, e.g.*, DENNIS P. MCKENNA ET AL., ILLINOIS STATE GEOLOGICAL SURVEY & ILLINOIS STATE WATER SURVEY, AGRICULTURAL CHEMICALS IN RURAL, PRIVATE WATER WELLS IN ILLINOIS: RECOMMENDATIONS FOR A STATEWIDE SURVEY, COOPERATIVE GROUNDWATER REPORT 11 (1989); *see also* DENNIS P. MCKENNA ET AL., ILLINOIS DEP'T OF ENERGY AND NATURAL RESOURCES, AN INITIAL EVALUATION OF THE IMPACT OF PESTICIDES ON GROUNDWATER IN ILLINOIS, COOPERATIVE GROUNDWATER REPORT 12 (1990).

61. *See* sources cited *infra* notes 62-64.

62. *See, e.g.*, Mahfouz H. Zaki et al., *Pesticides in Groundwater: The Aldicarb Story in Suffolk County, NY*, 72 AM. J. PUB. HEALTH 1391 (1982) (describing the 1979 detection of aldicarb in groundwater; 13.5% of 8404 wells tested exceeded recommended guideline of seven parts per billion; Union Carbide Corp. provided free activated carbon filtration system to owners of wells with over seven parts per billion aldicarb); *see also* Forrest E. Dierberg & Chris J. Given, *Aldicarb Studies in Ground Waters from Florida Citrus Groves and Their Relation to Ground-Water Protection*, 24 GROUND WATER 16 (1986) (laboratory study to determine aldicarb degradation rates); Keith S. Porter et al., *Field Research on Aldicarb Management Practices for Upstate New York*, 9 ENVTL. TOXICOLOGY & CHEMISTRY 279 (1990) (research on timing of aldicarb applications to potato fields; finding contamination of wells located very near treated fields when application made at usual planting time). *But see* R.L. Jones & R.C. Back, *Monitoring Aldicarb Residues in Florida Soil and Water*, 3 ENVTL. TOXICOLOGY & CHEMISTRY 9, 19 (1984) (study by scientists for Union Carbide Corp., the maker of aldicarb under the trademark TEMIK, finding relatively rapid degradation in Florida citrus groves; concluding "that the use of TEMIK aldicarb pesticide will not result in persistent residues in Florida groundwater").

63. *See* Robert J. Madison & Jilann D. Brunett, *Overview of the Occurrence of Nitrate in Ground Water of the United States*, *in* U.S. GEOLOGICAL SURVEY, NATIONAL WATER SUMMARY 1984: WATER-SUPPLY PAPER 2275 93 (1985) (discussing nitrate levels in 50 states and sources of nitrate in groundwater); OFFICE OF WATER, U.S. ENVTL. PROTECTION AGENCY, NATIONAL PESTICIDE SURVEY: NITRATE (1990) (four-page fact sheet summarizing findings of nitrate in the national pesticide survey, health effects of nitrate, water treatment, and prevention methods); *see also* Joseph H. Baier & Kenneth A. Rykbost, *The Contribution of Fertilizer to the Ground Water of Long Island*, 14 GROUND WATER 439 (1976) (nitrogen fertilizer on potatoes and turfgrasses contaminates groundwater); J.R. Gormley & R.F. Spalding, *Sources and Concentrations of Nitrate-Nitrogen in Ground Water of the Central Platte Region, Nebraska*, 17 GROUND WATER 291 (1979) (183 of 256 groundwater samples from three counties exceeded nitrate concentration of 10 milligrams per liter; fertilizer is primary source of contamination); *Threat from Nitrate Contamination Could Exceed Toxics Threat, Report Says*, 20 ENV'T REP. (BNA) 164 (1989) (report by California Water Re-

and the pesticide 1,2-dibromo-3-chloropropane (DBCP).[64] The evidence is conclusive: agricultural chemicals, both pesticides and nitrate, are contaminating groundwater that is used for drinking water.

C. *Health Risks of Consuming Contaminated Water*

Unfortunately, the health risks of consuming contaminated water are uncertain. The summary data, however, demonstrate that consuming contaminated water creates at least some risk of adverse health effects.

Of the thirteen chemicals detected by EPA in the national pesticide survey,[65] EPA considers seven to be probable or possible human carcinogens; each of these seven chemicals was detected at levels above EPA's one-in-a-million cancer risk level.[66] Of the eight detected chemicals with existing or proposed MCLs,[67] five (alachlor, atrazine, DBCP, EDB, and lindane) were detected in some samples at levels exceeding the MCL.[68] Of the seven detected chemicals with lifetime HALs,[69] two (atrazine and lindane) were detected in some samples at levels exceeding their lifetime HAL.[70] EPA states that "[w]ell water containing an analyte at levels exceeding EPA's MCLs or HALs may not be safe to consume."[71]

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sources Control Board; nitrate contamination is "threat to California's drinking water supply 'that is equal to or exceeds' threat posed by toxics").

64. *See* Sharon Frey, Comment, *DBCP: A Lesson in Groundwater Management*, 5 UCLA J. ENVTL. L. & POL'Y 81, 81-85 (1985) (history of DBCP production and use, and eventual suspension, cancellation, and cessation of production); *see also* Delwyn S. Oki & Thomas W. Giambelluca, *DBCP, EDB, and TCP Contamination of Ground Water in Hawaii*, 25 GROUND WATER 693 (1987) (DBCP used as nematicide in pineapple plantations; since 1979, discovered in groundwater of Hawaii and four other states); OFFICE OF WATER, U.S. ENVTL. PROTECTION AGENCY, NATIONAL PESTICIDE SURVEY: 1,2-DIBROMO-3-CHLOROPROPANE (DBCP) (1990) (four-page fact sheet summarizing findings of DBCP in the national pesticide survey, health effects, water treatment, and prevention methods).

65. The 13 chemicals are nitrate and 12 pesticides and pesticide degradates. *See supra* note 41.

66. EPA considers alachlor, DBCP, EDB, ethylene thiourea, and hexachlorobenzene to be probable human carcinogens; EPA considers lindane and simazine to be possible human carcinogens. *See, e.g.*, OFFICE OF WATER, U.S. ENVTL. PROTECTION AGENCY, NATIONAL PESTICIDE SURVEY: ALACHLOR 2 (1990) (fact sheet calling alachlor probable human carcinogen, listing its existing or proposed maximum contaminant level, lifetime health advisory level, and cancer risk). For information on the other chemicals, see EPA's similar fact sheets prepared for each chemical detected in the national pesticide survey.

67. A maximum contaminant level is "an enforceable standard defining the maximum permissible level of a contaminant in water that is delivered to any user of a public water system." NPS SUMMARY, *supra* note 11, at 3. MCLs do not legally apply to rural domestic wells. *Id.* They are designed both to be achievable and to protect human health. *Id.*

68. EPA has established or proposed MCLs for alachlor, atrazine, DBCP, dinoseb, EDB, hexachlorobenzene, lindane, and simazine. For the specific MCLs, see EPA's national pesticide survey fact sheets on these chemicals.

69. A lifetime health advisory level is "the concentration of a contaminant in water that may be consumed over an average human lifetime." *See* NPS SUMMARY, *supra* note 11, at 3. HALs are based on high-dose animal studies and include a margin of safety. *Id.*

70. For specifics, see EPA's national pesticide survey fact sheets on atrazine, bentazon, DPCA acid metabolites, dinoseb, lindane, prometon, and simazine.

71. NPS SUMMARY, *supra* note 11, at 3. *See generally* Sheldon D. Murphy, *Pesticides, in* CASARETT AND DOULL'S TOXICOLOGY 357-408 (2d ed. 1980).

D. Policy Options to Prevent Groundwater Contamination

Although this note focuses on liability rules to induce actions to prevent groundwater contamination, the note briefly mentions other options that policy makers have considered or might consider.

1. Voluntary Reductions in Chemical Use

Although agricultural chemicals are in widespread use in American agriculture,[72] methods do exist to produce crops while using fewer chemicals.[73] Most commonly called "alternative agriculture,"[74] the concept includes farmers' use of natural processes such as nutrient cycles, pest-predator relationships, the biological and genetic potential of plants and animals, adjustments in cropping patterns, and reduced amounts of chemicals and fertilizers.[75] Another concept that has met with fairly widespread farmer acceptance is integrated pest management (IPM),[76] which usually is defined as a method using "more biologically oriented pest control strategies . . . ."[77] Research continues on innovative approaches such as genetic methods of insect control and viral pesticides.[78] In response to recent concerns over agricultural chemical contamination of groundwater, the popular farm press has encouraged farmers to use IPM, choose low-leachability pesticides, conduct soil tests to minimize fertilizer applications, and handle pesticides safely.[79] Farmers should be commended for voluntary actions to reduce the threat of agricultural chemical contamination of groundwater. Voluntary actions alone, however, probably will not reverse the trend toward stricter regulations on agricultural chemical use.[80] Likewise, voluntary actions do not eliminate the justifications for imposing liability when agricultural chemicals do contaminate groundwater.[81]

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72. *See supra* notes 9-10.

73. *See infra* text accompanying notes 75-78.

74. *See* George Gunset, *Research Panel Backs "Alternative Agriculture"*, CHI. TRIB., Sept. 8, 1989, at 1 (describing the National Research Council's report on alternative agriculture).

