

September 1996

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Recommended Citation

Earle A. Herbert, *The Regulation of Deep-Well Injection: A Changing Environment Beneath the Surface*, 14 Pace Env'tl. L. Rev. 169 (1996)

DOI: <https://doi.org/10.58948/0738-6206.1375>

Available at: <https://digitalcommons.pace.edu/pelr/vol14/iss1/16>

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ARTICLES

The Regulation of Deep-Well Injection: A Changing Environment Beneath the Surface

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I. Introduction

"America's journey to environmental awareness has been a relatively recent one. Not so many years ago, Americans were still living under the illusion that a land as vast as ours was blessed with indestructible natural resources and beauty."¹ The illusion could not last, and reality has set in. The economic and population growth of the nation and the improvements in the standard of living enjoyed by its citizens require increased industrial production. Technological pro-

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The author wishes to express his sincere appreciation for the guidance offered by Professor Jeffrey Miller, of Pace University School of Law, in the development of this article, and to Peggy Lantz of the University of Houston Law School for her assistance. The opinions expressed in this article are solely those of the author and do not necessarily reflect the views of the author's agency.

1. RUSSELL E. TRAIN, U.S. ENVIRONMENTAL PROTECTION AGENCY, LEGAL COMPILATION, USEPA-M-L52S, vol. 1 (Jan. 1974).

gress and improvements in methods of manufacturing, packaging, and marketing of consumer products result in an ever-increasing mass of waste, including hazardous waste.² Regardless of the waste disposal technology utilized, under the right conditions, waste or constituents of wastes, particularly liquid wastes, migrate.

Once hazardous waste enters a body of natural groundwater, it can move great distances, undetected and hidden from view. The ultimate destination of that contaminated water may be a well supplying drinking water.³ Since about half of all Americans, and up to 95 percent of those in rural areas, rely on groundwater as their main source of drinking water, there is great concern for the ever-increasing contamination of groundwater by improper hazardous waste disposal.⁴

Environmentalists are particularly concerned with the potential for contamination of drinking water supplies caused by the practice of deep-well injection of hazardous wastes.⁵ Industry is also concerned about this practice, but from a different perspective. For industry, deep-well injection is a precious, limited resource. There are only so many places in which hazardous wastes can be disposed of with confidence. Many people in industry believe properly managed deep-well

2. See generally Resource Conservation and Recovery Act of 1976 (RCRA), Pub. L. No. 94-580, 90 Stat. 2795 (codified as amended at 42 U.S.C. §§ 6901-6992 (1988 & Supp. IV 1992)).

3. See U.S. ENVIRONMENTAL PROTECTION AGENCY, OFFICE OF SOLID WASTE MANAGEMENT PROGRAMS, REPORT TO CONGRESS: WASTE DISPOSAL PRACTICES AND THEIR EFFECTS ON GROUND WATER, USEPA-M-W28, at 81 (Jan. 1977)[hereinafter WASTE DISPOSAL PRACTICES AND THEIR EFFECTS ON GROUND WATER].

4. See U.S. GENERAL ACCOUNTING OFFICE, HAZARDOUS WASTE: CONTROLS OVER INJECTION WELL DISPOSAL OPERATIONS, REPORT TO CHAIRMAN, ENVIRONMENT, ENERGY, AND NATURAL RESOURCES SUBCOMMITTEE, COMMITTEE ON GOVERNMENT OPERATIONS, HOUSE OF REPRESENTATIVES, GAO/RCED-87-170, at 8 (Aug. 1987) [hereinafter HAZARDOUS WASTE: CONTROLS OVER INJECTION WELL DISPOSAL OPERATIONS].