75. *Id.* at 2. *But see* Sandra S. Batie, *Report on Reports: Alternative Agriculture*, 32 ENV'T, Apr. 1990, at 25 (reviewing BOARD ON AGRIC., NATIONAL RESEARCH COUNCIL, ALTERNATIVE AGRICULTURE (1989)). Professor Batie notes that the NRC's report met with a sharply divided response. *Id.* Despite the NRC's assertion that "[w]ider adoption of proven alternative systems would result in even greater economic benefits to farmers and environmental gains to the nation," *id.* at 26, Professor Batie states that "[i]n fact, there is as yet no unequivocal evidence that alternative agriculture would prove profitable when practiced on a wide scale." *Id.*

76. *See generally* INTEGRATED PEST MANAGEMENT (A.J. Burn, T.H. Coaker, P.C. Jepson eds., 1987) (discussing pest forecasting and monitoring, cultural methods, the effectiveness of natural enemies, chemical controls, genetic controls, and planning an integrated pest-management strategy in various crops).

77. *Id.* at vii.

78. *See generally* PESTICIDES AND ALTERNATIVES: INNOVATIVE CHEMICAL AND BIOLOGICAL APPROACHES TO PEST CONTROL (John E. Casida ed., 1990).

79. *See, e.g.*, *Good Farm Practices Protect Groundwater*, PROGRESSIVE FARMER, Sept. 1989, at 32.

80. *See infra* text accompanying notes 83-89.

81. *See infra* text accompanying notes 156-59.

2. *Governmental Regulation*

A number of federal, state, and local laws and regulations relate at least indirectly to agricultural chemical contamination of groundwater. The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)[82] governs the registration and labeling of pesticides and the certification of applicators of "restricted-use" pesticides.[83] In the future, certified applicators will have to keep records of their pesticide use.[84] Overall, however, the major federal environmental statutes represent a "fragmented, piecemeal . . . statutory structure" to address the problem of groundwater contamination[85] and are not directly relevant to this analysis, with limited exceptions.[86] In recent years a number of states have enacted statutes to protect groundwater from contamination,[87] and have enacted restrictions on the amounts of certain chemicals that farmers can apply.[88] If the recent trends continue, as seems likely, farmers in the future

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82. 7 U.S.C. §§ 136-136y (1988).

83. *See* James B. Wadley & Anita Settle, *Statutory Regulation of Hazardous Chemicals on the Farm*, AGRIC. L. UPDATE, July 1989, at 4. FIFRA's major impact is on the availability of pesticides. *Id.* FIFRA divides pesticides into the categories of general or restricted use; only persons who have received special training and have been certified may apply restricted-use pesticides. *Id.* *See generally* 40 C.F.R. pt. 171 (1990) (EPA regulations regarding certification of pesticide applicators). Under FIFRA, pesticide applicators "may be exposed to liability for civil damages and criminal fines for the unauthorized or uncertified application or resale of restricted chemicals . . . ." Wadley & Settle, *supra*, at 4. However, an applicator is "not likely [to] be individually punished under [FIFRA] for any pollution resulting from the chemical use." *Id.* For a criticism of FIFRA's regulatory scheme, see McCabe, *Pesticide Law Enforcement: A View from the States*, 4 J. ENVTL. L. & LITIG. 35, 38-46 (1989).

84. In the Food, Agriculture, Conservation, and Trade Act of 1990, Pub. L. No. 101-624, 104 Stat. 3359 (1990) (the 1990 Farm Bill), Congress required certified applicators of restricted-use pesticides to maintain the same type of records regarding pesticide use that the state requires of commercial certified pesticide applicators. *Id.* § 1491(a)(1), 104 Stat. 3627 (to be codified at 7 U.S.C. § 136i-1). If a state does not require commercial applicators to keep records, then certified applicators (which includes many farmers who apply their own restricted-use pesticides) must keep records of "the product name, amount, approximate date of application, and location of application of each such pesticide used for a 2-year period after such use." *Id.* These records potentially could be used to help to identify defendants and establish causation in cases of groundwater contamination. Congress, however, provided that the government may not "release data, including the location from which the data was derived, that would directly or indirectly reveal the identity of individual producers." *Id.* § 1491(a)(2).

85. Debbie Sivas, *Groundwater Pollution from Agricultural Activities: Policies for Protection*, 7 STAN. ENVTL. L.J. 117, 134 (1987-88). For an overview of federal environmental laws and an analysis of their limited applicability to groundwater contamination, see *id.* at 134-54 (discussing Clean Water Act; Safe Drinking Water Act; FIFRA; Toxic Substances Control Act; Resource Conservation and Recovery Act; and Comprehensive Environmental Response, Compensation, and Liability Act).

86. *See infra* text accompanying notes 102-05.

87. *See, e.g.*, IOWA CODE ANN. §§ 455E.1-455E.11 (West 1990); WIS. STAT. ANN. §§ 160.001-160.50 (West 1989 & Supp. 1990); *see also* Douglas A. Yanggen & Leslie L. Amrhein, *Groundwater Quality Regulation: Existing Governmental Authority and Recommended Roles*, 14 COLUM. J. ENVTL. L. 1, 7-52 (1989) (Wisconsin state and local regulations to protect groundwater). Several of the state groundwater protection statutes directly address the issue of liability for agricultural chemical contamination of groundwater. *See infra* text accompanying notes 109-32.

88. *See, e.g.*, JANET R. BATTISTA, UNIVERSITY OF WISCONSIN-MADISON, MANAGING PESTICIDES IN GROUNDWATER vii (1988) (Wisconsin Department of Natural Resources Board on June 23, 1988 adopted standards for alachlor and atrazine, two corn and soybean herbicides widely used in the state); Marcia Zarley Taylor, *Farmers Step Forward on Atrazine*, FARM J., Jan. 1990, at 22-E

may face more regulatory restrictions on their farming practices.[89]

3. *Impose Liability*

The final policy option to address groundwater contamination is to impose liability on the parties responsible for the contamination. Although cases imposing liability for agricultural chemical contamination of groundwater are not widespread,[90] courts frequently have imposed liability for groundwater contamination from other sources.[91] Courts have found parties liable for groundwater contamination based on various theories, including nuisance,[92] negligence,[93] and strict liability.[94] In closely analogous cases where aerially applied chemicals drift through the air and damage nontarget property,[95] a number of courts have held

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(Iowa Department of Agriculture approved restriction on atrazine use decreasing maximum application rate from four to three pounds per acre in most of the state, with more severe restrictions in northeast Iowa, which is most vulnerable to groundwater contamination); *see also* Rich Fee, *You'll Face More Limits on Nitrogen*, SUCCESSFUL FARMING, Mid-Feb. 1990, at 20 (local areas in Nebraska addressing nitrate contamination of groundwater by restricting the timing of nitrogen fertilizer applications on certain soils, requiring use of nitrification inhibitors in some situations, and requiring soil and water tests for nitrogen and nitrate).

89. Environmentalists have called for much stricter regulation of agricultural chemical use. The Natural Resources Defense Council (NRDC) has suggested that farmers should be regulated like municipal sewage treatment plants. *NRDC Offers Solutions to "Poison Runoff," Calls It Leading Source of Water Pollution*, 20 ENV'T REP. (BNA) 569 (1989). An NRDC spokesperson said that " '[a]gricultural pollution is probably the single biggest source of poison runoff, yet we do not regulate farmers like sewage treatment plants and factories . . . .' " *Id.* The Environmental Defense Fund has called for mandatory reductions in pesticide use. *Mandatory Cuts in Waste Disposal, Pesticide Use, Urged by Coalition*, 19 ENV'T REP. (BNA) 303 (1988) (calling for 25% reduction in pesticide use within five years and 60% reduction within 15 years). Some commentators have urged the adoption of mandatory land use regulations. *See, e.g.*, James C. Buresh, Note, *State and Federal Land Use Regulation: An Application to Groundwater and Nonpoint Source Pollution Control*, 95 YALE L.J. 1433, 1436-58 (1986) (prevention of groundwater contamination "ideal object of federally mandated state land use regulation"); Lawrence Ng, Note, *A DRASTIC Approach to Controlling Groundwater Pollution*, 98 YALE L.J. 773, 786-91 (1989) (proposing effluent charge system based on expected damage of different discharges and vulnerability to contamination of different areas).

90. Research for this note did not reveal any reported cases where courts imposed liability on farmers for damages caused by agricultural chemical contamination of groundwater. One reason for this may be that such cases more frequently are the subject of regulatory enforcement actions than lawsuits. *See, e.g.*, *Well-Meaning Acts Haunting Farmers*, N.Y. TIMES, Mar. 9, 1986, § 23, at 1 (describing Connecticut Department of Environmental Protection order against three farmers and several chemical companies and tobacco growers for pesticide contamination of groundwater).

91. *See* Peter N. Davis, *Federal and State Water Quality Regulation and Law in Missouri*, 55 MO. L. REV. 411, 484 n.597 (1990) (nationwide total of 201 pre-1974 reported cases on groundwater contamination; recent research finding 80 additional cases).

92. *E.g.*, Miller v. Cudahy Co., 858 F.2d 1449 (10th Cir. 1988) (upholding award of $3.06 million in actual damages and $10 million in punitive damages in nuisance action for salt manufacturer's contamination of groundwater aquifer used for irrigation); *see also* Davis, *supra* note 91, at 484 n.597 (86 pre-1974 nuisance cases and 26 more recent nuisance cases).

93. *E.g.*, North Ga. Petroleum Co. v. Lewis, 197 S.E.2d 437 (Ga. Ct. App. 1973) (allowing recovery in negligence action for groundwater contamination by gasoline); *see also* Davis, *supra* note 91, at 484 n.597 (74 pre-1974 negligence cases and 20 more recent negligence cases).

94. *E.g.*, Branch v. Western Petroleum Co., 657 P.2d 267 (Utah 1982) (allowing recovery on strict liability theory for contamination of two drinking water wells by oil well waste waters); *see also* Davis, *supra* note 91, at 484 n.597 (24 pre-1974 strict liability cases and six more recent strict liability cases).

95. The analogy between agricultural chemical contamination of groundwater and agricultural

farmers liable under various formulations of strict liability,[96] including the rule of *Rylands v. Fletcher*[97] and the "abnormally dangerous activity" formulation of the *Restatement (Second) of Torts*.[98] A number of commentators also have argued that courts should apply strict liability in chemical drift cases.[99]

The groundwater cases, the aerial drift cases, and the general trend toward strict liability[100] suggest that agricultural chemical users justifia-

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chemical damage due to drift is fairly strong. In both cases the chemical is intended to have some beneficial effect on crop production. In both cases the chemical moves, either through the soil or through the air, away from the intended area of application to an unintended area (groundwater or nontarget property) where it has negative effects.

96. *See, e.g.*, Gotreaux v. Gary, 94 So. 2d 293, 295 (La. 1957) (defendant hired aerial applicator to spray 2,4-D herbicide on his rice crop, herbicide drifted onto plaintiff's cotton and pea crops and destroyed them; court cited an earlier blasting case and held defendant strictly liable, stating that "negligence or fault, in these instances, is not a requisite to liability"); *see also* cases cited *infra* notes 97-98.

97. 3 L.R.-E. & I. App. 330 (Eng. H.L. 1868); *see, e.g.*, Young v. Darter, 363 P.2d 829 (Okla. 1961) (explicitly adopting the *Rylands* rule). The strict liability rule of *Rylands* is:

> If a person brings, or accumulates, on his land anything which, if it should escape, may cause damage to his neighbour, he does so at his peril. If it does escape, and cause damage, he is responsible, however careful he may have been, and whatever precautions he may have taken to prevent the damage.

Young, 363 P.2d at 833 (quoting *Rylands*, 3 L.R.-E. & I. App. at 340).

98. RESTATEMENT (SECOND) OF TORTS § 520 (1977); *see, e.g.*, Langan v. Valicopters, Inc., 567 P.2d 218 (Wash. 1977) (en banc) (aerially applied pesticides, intended for a neighbor's farm, contaminated and made worthless plaintiffs' organically grown vegetable crops; court applied six factors from *Restatement* and imposed strict liability on the hiring farmer and the aerial applicator). Under the *Restatement*, whether an activity is "abnormally dangerous" and thus the proper subject of strict liability depends upon the following six factors:

> (a) existence of a high degree of risk of some harm to the person, land or chattels of others;
> (b) likelihood that the harm that results from it will be great;
> (c) inability to eliminate the risk by the exercise of reasonable care;
> (d) extent to which the activity is not a matter of common usage;
> (e) inappropriateness of the activity to the place where it is carried on; and
> (f) extent to which its value to the community is outweighed by its dangerous attributes.

RESTATEMENT (SECOND) OF TORTS § 520 (1977).

Some commentators, however, question the *Langan* court's application of the six factors. Virginia E. Nolan & Edmund Ursin, *The Revitalization of Hazardous Activity Strict Liability*, 65 N.C. L. REV. 257, 275-78 (1987). The *Langan* court seemed to reject the applicability of the last three Restatement factors. *Id.* at 275. With the last three factors not limiting the application of strict liability, the first three factors alone impose absolute liability for dangerous activities. Groundwater contamination fully satisfies the first three factors: there is a high degree of risk of some harm; there is a likelihood that the harm that results will be great; and, despite the exercise of reasonable care, the risk cannot be eliminated. Thus, under the *Langan* court's application of the *Restatement*, farmers would be held absolutely liable for damages caused by agricultural chemicals, including the contamination of groundwater. *But see* Bennett v. Larsen Co., 348 N.W.2d 540, 553 (Wis. 1984) (honeybees injured after foraging on insecticide-treated sweet corn fields; court weighed six *Restatement* factors and held "that pesticide application is not an ultrahazardous activity warranting the application of strict liability for resulting harm").

99. *See* Richard S. Jensen, Comment, *Crop Dusting: Two Theories of Liability?*, 19 HASTINGS L.J. 476, 487-93 (1968) (courts should impose strict liability because negligence theory is inadequate and crop dusting is "abnormally dangerous" activity); Note, *Liability for Chemical Damage from Aerial Crop Dusting*, 43 MINN. L. REV. 531, 543 (1959) (calling for absolute liability because "the law must force farmers to weigh their potential gains against a proportionate share of the risk of damage loss").

100. *See generally* Nolan & Ursin, *supra* note 98; Julie S. Mebane, Comment, *Strict Liability for Hazardous Enterprises: Returning to a Flexible Analysis*, 9 UCLA-ALASKA L. REV. 67 (1979).

bly may be concerned about the possibility that courts could impose strict liability for agricultural chemical contamination of groundwater.

E. Statutory Liability Exemptions

This section analyzes those federal and state statutes that Congress and state legislatures have enacted or have proposed to exempt chemical users from liability for all or certain types of damages caused by agricultural chemicals.

1. Federal Provisions

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)[101] imposes strict liability on certain parties for the costs of remedial measures needed to address hazardous substances.[102] Because agricultural chemicals can be hazardous to human health, it would appear that farmers and other chemical users could be strictly liable for cleanup costs under CERCLA. Two provisions of CERCLA, however, effectively exempt farmers from such cleanup liability. "Release," which triggers potential liability, specifically is defined to exclude "the normal application of fertilizer."[103] This eliminates liability under CERCLA for most nitrates in groundwater.

CERCLA also expressly precludes recovery "for any response costs or damages resulting from the application of a pesticide product registered under the Federal Insecticide, Fungicide, and Rodenticide Act."[104] This eliminates liability under CERCLA for legally applied pesticides that leach into groundwater. However, this provision expressly does not affect or modify liability under any other provision of state or federal law, including common law, for damages from a release of any hazardous substance.[105] Therefore, although farmers cannot be held liable for CERCLA cleanup costs for groundwater contamination, they still can be liable for damages under other federal law or state tort law.

In 1988 Congress considered, but did not approve, legislation to exempt agricultural producers from liability under any federal environmental law for damages resulting from the use of pesticides.[106] The provision

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101. 42 U.S.C. §§ 9601-9675 (1988).

102. *Id.* § 9607.

103. *Id.* § 9601(22)(D).

104. *Id.* § 9607(i). FIFRA is codified at 7 U.S.C. § 136-136y (1988). For a summary of the 1988 amendments to FIFRA, Pub. L. No. 100-532, 102 Stat. 2654 (1988), see 3 WILLIAM H. RODGERS, JR., ENVIRONMENTAL LAW ix-xviii (1988).

105. 42 U.S.C. § 9607(i) (1988).

106. *See* S. 1516, 100th Cong., 2d Sess. § 2501 (1988) (as reported by the Senate Committee on Agriculture, Nutrition, and Forestry) [hereinafter S. 1516 as reported]; *see also* SENATE COMM. ON AGRIC., NUTRITION, AND FORESTRY, FEDERAL INSECTICIDE, FUNGICIDE, AND RODENTICIDE REFORM ACT OF 1988, S. REP. No. 346, 100th Cong., 2d Sess. 90-91 (1988). The FIFRA bill that Congress finally passed in 1988, S. 659, did not include any provision regarding farmer liability. *See* Pub. L. No. 100-532, 102 Stat. 2654 (1988). Congress removed many of the controversial provisions from S. 659 before passing it. *House Adopts FIFRA Reauthorization Bill; Senate Could Act Before October Adjournment*, 19 ENV'T REP. (BNA) 1092 (1988). The deleted provisions included those on

provided that agricultural producers would be exempt from liability if "the application was in compliance with labeling instructions and applicable law unless the agricultural producer acted negligently, recklessly, or with the intent to misuse such pesticide . . . ."[107] Thus, the bill would have exempted farmers from strict liability for damages caused by the proper application of agricultural chemicals; however, the provision would not have affected liability under state statutory or common law.[108]

2. *State Liability Exemptions*

Several states recently have enacted statutes that provide some exemption from state-law liability for farmers who use agricultural chemicals. Some of these statutes provide a complete or affirmative defense to liability,[109] some preclude the application of strict liability in certain causes of action,[110] and others grant very limited or no exemption.[111]

a. Complete or Affirmative Defense

Minnesota's statute[112] provides the most complete exemption from liability. The statute provides chemical end users and landowners with a "complete defense"[113] if the application: (1) complied with state law; (2) complied with any applicable labeling requirements; and (3) complied with orders of the commissioner.[114] This exemption from liability is clear and absolute—a complete defense against liability—provided the application complied with all three conditions.