5. See *Resource Conservation and Recovery Act Reauthorization: Hearings Before the Subcomm. on Commerce, Transp., and Tourism before the House Comm. on Energy and Commerce*, 97th Cong., 2d Sess. 258 (Mar. 31 and Apr. 21, 1982)(statement of Jane Bloom, Natural Resources Defense Council (NRDC)).

injection can be a useful tool, offering benefits that far outweigh its inherent risks.⁶ With the ever-increasing mass of waste produced as a result of society's demand for consumer goods, deep-well injection is a mainstay method of hazardous waste disposal for which no true replacement technology currently exists. It has been estimated that deep-well injection of hazardous wastes disposes of up to 59 percent of the 290 million tons of hazardous wastes generated in the United States each year.⁷

Currently, an outright ban on all but the most harmful land disposal methods is not feasible because of technological and economic limitations.⁸ Moreover, treatment does not necessarily result in the destruction of waste matter. Rather, its conversion to less toxic forms or non-toxic forms still requires proper disposal.⁹ Further, many hazardous wastes are not easily handled or treated in a cost-effective manner.¹⁰ For these reasons, deep-well injection of hazardous wastes, along with other existing land-based disposal methods, will remain a necessary, although disfavored, method of disposal until new approaches to treating hazardous waste are available.

As early as 1970, before the United States Environmental Protection Agency (EPA) was created, the Commissioner of the Federal Water Quality Administration issued a statement of federal policy concerning deep-well injection.¹¹ The

6. See Stanley M. Greenfield, *EPA - The Environmental Watchman*, in UNDERGROUND WASTE MANAGEMENT AND ENVIRONMENTAL IMPLICATIONS 14 (T.D. Cook ed., American Association of Petroleum Geologists, Tulsa, Oklahoma 1972) [hereinafter Greenfield, *EPA - The Environmental Watchman*].

7. See HAZARDOUS WASTE: CONTROLS OVER INJECTION WELL DISPOSAL OPERATIONS, *supra* note 4, at 8.

8. See Conference, *Performance and Costs of Alternatives to Land Disposal of Hazardous Waste*, Transactions of an APCA Int'l. Conference 217 (E. T. Opelt ed., Dec. 1986).

9. See *id.*

10. See *id.* at 22.

11. See Greenfield, *EPA - The Environmental Watchman*, *supra* note 6, at 15. "[The] statement of federal policy concerning deep-well injection was issued by David Dominick, Commissioner of the Federal Water Quality Administration [in October 1970]." *Id.* at 14, 15. The EPA was established on December 2, 1970.

statement concluded with a ringing declaration that subsurface injection is a technique that is limited in space and time, to be used with great caution and "only until better methods of disposal are developed."¹² It is within this context that Congress and the EPA have regulated deep-well injection.

II. Technology, Risks and Costs of Deep-Well Injection

"Underground injection" is the "subsurface emplacement of fluids through a bored, drilled or driven well; or through a dug well, where the depth of the dug well is greater than the largest surface dimension."¹³ This general definition does not provide an in-depth explanation of the complex mix of technical and geologic factors to be considered in the debate over this method of hazardous waste disposal. Thus, it becomes necessary to understand the technical aspects, risks, and advantages of deep-well injection before discussing its regulation.

A. Growth of Deep-Well Injection

The injection of industrial and municipal waste into deep-wells has been practiced for almost fifty years.¹⁴ Injection-well development was particularly rapid during the mid-1960s and 1970s.¹⁵ Early EPA inventories indicated that the number of deep-injection wells was growing at a rate of twenty-three per year since 1964.¹⁶ By the early 1970s, it

12. *Id.* at 15.

13. 40 C.F.R. § 260.10 (1992). An "injection well" is simply defined as "a well into which fluids are injected." *Id.* See 40 C.F.R. § 122.3 (1981) for the definition of "Well Injection."

14. See U.S. ENVTL. PROTECTION AGENCY, COMPILATION OF INDUSTRIAL AND MUNICIPAL INJECTION WELLS IN THE U.S., vol. 1, at 1 (1974) [hereinafter COMPILATION OF INDUSTRIAL MUNICIPAL INJECTION WELLS IN THE U.S.].

15. See *id.* at 1, 8. "Prior to 1964, 67 deep waste injection-wells had been drilled" *Id.* With the rapid proliferation of deep-wells in the 1970s, federal, state and local governments became concerned as to the fate of hazardous wastes injected into the ground. See *id.*

16. See *id.* at 1. See also OFFICE OF TECHNOLOGY ASSESSMENT, TECHNOLOGIES AND MANAGEMENT STRATEGIES FOR HAZARDOUS WASTE CONTROL 191 (Mar. 1983) [hereinafter TECHNOLOGIES AND MANAGEMENT STRATEGIES FOR HAZARDOUS WASTE CONTROL]. As of 1985, of 533 Class I hazardous waste and industrial and municipal nonhazardous waste wells, only 181 were injecting

was estimated that there were a combination of 333 permitted industrial and municipal waste injection-wells in the United States, of which 278 were drilled and 178 were in operation.¹⁷