In 1987, Iowa, a major agricultural state, passed its comprehensive

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groundwater contamination by pesticides and the farmer liability exemption. *See House Agriculture Committee Adopts "Core" FIFRA Bill Addressing Fees, Indemnification, Disposal*, 19 ENV'T REP. 995, 996 (BNA) (1988). The Senate passed the House version without amendment. *See Senate Passes FIFRA Reauthorization; President Expected to Sign Legislation*, 19 ENV'T REP. (BNA) 1157 (1988); *see also* Pub. L. No. 100-532, 102 Stat. 2654 (1988) (final FIFRA bill contains no liability exemption provision).

107. S. 1516 as reported, *supra* note 106, § 2501(a)(1).

108. *Id.* § 2501(a)(3)(A) (provision does not "preempt or assign or transfer liability under a state law, whether statutory or common law"). Thus, in fact, the provision's effect would have been very limited. Provisions in CERCLA already exempt farmers from liability for cleanup costs due to fertilizer or pesticide damages. *See supra* text accompanying notes 103-04. Therefore, the only real change that S. 1516 as reported would have made would have been to exempt farmers from potential liability under federal environmental statutes other than CERCLA.

109. *See infra* text accompanying notes 112-18.

110. *See infra* text accompanying notes 119-27.

111. *See infra* text accompanying notes 128-31.

112. MINN. STAT. ANN. § 18D.101 (West Supp. 1991). The statute provides:

> (a) Notwithstanding other law relating to liability for agricultural chemical use, an end user or landowner is not liable for the cost of active cleanup, or damages associated with or resulting from agricultural chemicals in groundwater if the person has applied or has had others apply agricultural chemicals in compliance with state law, with any applicable labeling, and orders of the commissioner.
>
> (b) It is a complete defense for liability if the person has complied with the provisions in paragraph (a).

Id.

113. *Id.* § 18D.101(b).

114. *Id.* § 18D.101(a).

Groundwater Protection Act.[115] The Iowa statute includes a liability exemption, like Minnesota's, that specifically applies to groundwater contamination. The statute provides an "affirmative defense" to liability for groundwater contamination cleanup costs or damages if the farmer had a valid pesticide applicator's license and complied with label instructions.[116] An almost identical clause exempts farmers from liability for nitrates in groundwater, provided application was in accordance with soil test results and the farmer complied with the fertilizer's label instructions.[117]

This language seems clear—a farmer is not liable for pesticide or nitrate contamination of groundwater. However, conflicting language appears to limit the exemption. The Iowa statute states that it "shall not enlarge, restrict, or abrogate any remedy which any person or class of persons may have under other statutory or common law *and which serves the purpose of groundwater protection*."[118] The meaning of the highlighted language is unclear.

b. No Strict Liability in Certain Causes of Action

Other states have purported to exempt farmers from strict liability for damages from agricultural chemical use, but with unclear results. Georgia, for example, requires "proof of negligence or lack of due care" to impose liability on a farmer or similar person for any response costs, damages, or injunctive relief because of the application of any fertilizer, pesticide, or plant growth regulator.[119] This is an exemption from strict liability, thus making negligence the standard. However, the exemption from strict liability is very limited for two reasons. First, the exemption is only from liability "under this title,"[120] which is the statutory title relating to agriculture. Second, the exemption applies only if several specific, stringent conditions are met.[121] Furthermore, because the statute

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115. 1987 Iowa Acts 72d Gen. Assembly, ch. 225 (codified at IOWA CODE ANN. §§ 455E.1-455E.11 (West 1990)).

116. IOWA CODE ANN. § 455E.6 (West 1990). The section's third paragraph provides:

> Liability shall not be imposed upon an agricultural producer for costs of active cleanup, or for any damages associated with or resulting from the detection in the groundwater of pesticide provided that the applicator has properly complied with label instructions for application of the pesticide and that the applicator has a valid appropriate applicator's license. Compliance with the above provisions may be raised as an affirmative defense by an agricultural producer.

Id.

117. *Id.* The section's second paragraph provides:

> Liability shall not be imposed upon an agricultural producer for the costs of active cleanup, or for any damages associated with or resulting from the detection in the groundwater of any quantity of nitrates provided that the application has been in compliance with soil test results and that the applicator has properly complied with label instructions for application of the fertilizer. Compliance with the above provisions may be raised as an affirmative defense by an agricultural producer.

Id.

118. *Id.* (emphasis added).

119. GA. CODE ANN. § 5-4101 (Michie Supp. 1989).

120. *Id.* § 5-4101(a).

121. To qualify for Georgia's exemption from strict liability, the following conditions must be

details a required standard of care to be used in applying agricultural chemicals, failure to qualify for the exemption from strict liability could be construed as proof of negligence or lack of due care.[122] Thus, Georgia's attempt to limit farmer liability actually may have exposed farmers to greater liability.

The Georgia statute contains other language that makes it unclear whether there is any real exemption from liability. Subsection (b) provides: "[n]othing in this article shall affect or limit any right of action of an individual against any . . . [chemical user] for injury to person or property resulting from such chemical application or use."[123] If Georgia law generally allows actions in strict liability, this language arguably preserves such a right to sue a chemical user based on strict liability for agricultural chemical damages. If so, the statute is of even more questionable value in terms of limiting the liability of chemical users. Interestingly, the Georgia statute explicitly does not prohibit "any cause of action based on strict tort liability against any manufacturer of" an agricultural chemical.[124]

Vermont has created a statutory cause of action for equitable relief or damages "for the unreasonable harm caused by another person . . . altering the character or quality of groundwater."[125] However, a person who alters or contaminates groundwater as a result of agricultural activities, unlike other persons, cannot be held strictly liable—liability under the statute attaches "only if the alteration [of groundwater] was either negligent, reckless or intentional."[126] Thus, the statute treats farmers and other agricultural chemical users differently than persons who contaminate groundwater in other ways. The exemption from strict liability may be of limited benefit, however, because a different subsection pro-

met. First, application must have been consistent with the labeling instructions and in accordance with acceptable agricultural management practices and all applicable state and federal laws. *Id.* § 5-4101(a)(1). Second, the state or federal government must have approved, recommended, or permitted the application; the user must not have violated any conditions of such approval, recommendation, or permit; and the user must not have ignored any warnings or limits on use. *Id.* § 5-4101(a)(2). Third, the chemical must have been licensed or registered by the state or federal government and the user "[must have] kn[own] of no special geological, hydrological, or soil type condition existing on the land which rendered such application or use likely to cause pollution." *Id.* § 5-4101(a)(3).

122. *See generally* W. PAGE KEETON ET AL., PROSSER AND KEETON ON THE LAW OF TORTS § 36 (5th ed. 1984) [hereinafter PROSSER & KEETON] (violation of statute).

123. GA. CODE ANN. § 5-4101(b) (Michie Supp. 1989).

124. *Id.* § 5-4101(d).

125. VT. STAT. ANN. tit. 10 § 1410(c) (Supp. 1991).

126. *Id.* § 1410(d). Subsections (c) and (d) provide:

> (c) Any person may maintain under this section an action for equitable relief or an action in tort to recover damages, or both, for the unreasonable harm caused by another person withdrawing, diverting or altering the character or quality of groundwater.
> (d) Notwithstanding the provisions of subsection (c) of this section, a person who alters groundwater quality or character as a result of agricultural or silvicultural activities, or other activities regulated by the commissioner of the department of agriculture, food and markets, shall be liable only if the alteration was either negligent, reckless or intentional.

Id. § 1410(c)-(d).

vides that the exemption does not "preclude or supplant any other statutory or common-law remedies."[127]

c. Very Limited or No Exemptions

Arizona exempts from liability for hazardous substance cleanup costs those persons who applied according to label requirements a pesticide registered pursuant to FIFRA.[128] This liability exemption parallels that embodied in CERCLA[129] and is of very limited scope. Other states have a comprehensive groundwater protection law[130] but do not provide any statutory exemptions from liability for agricultural chemical contamination of groundwater.[131]

d. Summary

The state exemption statutes enacted to date do not satisfactorily resolve the issue of farmer liability for groundwater contamination. The statutes frequently are ambiguous,[132] and appear to reflect a desire both to exempt farmers from liability and at the same time to preserve the right of groundwater contamination victims to recover damages. This uncertainty perhaps can be explained as a compromise between agricultural interests and environmental interests. But this situation is unacceptable as a legal solution to a potentially serious environmental threat. Users of agricultural chemicals do not know whether they will be held liable for groundwater contamination. Persons using groundwater for drinking water or other purposes do not know whether they will be compensated if their groundwater is contaminated.

An ambiguous or only partial liability exemption will not solve the concerns of either chemical users or groundwater users. On the other hand, a clear and absolute liability exemption is problematic for different reasons. A clear and absolute liability exemption provides no incentive to prevent groundwater contamination and leaves contamination victims uncompensated. A clear exemption from strict liability, precluding a contamination victim's recovery without proof of at least negligence, raises serious questions regarding the proper incentives for prevention and the specter of innocent contamination victims going uncompensated because of difficulties of proof. These important questions are uniquely suited to an economic analysis, which the next section provides.

127. *Id.* § 1410(f).

128. ARIZ. REV. STAT. ANN. § 49-283(D)(5) (1988).

129. *See supra* text accompanying note 104.

130. *See, e.g.*, WIS. STAT. ANN. §§ 160.001-160.50 (West 1989 & Supp. 1991).