The overall annual growth rate of the number of injection-wells has gradually declined since the 1980s.¹⁸ Although many generators are currently trying to scale back their injection of hazardous wastes in favor of recycling and regeneration,¹⁹ the volume of injected waste is still growing.²⁰ The waste management industry has been hit hard by the current recession; however, it is predicted to rebound with the economy due to the increase in industrial waste volumes.²¹ Some industry analysts predict a short-term growth in the hazard-

hazardous waste. HAZARDOUS WASTE: CONTROLS OVER INJECTION WELL DISPOSAL OPERATIONS, *supra* note 4, at 13. By far the most common well type are Class II wells used for oil and gas production. *See id.* By 1985, there were an estimated 153,126 active Class II wells in operation. *See id.* For a detailed description of well classification under the Underground Injection Control program, see *infra* note 43.

17. *See* COMPILATION OF INDUSTRIAL MUNICIPAL INJECTION WELLS IN THE U.S., *supra* note 14, at 1.

18. *See* U.S. ENVIRONMENTAL PROTECTION AGENCY, OFFICE OF DRINKING WATER, REPORT TO CONGRESS: INJECTION OF HAZARDOUS WASTE, USEPA 570/9-85-003 at II-10 (May 1985) [hereinafter REPORT TO CONGRESS: INJECTION OF HAZARDOUS WASTE]. The largest yearly increases in injection-well population was from 1973-1975, possibly as a result of the implementation of the Federal Water Pollution Control Act Amendments of 1972. *See id.* *See also* Federal Water Pollution Control Act Amendments of 1972, Pub. L. No. 92-500, § 2, 86 Stat. 816 (codified as amended at 33 U.S.C. §§ 1251-1387 (1988 & Supp. V 1993)).

19. *See* Ronald Begley, *TRI Releases Down Sixth Year In A Row*, Chemical Week, Technology Newsletter 7, Apr. 20, 1994, available in Lexis, Environment Library, ALLNEWS file. Concerns of environmental activists and people living in the vicinity of plants, along with high Toxic Release Inventory (TRI) numbers associated with deep-well injection, are prompting many companies to stop injection in favor of recovery and regeneration. For example, Monsanto and DuPont plan to eliminate hazardous waste injection by the year 2000. *See* Elisabeth Kirschner, *An Anxious Industry Sees New Limits To Its Options*, Chemical Week, Aug. 18, 1993, at 23.

20. *See* Ronald Begley, *TRI Releases Down Sixth Year In A Row*, *supra* note 19, at 7. Although the chemical industry claims that TRI chemical discharges were reduced by up to 40% from 1987 and 4% from 1991, it noted that deep-well injection increased 1%. *See id.*

21. *See* Rick Mullin, *New Direction On Hazwaste*, Chemical Week, Jan. 20, 1993, at 26.

ous waste management market, with deep-well injection gradually expanding anywhere from 5 to 10 percent by the year 2000.²²

B. Well Design

There is no standard injection-well design. However, all such wells have similar features.²³ The typical injection-well is constructed with three concentric casings: (1) the exterior surface casing, (2) the intermediate protective casing, and (3) the innermost casing.²⁴ The exterior surface casing is designed to protect freshwater in the aquifers through which the well passes and to prevent corrosion.²⁵ It extends from the surface to below the base of the deepest potable water aquifer, and is cemented along its full length.²⁶ The intermediate protective or "long string" casing extends from the surface through the top of the injection zone and is cemented along its full length.²⁷ The innermost casing is the injection tubing in which the waste is actually transported.²⁸ This casing extends from the top of the well into the top of the injection zone.²⁹

Waste is injected through the injection tubing and exits through perforations at the bottom of the tubing. The injection tubing is sealed off from the intermediate casing, creating a space called the annulus that is filled with pressurized fluid containing corrosion inhibitors.³⁰ The annulus is closed off at the bottom end by a packer, a device that keeps injected