131. *See id.* § 160.32(1) ("Nothing in this chapter restricts or abrogates any remedy which any person or class of persons may have under other statutory or common law.").

132. *See supra* text accompanying notes 118 & 123.

III. ECONOMIC ANALYSIS OF ALTERNATIVE LIABILITY RULES AND THEIR INCENTIVES TO MINIMIZE THE HARMS OF GROUNDWATER CONTAMINATION

This section applies an economic analysis to the problems of groundwater contamination. The analysis focuses on the economic incentives that the major liability alternatives—no liability, a negligence standard, and strict liability—can create to induce chemical beneficiaries[133] to minimize the risk of groundwater contamination.

A. Introduction to the Actors and the Economic Assumptions

1. Chemical Beneficiaries as Injurers and Groundwater Users as Victims

The analysis initially will be simplified by assuming that there are only two relevant actors in a groundwater contamination case: chemical beneficiaries and groundwater users.[134] These parties, in the literature of law and economics discussing liability rules, are referred to as "injurers" and "victims."[135] In the groundwater contamination case, chemical beneficiaries are the injurers because the manufacture, sale, and use of agricultural chemicals results in groundwater contamination. Groundwater users suffer injury in two ways: (1) by an increased risk of negative health effects from drinking contaminated water;[136] and (2) in some cases by incurring costs either to establish a new noncontaminated drinking water source[137] or to remove contaminants from an existing water source.[138]

2. The Goal of Profit or Utility Maximization

The basic economic assumption underlying the analysis is that chemical beneficiaries and groundwater users make decisions with the goal of maximizing their expected profit or utility.[139] With uncertainty,

133. The term *chemical beneficiaries* is used to refer to all of the economic actors that benefit from the use of agricultural chemicals. Thus, the term includes chemical manufacturers, others in the business of marketing chemicals such as retailers, and farmers.

134. The interrelationship between the different types of chemical beneficiaries is analyzed briefly in a subsequent section. *See infra* text accompanying notes 221-31. The analysis also considers the role of chemical manufacturers and dealers, as well as farmers, as possible joint tort-feasors. *See infra* note 231. The analysis throughout assumes that groundwater users, specifically those who use groundwater for drinking water purposes, are the victims of groundwater contamination.

135. *See* SHAVELL, *supra* note 18, at 5.

136. See *supra* notes 65-71 and accompanying text for a discussion of the health risks of groundwater contamination.

137. *See* 2 WILLIAM H. RODGERS, JR., ENVIRONMENTAL LAW § 4.7, at 95-96 (1986) (costs of new well "a common element of damages" in groundwater contamination cases).

138. The costs of removing contaminants from groundwater can be very high. *See Fresno Files $650 Million Lawsuit Over Contamination of Drinking Water*, 20 ENV'T REP. (BNA) 1775 (1990) (citing Fresno v. Shell Oil Co., No. 914400 (Cal. Super. Ct. Jan. 2, 1990)). The complaint sought $250 million in compensatory damages for the costs of constructing and operating a system to remove DBCP and EDB from the City of Fresno's municipal water supply. *Id.* at 1776.

139. *See* SHAVELL, *supra* note 18, at 2.

expected profit or utility is the probability of each possible outcome multiplied by the profit or utility that will be obtained from that outcome, summed over all possible outcomes.[140] The general assumption that firms seek to maximize profits[141] is applicable to chemical beneficiaries.

One factor that profit-maximizing chemical beneficiaries must consider in making their manufacturing, sales, or cropping decisions is their expected *disutility* from groundwater contamination—the probability that they will be held liable for damages due to groundwater contamination multiplied by the estimated value of those damages. Groundwater users are assumed to seek to maximize their expected utility from consuming drinking water and from engaging in other activities. One factor that utility-maximizing groundwater users must consider is the probability that their drinking water supply is or will be contaminated with agricultural chemicals.

This analysis assumes that society's goal is to maximize the total utility of all members of society. To do so, society's goal in the specific area of groundwater contamination is to minimize the sum of the costs of groundwater contamination and the costs of preventing groundwater contamination.[142] The costs of groundwater contamination include negative health risks[143] and the expense of providing an alternative water supply[144] or of cleaning up a contaminated source.[145] The costs of preventing groundwater contamination include the loss of the crop production benefits of agricultural chemicals that would result if agricultural chemical use were decreased. Other potential costs of preventing groundwater contamination include the costs of developing nonleaching chemicals and the costs of substitute production inputs such as additional labor, management, tillage practices, and natural sources of nitrogen.

3. *The Disutility of Externalities*

An externality is a cost that one party's actions impose on another party without that party's consent.[146] Pollution is one example of an externality.[147] An externality results in what economists call "market

140. *Id.* The theory of expected utility is widely accepted by economists and statisticians. *Id.* at 2 n.3.

141. SHAVELL, *supra* note 18, at 47.

142. The stated goal for society regarding groundwater contamination is adapted from Dean Guido Calabresi's goal for society for accidents generally: "[T]he principal function of accident law is to reduce the sum of the costs of accidents and the costs of avoiding accidents." GUIDO CALABRESI, THE COSTS OF ACCIDENTS: A LEGAL AND ECONOMIC ANALYSIS 26 (1970).

143. *See supra* text accompanying notes 65-71.

144. *See supra* note 137.

145. *See supra* note 138.

146. *See* ROBERT D. COOTER & THOMAS S. ULEN, LAW AND ECONOMICS 45 (1988).

147. *Id.* Professors Cooter and Ulen give the following example of pollution as an externality: A factory dumps toxic materials into a river at a point upstream from a city. The factory's action imposes an unbargained-for cost on the city because the city is forced to pay to clean up the water or to bring in safe water from elsewhere. Because the factory does not have to pay for these costs they

failure," because the party causing the external cost (the injurer) does not have to pay for the harm he imposes on the other party (the victim).[148] In economic terms, the result of an externality is a divergence between private marginal cost and social marginal cost.[149] Private marginal cost includes only those costs that the injurer has to pay.[150] Social marginal cost is the sum of private marginal cost and the external costs imposed on the victims.[151] Thus, social marginal cost is greater than private marginal cost.[152] This is true because, by definition, social marginal cost includes the external cost.

Society as a whole, because it bears all costs including costs external to the private decision maker, is better off if decisions are made based on social marginal costs. However, a profit-maximizing actor will make decisions based only on private marginal cost unless induced to do otherwise.[153] The result, which best can be demonstrated graphically,[154] is that the profit-maximizing actor will engage in the externality-generating activity more than would be socially optimal.[155]

4. *Groundwater Contamination Is an Externality*

Groundwater contamination clearly is an externality. Absent liability, chemical beneficiaries' decisions regarding the manufacture, sale, or use of agricultural chemicals will be based only on private marginal cost. Profit-maximizing chemical beneficiaries will *not* consider the external costs that the use of agricultural chemicals imposes on groundwater users. However, the social marginal cost of using agricultural chemicals clearly *does* include these external costs. Therefore, chemical beneficiaries will manufacture, sell, or use more agricultural chemicals than is socially optimal, and groundwater contamination will exceed the social optimum.

This section has provided the analytical framework for evaluating alternative liability rules in terms of their economic incentives to reduce groundwater contamination to socially optimal levels. The following sections examine the relative efficiency of the three major liability alternatives—no liability, negligence, and strict liability.

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are external to the factory's decision making. *Id.* at 46. This assumes that the factory is not held liable for the costs imposed on the city. The groundwater contamination case is strikingly similar.

148. *Id.*

149. *Id.*

150. *Id.*

151. *Id.*

152. *Id.*

153. *Id.*

154. See *id.* at 47 for a graph depicting the divergence between private marginal cost and social marginal cost due to an externality.

155. *Id.* at 46.

B. A Rule of No Liability Creates No Incentive to Reduce the Harms of Groundwater Contamination

If no liability is imposed on chemical beneficiaries, they will have no incentive to prevent groundwater contamination.[156] Generally, "[i]n the absence of liability, injurers will not exercise any care. Total accident costs will therefore generally exceed their optimal level . . . ."[157] With no liability for groundwater contamination, profit-maximizing chemical beneficiaries will make their manufacturing, sales, or use decisions based only on private marginal cost and will ignore the external cost of groundwater contamination.[158] A rule of no liability, therefore, results in a level of groundwater contamination that is higher than socially optimal.[159]

The key issue for society's decision makers is how to induce chemical beneficiaries to consider the external costs of groundwater contamination. In economic terms, achievement of the social optimum where externalities exist requires policies to induce private profit-maximizers to operate along the social marginal cost curve instead of the private marginal cost curve.[160] This forces the profit-maximizing actor to "internalize" the externality, that is, to consider the external costs it imposes on others. In economic terms, a rule of no liability provides no incentive for the chemical beneficiary to internalize the external costs of groundwater contamination. The following sections analyze the degree to which the liability rules of negligence or strict liability can induce chemical beneficiaries to internalize this cost.

C. A Negligence Standard

The *Restatement (Second) of Torts* defines negligence as "conduct which falls below the standard established by law for the protection of others against unreasonable risk of harm."[161] The first element of a negligence cause of action is the existence of a legally recognized duty to conform to a certain standard of conduct.[162] The second element is a breach of the duty—failure to meet the required standard of conduct.[163]

156. This conclusion ignores certain incentives to prevent groundwater contamination that may exist even absent the imposition of liability on chemical beneficiaries. First, a farmer who uses groundwater for drinking water has some incentive to prevent contamination of his or her own water supply. This incentive, however, is not applicable for all farmers. Even where applicable it is clearly less strong than if, in addition to preventing personal harm, the farmer knows that he or she will be liable for the damages imposed on other groundwater users. Second, chemical beneficiaries may have a general concern for the environment that leads them to do more to prevent groundwater contamination than mere profit-maximization alone would call for. However, this does not nullify the general proposition that absent the threat of liability, chemical beneficiaries will have little or no incentive to prevent groundwater contamination.

157. SHAVELL, *supra* note 18, at 8.

158. *See supra* text accompanying notes 146-52.

159. *See supra* text accompanying notes 153-55.

160. COOTER & ULEN, *supra* note 146, at 46.

161. RESTATEMENT (SECOND) OF TORTS § 282 (1965).

162. PROSSER & KEETON, *supra* note 122, at 164.

163. *Id.*

Thus, if an actor's actual conduct meets the required standard of care ("due care") there will be no liability. The final elements of a negligence action are causation, both actual and proximate, and actual damage.[164] The following sections discuss the economic implications of a negligence standard.

1. *When Negligence Will Induce Optimal Levels of Prevention*

A negligence standard will produce socially optimal results "[i]f due care is chosen by courts to equal the socially optimal level of care . . . ."[165] The problem of determining the socially optimal level of care is considered in the next section.[166] This section assumes that it is possible to set the level of due care at the socially optimal level. If this assumption holds in the real world, a negligence standard will create clear incentives for injurers to take socially optimal levels of care to prevent groundwater contamination—neither too much care (beyond the socially optimal level) nor too little care (below the socially optimal level).[167]

The socially optimal level of care, by definition, is that level of care that will minimize the sum of groundwater contamination costs and prevention costs.[168] Chemical beneficiaries who, in fact, utilize the socially optimal level of care will not be found negligent. Chemical beneficiaries will not take too much care because the additional care will be costly but will provide no additional benefits; likewise, they will not take too little care because falling below the level of due care will make them liable for groundwater contamination damages while a less costly alternative, prevention, exists.[169]

2. *Negligence Fails if the Required Level of Due Care Is Not Set Accurately*

The ability of a negligence standard to induce injurers to take optimal levels of prevention is critically dependent on whether decision makers can correctly set the required level of due care at the socially optimal level.[170] This section examines the difficulties of accurately setting the level of due care and the resulting implications for the ability of a negligence standard to encourage chemical beneficiaries to take optimal levels of care to prevent groundwater contamination.

Establishing the socially optimal level of due care requires the same sort of weighing of the magnitude of risk of harm against the cost of care that is involved in applying the *Restatement* definition.[171] One commen-

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164. *Id.* at 165.
165. SHAVELL, *supra* note 18, at 8.
166. *See infra* text accompanying notes 170-76.
167. SHAVELL, *supra* note 18, at 8.
168. *See supra* text accompanying notes 142-45.
169. *See generally* SHAVELL, *supra* note 18, at 8.
170. *See id.* at 9.
171. *Id.* at 19.

tator argues that "due care is in fact found by a process that operates *as if* it were designed to identify behavior that minimizes total accident costs."[172] The economic argument is that when courts establish the level of due care, they consider the same factors they would consider if their goal were to minimize total accident costs.[173] Those factors are the magnitude of harm, the number of potential victims, and injurers' ability to alleviate the risk.[174]

In the real world, courts may incorrectly establish the level of required due care because of the difficulty of obtaining and evaluating relevant information.[175] A high degree of uncertainty is likely to exist regarding the probability of groundwater contamination occurring, the magnitude of resulting harm, and the number of groundwater users affected. Uncertainty also is likely to exist regarding chemical beneficiaries' options for preventing contamination. Therefore, particularly where the required information is complicated and technical, courts are likely to make errors in establishing the required levels of due care.[176] The assumption that the level of required due care can accurately be established, which must be satisfied for a negligence standard to be socially optimal, is not likely to be satisfied in the groundwater contamination case.

3. *Negligence Fails if the Actual Level of Care Is Not Measured Accurately*

The second element in a negligence case is breach—that the actor's actual conduct fell below the required level of due care.[177] In making this determination courts may erroneously assess a party's true level of care.[178] This error could occur in two directions: finding that an injurer used less care than he or she actually did, or finding that an injurer used more care than he or she actually did.[179] One commentator has concluded that a general consequence of this potential error "is that parties will tend to be led to take more than due care—and thus to take socially excessive levels of care . . . ."[180] The result is not socially optimal. Due

172. *Id.* at 19 (footnote omitted).

173. *Id.* at 20.

174. *Id.*

175. *Id.* at 56.

176. *Id.*

177. PROSSER & KEETON, *supra* note 122, at 164.

178. SHAVELL, *supra* note 18, at 79. In the case of groundwater contamination, consider what type of evidence a court would require to determine how much care was used by: (1) a chemical manufacturer in testing the leachability of a pesticide; (2) a chemical dealer in recommending a particular pesticide and application amounts and procedures; and (3) a farmer in mixing the chemical and calibrating the sprayer. The complexity and fact-specific nature of the required information suggests that courts will find it difficult to determine how much actual care a chemical beneficiary used in a particular case.

179. *Id.*

180. *Id.* at 80. This assumes that the required level of due care is set at the socially optimal level. *Id.*

to the uncertainty regarding the determination of their actual levels of care, chemical beneficiaries will incur additional precaution costs and will reduce the manufacture, sale, and use of agricultural chemicals *to a greater extent than is justified* by the additional reduction in groundwater contamination.

4. *The Problem of Multidimensional Precaution*

In the real world an injurer probably can take many different actions, alone or in combination, to reduce the risk of injury. For example, a farmer may have at least two options to reduce the risk of groundwater contamination: simply reduce the amount of chemicals applied per acre or change the type of chemicals used from those with high leachability to those with low leachability. Assume courts only create a due care standard for one dimension of care, for example rate per acre. Farmers then will have less incentive to consider switching to low-leachability chemicals than if courts also created a due care standard for when chemical switching is appropriate.

Perhaps the different aspects of care are incorporated into one generalized standard of care. But if they are not, a negligence standard can induce efficient levels of care only if the socially optimal level of due care is established for every distinct dimension of care. This would require courts to consider and accurately assess *every* option available to chemical beneficiaries to reduce groundwater contamination—a formidable and perhaps impossible task. The injurer will not have an incentive to take care for any dimension for which no standard of due care is established. The reason is straightforward: if no due care standard is established, no amount of care, even zero care, can fall below what does not exist, so there is no liability for not exercising the socially optimal level of care.[181]

5. *Negligence Leaves Some Victims of Groundwater Contamination Uncompensated*

A negligence standard will not result in liability in all cases. By definition, if the injurer uses care that equals or exceeds the legally required level of due care, the injurer will not be found liable. Therefore, the victim retains some residual risk that he or she will be injured and will not be compensated. This is true because an injurer's use of due care will not prevent all injury, but rather only that injury that is socially desirable to prevent. Thus, with a negligence standard, in some cases groundwater users will be injured but will be left uncompensated. From a policy perspective, this result calls into serious question the fairness of applying a negligence standard in groundwater contamination cases.

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181. The analysis of this paragraph is presented in general terms in SHAVELL, *supra* note 18, at 9.

D. *Strict Liability*

Strict liability is "liability that is imposed on an actor apart from . . . a breach of a duty to exercise reasonable care . . . ."[182] Courts have imposed strict liability for groundwater contamination.[183] This section analyzes strict liability's economic incentives to prevent groundwater contamination. In doing so, this section also will compare strict liability against the alternatives of no liability and a negligence standard.

1. *Strict Liability Internalizes the External Costs of Groundwater Contamination*

Under strict liability, injurers are liable for the damages they cause regardless of the level of care they exercise.[184] In economic terms, if strict liability is imposed, an injurer's total costs will equal total accident costs.[185] This means that private marginal cost will equal social marginal cost.[186] Thus, the externality problem of a divergence between private marginal cost and social marginal cost is solved.[187] Strict liability, therefore, "internalizes" the external costs of accidents.[188]

Injurers, as profit-maximizers, will seek to minimize their total costs.[189] Therefore, in furthering their own economic self-interest, injurers at the same time will seek to minimize total accident costs,[190] which is society's goal.[191] Thus, under strict liability, "injurers will be induced to choose the socially optimal level of care."[192]

If strict liability is imposed for groundwater contamination, chemical beneficiaries will know that they will be held liable for any groundwater contamination caused by their manufacture, sale, or use of agricultural chemicals. Chemical beneficiaries will bear these costs regardless of how much care they use to prevent groundwater contamination. Thus, chemical beneficiaries will consider their expected liability for groundwater contamination when they make their manufacturing, sales, or cropping decisions. Because expected liability will equal expected damages from groundwater contamination, chemical beneficiaries will consider fully all costs of groundwater contamination, including those costs that are imposed on groundwater users. As a result, chemical beneficiaries will determine, and will take, the optimal level of care to prevent groundwater contamination—without any explicit instruction to do so from a court or other decision maker.