22. See *id.* Industry sources also predict solid growth for incineration (20%-25%), landfill (15%-20%) and "aqueous treatment, solvent and oil recovery and other applications." *Id.* However, under current regulatory mandates such as RCRA, it is predicted that there will be a shift away from land disposal toward alternatives such as treatment and recycling. See *id.*

23. See TECHNOLOGIES AND MANAGEMENT STRATEGIES FOR HAZARDOUS WASTE CONTROL, *supra* note 16, at 190 fig. 13.

24. See *id.* at 190.

25. See *id.*

26. See *id.*

27. See *id.*

28. See TECHNOLOGIES AND MANAGEMENT STRATEGIES FOR HAZARDOUS WASTE CONTROL, *supra* note 16, at 190.

29. See *id.*

30. See *id.*

fluids from entering the annular space.³¹ Since the pressure of the fluid in the annulus is known and can be controlled, the integrity of the well can be monitored.³² If annular pressure is maintained higher than injection pressure, a drop in well annulus fluid indicates a leak in either the injection tubing or in the outer casing.³³ When a drop in pressure occurs, injection should cease until the leak is located and the well repaired.³⁴ After injection operations permanently cease, the well must be properly plugged to prevent migration of injected wastes from the injection zone.³⁵ The maintenance of pressure prevents the mixture of fluids from different geologic strata and the flow of liquids from the injection zone to the surface.³⁶ To control and monitor injection and annular pressure, the surface portion or wellhead contains various valves and gauges.³⁷

Notwithstanding that there is no standard injection-well design, EPA regulations for deep-well injection do set forth general construction criteria and standards to be considered in the permitting of a specific injection-well. For example, general factors for the construction and completion of existing and new Class I hazardous waste injection-wells include design features that: "(1) [p]revent the movement of fluids into or between USDW's [Underground Sources of Drinking Water] or into unauthorized zones; (2) [p]ermit the use of appropriate testing devices and workover tools; and (3) [p]ermit continuous monitoring of injection tubing and long-string casing"³⁸

Additionally, "all well materials must be compatible with fluids with which the materials may be expected to come into

31. See *id.* at fig. 13.

32. See *id.* at 190.

33. See TECHNOLOGIES AND MANAGEMENT STRATEGIES FOR HAZARDOUS WASTE CONTROL, *supra* note 16, at 190.

34. See *id.*

35. See *id.*

36. See *id.*

37. See HAZARDOUS WASTE: CONTROLS OVER INJECTION WELL DISPOSAL OPERATIONS, *supra* note 4, at 9.

38. 40 C.F.R. § 146.65 (1993).

contact.”³⁹ The casing and cement used in new wells must be designed for the well’s life expectancy.⁴⁰ Moreover, the EPA Administrator also considers information such as depth of the injection zone, injection pressure, hole size, cement, chemicals to be injected, size and grade of casing, and alternative design factors.⁴¹

Injection-well design requirements are also dictated by site-specific considerations, such as the compatibility of the chemicals to be injected with the mineral characteristics of the injection zone and confining formations.⁴² EPA regulations set out minimum criteria for the siting of each of five classes of injection-wells. However, only those wells listed as Class I injection-wells may inject hazardous waste.⁴³ Thus,

39. *Id.*

40. *See id.*

41. *See id.* §§ 146.12, 146.65 (1993). For definitions of the five classes of well under the Underground Injection Control program, see 40 C.F.R. § 144.6.

42. *See* TECHNOLOGIES AND MANAGEMENT STRATEGIES FOR HAZARDOUS WASTE CONTROL, *supra* note 16, at 190. “Characteristics of a liquid that limit the applicability of injection well disposal are: high suspended solids content, high viscosity, and chemical incompatibility with [either] the [geologic] formation or the formation fluids.” *Id.* “Chemical pretreatment of the waste can sometimes make them more compatible with [the] injection zone [.]” *Id.* For example, highly acidic or alkaline wastes may be neutralized to make them more suitable to a specific injection zone. *See id.* *See also* WARNER & LEHR, *infra* note 55, at 159-177.