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182. PROSSER & KEETON, *supra* note 122, at 534.
183. *See supra* notes 91-94.
184. *See* PROSSER & KEETON, *supra* note 122, at 534.
185. SHAVELL, *supra* note 18, at 8.
186. *See* COOTER & ULEN, *supra* note 146, at 363.
187. *See supra* text accompanying notes 146-55.
188. *See* COOTER & ULEN, *supra* note 146, at 363.
189. *See id.*
190. *See id.*
191. *See supra* text accompanying note 142.
192. SHAVELL, *supra* note 18, at 8.

2. *Strict Liability Avoids the Major Problems of a Negligence Standard*

Strict liability avoids the two problems that prevent a negligence standard from inducing injurers to take optimal care.[193] With strict liability there is no need for a court to establish a required level of due care.[194] Thus, with a rule of strict liability, the problem of establishing the socially optimal level of due care in a groundwater contamination case[195] is irrelevant. Likewise, with strict liability there is no need for a court to determine a chemical beneficiary's actual level of care.[196]

3. *Easing the Victim's Problems of Proof*

Strict liability has a practical advantage over a negligence standard in terms of avoiding what may be very real problems of proof. Under a negligence standard, even assuming that a court can set the required level of due care at the socially optimal level, chemical beneficiaries will have no incentive to take optimal precautions if they believe that contamination victims will be unable to prove in court that actual care fell below the legally required level of due care. If problems of proof of the actual level of care are serious, as they seem likely to be, a negligence rule effectively becomes a rule of no liability. Strict liability, however, avoids this proof problem because the contamination victim need not prove that the level of actual care fell below the legally defined level of due care.

4. *Chemical Beneficiaries, but Not Groundwater Users, Can Take Care to Prevent Groundwater Contamination*

For some types of accidents, both injurers and victims can take care to decrease total accident costs. These are bilateral accidents.[197] In a bilateral accident the actions of injurers and victims are interdependent.[198] For other types of accidents, only injurers can take care to decrease total accident costs—victims can do nothing to decrease the risk or harm of accidents. These are unilateral accidents.[199] In a unilateral accident the actions of injurers do affect accident risks and harms but those of victims do not.[200]

Groundwater contamination clearly is a unilateral accident. Only chemical beneficiaries can do anything to prevent groundwater contamination; the groundwater user is helpless to do anything to keep his or her

193. *See supra* text accompanying notes 170-80.

194. SHAVELL, *supra* note 18, at 56. Although courts will not have to establish the socially optimal level of due care, individual chemical beneficiaries will have to decide what level of care is appropriate.

195. *See supra* text accompanying notes 170-76.

196. *See supra* text accompanying notes 177-80.

197. *See* SHAVELL, *supra* note 18, at 9.

198. *Id.* at 10.

199. *Id.* at 6.

200. *Id.*

water supply uncontaminated. Therefore, to achieve the socially optimal level of care to prevent groundwater contamination, the selected liability rule must create incentives for chemical beneficiaries to take care but need not create any incentives for contamination victims to change their behavior.

Under a negligence standard, however, victims have an incentive to take care because they will not receive compensation if the injurer exercised due care.[201] Therefore, with a negligence standard, victims bear residual liability for their injuries.[202] Thus, the residual liability that a negligence standard creates, and that induces care by potential victims, is not required in the case of groundwater contamination.

Strict liability is different. Victims will receive compensation regardless of the injurer's level of care.[203] Strict liability leaves no residual liability on victims, so victims have no incentive to take care.[204] Strict liability does, however, create clear incentives for injurers to take care to prevent accidents.[205] Since groundwater contamination is a unilateral accident,[206] strict liability can produce optimal results. Strict liability for groundwater contamination perfectly directs the incentives to take care to chemical beneficiaries—the only parties who *can* take care to prevent groundwater contamination.

The analysis to this point has assumed that the value of groundwater contamination damages can be accurately determined. The analysis also has assumed that the amount of liability imposed on chemical beneficiaries equals the actual amount of damages. The following section evaluates the problem of accurately assessing the actual amount of groundwater contamination damages and the implications of this problem on the choice of liability rules.

5. *Strict Liability Requires an Accurate Valuation of Groundwater Contamination Damages*

The ability of strict liability[207] to induce injurers to take socially optimal levels of care is critically dependent on correctly determining the actual amount of damages.[208] Only if damages are perfectly compensatory[209] will the injurer fully internalize the cost of accidents.[210] This is

201. *See id.* at 14.
202. *Id.*
203. *See supra* text accompanying notes 194-96.
204. SHAVELL, *supra* note 18, at 11.
205. *See supra* text accompanying notes 184-92.
206. *See supra* notes 197-200 and accompanying text. Strict liability will not produce an optimal result if applied to a bilateral accident. SHAVELL, *supra* note 18, at 11.
207. This section on damages assumes that strict liability is applied to a unilateral accident. This is the case for groundwater contamination. *See supra* text accompanying notes 197-206.
208. *See* COOTER & ULEN, *supra* note 146, at 362-63.
209. A damage award is perfectly compensatory when "the victim is indifferent between there being no accident and there being an accident with compensatory damages." *Id.* at 363.
210. *Id.*

true because the injurer decides the level of care to exercise based on expected liability costs.[211] If damages are not perfectly compensatory, the expected liability that the injurer considers will be either less or greater than the amount that must be internalized to induce socially optimal levels of care to prevent contamination.[212] Unless the injurer internalizes the exact amount of external costs, the result will not be socially optimal.[213]

In the case of groundwater contamination, calculating perfectly compensatory damages may be difficult. Courts have experience in calculating damages to property caused by groundwater contamination.[214] However, as to the harms to personal health caused by groundwater contamination,[215] calculating damage awards that will perfectly compensate contamination victims is a more difficult task. Although compensating victims for any actual medical treatment or monitoring expenses should be straightforward, perfectly compensating victims for more novel injuries, such as an increased risk of cancer or mental distress,[216] seems at best uncertain.

However, this potential problem can be avoided even if courts cannot accurately assess the level of damages in a particular case. Over numerous cases, courts may be able to make estimates of damages that are correct on average. If so, the result with strict liability will be socially optimal because injurers' expected liability still will equal expected actual damages.[217]

E. *Summary: Strict Liability Is the Appropriate Liability Rule for Groundwater Contamination*

The previous analysis compels several conclusions regarding the appropriate liability rule for groundwater contamination. A rule of no liability clearly is unacceptable because it creates absolutely no incentive for chemical beneficiaries to consider the external costs of groundwater contamination imposed on groundwater users. If no potential liability exists, chemical beneficiaries will manufacture, sell, and use more agricultural chemicals, and perhaps the wrong types of agricultural chemicals, than they otherwise would if they were responsible for the external costs of their decisions. The result is more groundwater contamination than is

211. *See supra* text accompanying notes 184-92.
212. *See generally* COOTER & ULEN, *supra* note 146, at 363.
213. *See supra* text accompanying notes 153-55.
214. *See, e.g.*, cases cited *supra* notes 92-94.
215. *See supra* text accompanying notes 65-71.
216. *See* Kevin A. Lavelle, Comment, *Groundwater Contamination: Removal of the Constraints Barring Recovery for Increased Risk and Fear of Future Diseases*, 1988 DET. C.L. REV. 65, 75-90 (discussing compensation for mental injuries and increased risk); *see also* Francis Edwards & Al Ringleb, *Exposure to Hazardous Substances and the Mental Distress Tort: Trends, Applications, and a Proposed Reform*, 11 COLUM. J. ENVTL. L. 119 (1986) (arguing for strict liability for mental injuries caused by exposure to hazardous substances).
217. SHAVELL, *supra* note 18, at 131.

socially optimal. A rule of no liability also is unacceptable because it leaves uncompensated the innocent victims of groundwater contamination.[218]

A negligence standard is highly unlikely to create incentives for optimal prevention of groundwater contamination. Courts are unlikely to be able to accurately establish the required level of due care at the socially optimal level.[219] Courts also are unlikely to be able to accurately measure the chemical beneficiaries' actual level of care.[220] Furthermore, with a negligence standard, some victims of groundwater contamination will go uncompensated either because contamination occurred despite the exercise of due care or because of problems of proving what level of care the injurer actually used. These results suggest that a negligence standard is not the appropriate liability rule for groundwater contamination.

Strict liability is the best liability rule both to induce chemical beneficiaries to fully internalize the external costs of groundwater contamination and to ensure that groundwater contamination victims are compensated. Strict liability avoids the problems that plague a negligence standard and eases the victim's problems of proof. The one hurdle to achieving optimal prevention with strict liability—accurately valuing groundwater contamination damages—arguably is surmountable, at least on an average basis.

IV. Applying Strict Liability to All Chemical Beneficiaries

This part briefly examines some of the issues that will be raised if jurisdictions attempt to implement the results of the economic analysis by imposing strict liability on all chemical beneficiaries.

A. Manufacturers, Retailers, and Farmers Can Act to Prevent Groundwater Contamination

1. Manufacturers' Options for Prevention

Manufacturers of agricultural chemicals[221] can take several actions to decrease the risk of agricultural chemical contamination of groundwater. The most obvious, and most drastic, option simply is to stop the manufacture and sale of agricultural chemicals with a high risk of leaching into groundwater. A less drastic option is for manufacturers to con-

218. A rule of no liability leaves groundwater contamination victims uncompensated by those who caused the groundwater contamination. *See supra* text accompanying notes 156-59. However, this does not preclude compensation by the government.