43. *See* 40 C.F.R. § 146.5 (1993). Class I wells are those “used by generators of hazardous waste or owners or operators of hazardous waste management facilities to inject hazardous waste beneath the lowermost formation containing, within one quarter (1/4) mile of the well bore, an underground source of drinking water.” *Id.* § 146.5(a). Class II wells inject fluids “[w]hich are brought to the surface in connection with conventional oil or natural gas production . . .” *Id.* § 146.5(b). Class III wells “inject for extraction of minerals . . .” *Id.* § 146.5(c). Class IV wells are “used by generators of hazardous waste or of radioactive waste . . .” to inject hazardous wastes into or above an underground source of drinking water. *Id.* § 146.5(d). Class V wells are those not included in the other classes, and include cesspools, septic system wells, spent brine injection wells and some radioactive waste wells. *See id.* § 146.5(e). Currently, a well that receives hazardous waste (as defined under RCRA) is classified as either a Class I or Class IV well. As Class IV wells were banned under the 1984 Amendments, only Class I wells may presently inject hazardous waste. *See* 42 U.S.C. § 6939b(a) (1988 & Supp. IV 1992).

the regulations serve to limit such wells to "areas that are geographically suitable."⁴⁴

C. Geologic and Site Considerations

In the United States, deep-injection wells range in depth from 300 to 12,000 feet, and have been used for waste disposal into a wide variety of subsurface geologic formations.⁴⁵ Typically, most injection-wells are found in areas with long histories of oil and gas exploration, since the subsurface formations in these areas are usually suited for waste disposal zones and the geologic characteristics are thoroughly documented.⁴⁶ "[I]ndustrial injection wells proliferate in major petroleum producing states such as Kansas, Louisiana, Michigan, Oklahoma, and Texas."⁴⁷ Unfortunately, unplugged abandoned oil and gas wells intercepting the injection zone can provide a conduit for the migration of injected waste fluids, resulting in pollution of ground and even surface waters.⁴⁸ Since the location of all such abandoned wells are un-

44. 40 C.F.R. § 146.62 (1993). While all permitting criteria and standards for all classes of injection-wells under the UIC require consideration of the lithology of the injection zone, the geologic suitability of a Class I hazardous waste injection-well will be determined by the Director upon:

- (1) An analysis of the structural and stratigraphic geology, the hydrogeology and the seismicity of the region;
- (2) [D]etailed information regarding stratigraphy, structure and rock properties, aquifer hydrodynamics and mineral resources; and
- (3) A determination that the geology of the area can be described confidently and that the limits of waste fate and transport can be accurately predicted through the use of models.

Id.

45. See NELSON L. NEMEROW, *LIQUID WASTE OF INDUSTRY: THEORIES, PRACTICES, AND TREATMENT* 124 (Addison-Wesley Publishing Co., London 1971). Many deep geologic formations used for disposal of hazardous wastes consist of unconsolidated sands and sandstones. See *id.* Injection zones also may consist of fractured gneiss, limestone and other carbonate rocks. See *id.*

46. See TECHNOLOGIES AND MANAGEMENT STRATEGIES FOR HAZARDOUS WASTE CONTROL, *supra* note 16, at 191.

47. WASTE DISPOSAL PRACTICES AND THEIR EFFECTS ON GROUND WATER, *supra* note 3, at 379.

48. See *id.* For example, the development and abandonment of the Lima-Indiana oil field has eliminated the Trenton limestone formation for deep-well injection. See *id.* "In the late 1800's and early 1900s, nearly 75,000 wells were drilled in [the area and many of the locations are presently unknown.]" *Id.*

known, the best security measure is not to install injection wells in areas of extensive oil exploration. Unfortunately, these are the same areas best suited to injection, and therefore, this caution has not been followed.⁴⁹ Underground injection uses porous rock strata, which is commonly found in oil producing states, to hold liquid waste.⁵⁰ The porous rock formations naturally contain both gases and liquids under pressure caused by overlying strata.⁵¹ Such pressures can vary significantly, depending on the rock formation.⁵²

Underground injection entails drilling a well to the depth needed to intersect a suitable geologic formation known as an injection zone.⁵³ This formation must be carefully selected using the following criteria:

- (1) The formation should not contain a valuable resource, such as a source of drinking water or hydrocarbons;
- (2) The injection formation must have sufficient porosity and size to accept the volume of liquids that is anticipated;
- (3) The formation should be sealed both above and below by containment formations strong enough to prevent migration of waste from the disposal zone; and
- (4) The disposal zone should be in a location with little seismic activity, in order to minimize the risk of earth-

49. See U.S. ENVIRONMENTAL PROTECTION AGENCY, OFFICE OF RESEARCH AND DEVELOPMENT, *ASSESSING THE GEOCHEMICAL FATE OF DEEP-WELL-INJECTED HAZARDOUS WASTE: SUMMARIES OF RECENT RESEARCH*, EPA 625/ 6-81025b, at 68 (July 1990) [hereinafter *GEOCHEMICAL FATE OF DEEP-WELL-INJECTED HAZARDOUS WASTE*]. Approximately two-thirds of deep-injection wells are located in Texas and Louisiana. See *id.* These wells receive 90% of injected wastes. See *id.* The injection zones of these Class I wells are normally in deep sedimentary basins composed of sand and sandstone aquifers, confined by clay and shale strata that may range from tens to hundreds of feet thick. See *id.*

50. See *TECHNOLOGIES AND MANAGEMENT STRATEGIES FOR HAZARDOUS WASTE CONTROL*, *supra* note 16, at 189.

51. See *id.*

52. See *id.*

53. See 40 C.F.R. § 146.3 (1993). "Injection zone means a geological 'formation', group of formations, or part of a formation receiving fluids through a well." *Id.*

quake damage to the well and the risk of triggering seismic events.⁵⁴

Once an injection-well is drilled into the formation, liquid waste is pumped into the formation with sufficient pressure, displacing the natural fluids or gases. Caution must be exercised so as to not: (1) fracture the integrity of the containment formation through the introduction of too much pressure, or (2) cause leakage into the surrounding aquifer through poor design or planning.⁵⁵

D. Types of Injection Wastes

A large variety of waste liquids are injected into deep-wells, including chemicals, petrochemicals, pharmaceutical products, hydrocarbon refining by-products, metal manufacturing wastes, and municipal sewage.⁵⁶ Chemical and pharmaceutical plants are the largest users of waste injection-wells, with combined petroleum refining and sanitary second,

54. See TECHNOLOGIES AND MANAGEMENT STRATEGIES FOR HAZARDOUS WASTE CONTROL, *supra* note 16, at 189.

55. See *id.* See also DON L. WARNER AND JAY H. LEHR, SUBSURFACE WASTE-WATER INJECTION 124-127, (Premier Press 1981). Injection wells can result in ground-water contamination through the following mechanisms:

1. Direct emplacement into potable [drinkable] water zones
2. Escape into potable aquifer through well-bore failure
3. Upward migration [of waste] from receiving zone along outside of [well] casing
4. Leakage from inadequate confining beds
5. Leakage through confining beds due to unplanned hydraulic fracturing
6. Leakage through deep abandoned wells
7. Displacement of saline water into potable aquifer
8. Injection into salaquifer [saltwater containing aquifer] eventually classified as a potable water source
9. Migration into a potable water zone of the same aquifer

WASTE DISPOSAL PRACTICES AND THEIR EFFECTS ON GROUND WATER, *supra* note 3, at 366.

56. See TECHNOLOGIES AND MANAGEMENT STRATEGIES FOR HAZARDOUS WASTE CONTROL, *supra* note 16, at 190-191. Examples of wastes that have been disposed of by deep-well injection are: acid and alkaline solutions, metal containing solutions, inorganic chemicals, hydrocarbons, solvents, and organic solutions. See *id.*

followed by gas extraction and primary metal plants, respectively.⁵⁷

Depending on the type of waste injected, wastes can chemically, physically, and biologically degrade and pollute potable water sources. Chemical degradation is an important concern, due to the fact that there is little known about the chemical reactions of injectants once they are underground.⁵⁸ For example, many chemical reactions, which do not regularly occur at room temperature and atmospheric pressure, occur under the pressure and heat in the subsurface.⁵⁹ Moreover, "[i]njectants often contain biological contaminants which are health hazards, sometimes greater than those of the chemical constituents in the fluid."⁶⁰ Primary treated and secondary treated raw sewage often put into injection-wells are highly active biologically.⁶¹ "Bacteria and viruses from human and animal wastes are assumed to be removed naturally after injection into a porous medium with an anaerobic environment."⁶² However, it is now known that bacteria in such subsurface environments may survive and travel hundreds of feet, but "little [remains] known about the [underground] movement of viruses."⁶³

57. See *id.* at 191 (citing WARNER & LEHR, SUBSURFACE WASTEWATER INJECTION, *supra* note 55, at 5). Industries using injection wells for waste disposal include: chemical and allied products (49%); petroleum refining (20%); sanitary services (9%); oil and gas extraction (6%); primary metals (6%); all others (10%). See *id.*

58. See WASTE DISPOSAL PRACTICES AND THEIR EFFECTS ON GROUND WATER, *supra* note 3, at 367.

59. See *id.*

60. *Id.* at 369.