219. *See supra* text accompanying notes 170-76.

220. *See supra* text accompanying notes 177-80.

221. There are at least 29 manufacturers of agricultural chemicals. *See* Crop Protection Chemicals Reference (4th ed. 1988) (29 companies listed in table of contents including such well-known corporations as Chevron Chemical Company, The Dow Chemical Company, Monsanto Agricultural Company, and Uniroyal Chemical Company).

duct research and development activities to discover, produce, and market new chemicals with lower leachability potential than existing chemicals. Manufacturers voluntarily could place restrictions on the chemical label to restrict application rates in moderate leachability risk areas and to prohibit use entirely in high-risk areas. Manufacturers also could require farmers who purchase agricultural chemicals to have additional training in chemical alternatives, selection, and application.[222]

2. *Retailers' Options for Prevention*

Retailers of agricultural chemicals[223] potentially can take some actions to prevent agricultural chemical contamination of groundwater. One action that retailers currently are required to take, which arguably may reduce groundwater contamination, is to sell restricted-use pesticides only to certified applicators.[224] Retailers also have a role in disseminating to farmers information such as warnings about chemical hazards, recommendations on alternative chemical products, and usage data such as application rates and unsuitable soil types. Retailers who also provide application equipment can act to ensure that the equipment is calibrated to accurately apply the indicated rates. Retailers who provide application services[225] can act to ensure that applicator employees are properly trained and use care in application.

3. *Farmers' Options for Prevention*

Farmers, the purchasers and users of agricultural chemicals, can take several actions to help prevent agricultural chemical contamination of groundwater. Farmers can acquire information on the leachability of different chemicals. They can use this information to select low-leachability chemicals and to reduce application rates, where possible, to minimize the risk of groundwater contamination. Farmers can minimize the potential for nitrate contamination by limiting nitrogen fertilizer applications to the amounts called for by soil tests. Farmers may be able to substitute nonchemical production inputs, such as handweeding, mechanical cultivation, and legume cover crops, for chemical products. In addition, farmers may be able to change crops from those requiring high levels of chemicals, such as corn and soybeans, to those with low chemical input requirements, such as wheat and pasture.

The potential preventive actions of manufacturers, retailers, and

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222. *Cf.* 40 C.F.R. pt. 171 (1990) (EPA regulations regarding certification of pesticide applicators).

223. Retailers of agricultural chemicals typically include farm supply retailers such as farmer cooperatives, private agricultural supply businesses, and specialized fertilizer and pesticide dealers, all of whom frequently also provide application equipment or application services.

224. *See supra* note 83.

225. In a typical application service, the farmer buys the product and pays the retailer a per-acre application fee. The retailer then applies the pesticide or fertilizer to the farmer's fields using the retailer's equipment and labor.

farmers share the common fact that they will be costly. The key point, however, is that all three injurers can take action to prevent groundwater contamination. Therefore, to induce optimal levels of prevention, all three injurers—manufacturers, retailers, and farmers—must be subject to strict liability for agricultural chemical contamination of groundwater.

B. *Strict Liability and Multiple Injurers*

Unlike the case of a single injurer, where there are multiple injurers[226] strict liability may not induce optimal levels of prevention.[227] If the injurers act independently "there is no division of liability which will induce injurers to behave optimally . . . ."[228] On the other hand, "if injurers act in concert, . . . to minimize their joint expenses, they will all choose to exercise optimal care, regardless of the particular assignment of liability among them."[229] The latter situation is equivalent to the case of a single injurer under strict liability, where prevention will be optimal.[230]

Strict liability for groundwater contamination can induce all potential injurers—manufacturers, retailers, and farmers—to use optimal care because they are linked contractually in the marketplace for agricultural chemicals. Thus, if strict liability is imposed on one party, for example manufacturers, that party is likely to look to the other parties in the marketing chain to assume some share of the liability for groundwater contamination. This might be done through warranty or contractual assurances. Alternatively, holding manufacturers, retailers, and farmers jointly and severally liable immediately makes the damages of groundwater contamination a joint expense, thereby creating an incentive for all three parties to use optimal care. In a particular case, the party who paid damages to a groundwater contamination victim usually would have a right to contribution from the other liable parties based on each party's equitable share of the liability.[231]

C. *The Problem of Causation*

Even in a strict liability case, the contamination victim-plaintiff

226. Multiple injurers exist if "more than one injurer may contribute to the occurrence of an accident . . . ." SHAVELL, *supra* note 18, at 164. An example of multiple injurers is one in which the chemicals in smoke from two factories react and cause pollution damage. *Id.*

227. *See* SHAVELL, *supra* note 18, at 162-63.

228. *Id.* at 165. This assumes that each injurer is liable for a fraction of losses that does not depend on the level of care. *Id.* at 164.

229. *Id.* at 165.

230. *Id.*

231. *See* RESTATEMENT (SECOND) OF TORTS § 886A (1979). For example, assume that a groundwater contamination victim sues the manufacturer of the contaminating chemical, the one retailer of agricultural chemicals in the area, and all of the farmers in the area who have used the contaminating chemical. Assume further that the court holds all of the defendants jointly and severally liable, and the plaintiff collects the full amount of the judgment from the manufacturer. In this case, the manufacturer could seek contribution from the retailer and the farmers for their equitable shares of liability for the judgment.

faces a difficult task to prove causation. "[C]ausation problems . . . must be presumed to account in some degree for the enormous disparities between the millions of [groundwater contamination] victims reported in the macro-data . . . and the handful of successful plaintiffs disclosed by the micro-data of the case reports."[232]

To establish causation for physical injuries, increased risk of disease, or mental distress, the groundwater contamination victim must establish both medical causation and legal causation.[233] Proof of medical causation requires identifying the contaminant that caused the victim's injuries.[234] The ability of groundwater contamination victims to prove medical causation will improve in the future as better medical and epidemiological data on the health effects of consuming chemical-contaminated water become available.

Proof of legal causation requires identifying the defendants who are responsible for the victim's exposure to the contaminant.[235] The ability of groundwater contamination victims to establish legal causation against the one or few manufacturers of a particular contaminating chemical seems relatively clear. On the other hand, because there could be hundreds of farmers in a particular area who have used the contaminating chemical, the ability of a plaintiff to establish legal causation against individual farmers seems relatively slight.

V. CONCLUSION

Agricultural chemical contamination of groundwater is a serious and only recently recognized threat to human health.[236] Due to the nature of the groundwater resource, the appropriate liability rule must encourage prevention of contamination. Because groundwater users cannot take any action to prevent groundwater contamination, they are innocent

232. RODGERS, *supra* note 137, § 4.7, at 101 (1986); *see also* Comment, *supra* note 216, at 90-92 (difficulties of proving causation).

233. *Cf. Developments in the Law—Toxic Waste Litigation*, 99 HARV. L. REV. 1458, 1617-30 (1986) [hereinafter *Developments*].

234. *Id.* at 1617. Proof of medical causation in toxic substances cases often involves the use of epidemiological studies. *Id.* at 1618. *See generally* Junius C. McElveen, Jr. & Pamela S. Eddy, *Cancer and Toxic Substances: The Problem of Causation and the Use of Epidemiology*, 33 CLEV. ST. L. REV. 29 (1984-85). The relatively limited data on the health risks of consuming contaminated water, *see supra* text accompanying notes 65-71, suggests that establishing medical causation in a groundwater contamination case will be extremely difficult.

235. *Developments*, *supra* note 233, at 1624. If the contaminating chemical is manufactured by only one company, establishing legal causation against the manufacturer should be straightforward. If the chemical is made by more than one manufacturer, however, some sort of proportional liability will be appropriate. The more difficult problem is how to establish legal causation with respect to the one, or several, or perhaps even hundreds of farmers who have used the contaminating chemical in an area from which it could have contaminated the victim's water supply. Allowing plaintiffs access to the newly required records of chemical use by certified pesticide applicators, *see supra* note 84, would make the plaintiff's task somewhat more manageable. Absent special circumstances or access to these or similar records, it seems that it will be virtually impossible for groundwater contamination victims even to identify possible farmer-defendants, much less establish legal causation.

236. *See supra* text accompanying notes 65-71.

victims and should be compensated for their injuries. Based on an economic analysis, strict liability is the best liability rule to encourage all chemical beneficiaries—chemical manufacturers, retailers, and farmers—to take care to prevent groundwater contamination.[237]

This conclusion calls into question the statutory liability exemptions that some jurisdictions have enacted or considered.[238] Even with strict liability, the ability of groundwater contamination victims to recover is not assured, particularly due to the difficulties of proving causation, although proving causation against chemical manufacturers should be less difficult than against retailers or farmers.[239] The impact of imposing strict liability on all chemical beneficiaries will include higher agricultural chemical prices, elimination of certain high-risk chemicals from the market, substitution of nonchemical inputs for chemicals, and more warnings on chemical risks. All of these actions are costly. The social benefits of these actions, however, will be a decreased risk of agricultural chemical contamination of groundwater and a greater assurance that innocent victims of groundwater contamination will be compensated.

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237. *See supra* text accompanying notes 133-220.
238. *See supra* text accompanying notes 101-32.
239. *See supra* text accompanying notes 232-35.