61. See *id.*

62. *Id.*

63. See WASTE DISPOSAL PRACTICES AND THEIR EFFECTS ON GROUND WATER, *supra* note 3, at 369. For example, "there [were] an estimated 3,000 [unregulated domestic] waste disposal wells in Oregon" and some 5,000 disposal wells in the Snake River Plain injecting sewage effluent and industrial wastes into lava and interbedded sediments. *Id.* Bacterial contamination of domestic wells by waste water discharged into the Snake River Plain through irrigation drain wells in the area south of Idaho Falls has been documented. See *id.* Such incidents help serve to confirm the ability of bacteria to thrive and migrate in subsurface environments previously considered immune from such contamination. See *id.* at 374.

There is such a wide variety of wastes injected by deep-well techniques that it is impossible to give a complete characterization of each one. Most waste stream compositions are relatively dilute.⁶⁴ However, even in a diluted state, waste streams can be extremely diverse, containing either organic constituents or a variety of toxic heavy metals, and can be either exceedingly acidic or alkaline.⁶⁵

E. Risks of Deep-Well Injection

With such a wide variety of wastes injected into subsurface environments, there is a broad spectrum of risks to human health and the environment. Operations are generally monitored to make sure that the proper level of effluent is going into the well safely. However, the monitoring of injection-wells has historically been grossly inadequate. For many types of injection, such as drainage wells and sewage effluent wells, no monitoring has occurred. Even for industrial and radioactive waste injection, monitoring is limited.⁶⁶

64. See GEOCHEMICAL FATE OF DEEP-WELL-INJECTED HAZARDOUS WASTE, *supra* note 49, at 68. Most waste stream compositions are greater than 90% water by weight. *See id.*

65. *See id.* On occasion, an injection zone is composed of limestone, which, provided precautions are taken, is a beneficial choice for the injection and neutralization of acid wastes. *See id.* Limestone and dolomite aquifers are composed of carbonate minerals and act as cementing agents in sandstone. *See* INDUSTRIAL WASTE DISPOSAL 252 (R.D. Ross ed., 1968). Such carbonates are soluble in acids resulting in beneficial neutralization, however, precautions must be taken to assure that no undesirable precipitates result and that the "generation of carbon dioxide gas does not cause excessive pressure buildup or plugging of the injection horizon." *Id.*

66. EPA regulations currently set forth minimum testing and monitoring requirements under the Underground Injection Control program. *See* 40 C.F.R. § 146.68(a). The regulations require site-specific, ambient monitoring. *See id.* § 146.68(e). "Based on a site-specific assessment of the potential for fluid movement from the well or injection zone, and on the potential value of the monitoring wells to detect such movement, the Director shall require the owner or operator to develop a monitoring program. . . ." *Id.* § 146.68(a). The Director also may require continuous monitoring for pressure changes in the first aquifer overlying the confining zone; the use of indirect, geophysical techniques to determine the position of the waste front; periodic ground water quality and seismic monitoring. *See id.* With the high cost of drilling monitoring wells, there are only a few hazardous waste injection facilities at which deep aquifers are monitored. *See* REPORT TO CONGRESS: INJECTION OF HAZARDOUS WASTE, *supra* note 18, at 8. Such monitoring wells are undesirable because they can

"Only infrequently is [there] monitoring of the injection zone or shallower zones."⁶⁷

Although the injection of hazardous industrial wastes into deep geologic formations has been considered advantageous in the past, there is admittedly little knowledge as to how the wastes interact with the subsurface formation.⁶⁸ "The full extent to which injected hazardous waste has contaminated underground sources of drinking water is unknown."⁶⁹ While there are very few documented cases of contaminated drinking water in the United States,⁷⁰ experience has shown that there are inherent risks in poorly conceived deep-well projects. For example, in 1975, both an injection-well owned by Tenneco Oil Company in Chalmette, Louisiana and an injection-well owned by Velsicol Chemical Corporation in Beaumont, Texas contaminated drinking water aquifers.⁷¹ Both of these injection-wells were "con-

become another possible pathway for upward migration and are difficult to site. *See id.* At most of the facilities, monitoring is only done on surface aquifers that can be affected by surface facilities associated with the injection wells. *See id.*

67. WASTE DISPOSAL PRACTICES AND THEIR EFFECTS ON GROUND WATER, *supra* note 3, at 379.

68. *See generally* GEOCHEMICAL FATE OF DEEP-WELL-INJECTED HAZARDOUS WASTE, *supra* note 49. As of 1990, there had been a ten-year hiatus in the study of deep-well injected waste. *See id.* at 1. "The last period of active research on the subject took place from the late 1960s to the late 1970s." *Id.* Still, "very little research addresses the geochemical fate of deep-well-injected hazardous wastes, particularly in the context of the current federal and state regulatory environment." *Id.* Further, "most . . . literature is based on laboratory studies and/or field studies that do not [effectively] simulate deep-well environment[s]." *Id.* at 1.

69. HAZARDOUS WASTE: CONTROLS OVER INJECTION WELL DISPOSAL OPERATIONS, *supra* note 4, at 19. As of 1987 "there [had] been only two documented cases of contaminated drinking water, one additional case of suspected [drinking water] contamination, and eight cases of nondrinking-water contamination." *Id.* However, all of these documented cases have "involved well malfunctions that [resulted] in contamination around the well-bore, where it is . . . easy to detect." *Id.* There have been no documented "cases of groundwater contamination resulting from underground channels - as opposed to malfunctioning wells -, . . . but such contamination would be far more difficult to detect if it did not produce effects on the surface." *Id.* Moreover, "a reliable method for sampling and testing [large] underground areas for contaminants has not been [devised]." *Id.*

70. *See id.*

71. *See id.* at 20.

structed without packers and tubing, with injection occurring directly through the casing," resulting in leakage of contaminants.⁷²

Despite current Underground Injection Control (UIC) program regulations which require double casing and cementing that would have prevented the Louisiana and Texas mishaps, some risks of deep-well injection of hazardous waste remain ever-present. Contamination of potable water supplies may occur, either by (1) lateral migration of acid wastes to existing unplugged dry holes or producing wells, or (2) by vertical migration through the subsurface aquifer due to mechanical failure or geologic fault line shifting.⁷³ Perhaps the most dramatic risk of geologic faulting associated with deep-well injection of liquid wastes is the potential for the stimulation of earthquakes in certain seismic areas.⁷⁴

F. Costs

Industrial wastes are difficult to treat to an acceptable level of purity for surface discharge. The complexity of surface treatment processes makes industrial wastes difficult to handle. Considerable capital investment, combined with high operating and chemical costs, has resulted in a search for cheaper disposal methods.⁷⁵ This search has been hampered by the lack of consistent information available about

72. *Id.* at 21. As a result of the Tenneco mishap in Louisiana, a groundwater recovery system was installed. *See id.* Between 1982 and 1986 approximately 250,000 barrels of contaminated water were removed from the aquifer. *See id.* The leaking Velsicol well in Texas was plugged and a monitoring well pumped for 90 days to remove the contaminants from the aquifer. *See id.*

73. *See* NEMEROW, *supra* note 45, at 128. *See also* 40 C.F.R. Part 146, Underground Injection Control program: Criteria And Standards.

74. *See* Greenfield, *EPA - The Environmental Watchman*, *supra* note 6, at 16. The injection of liquid wastes 2 miles below the Rocky Mountain Arsenal, near Denver, Colorado, has been blamed for earthquakes dating back to 1962. *See id.* It has been suggested that there is the possibility that hazardous wastes that triggered the Denver earthquakes could migrate hundreds of miles eastward to groundwater sources in Nebraska. *See id.* at 17.

75. *See* Erle C. Donaldson, *Injection Wells and Operations Today*, in UNDERGROUND WASTE MANAGEMENT AND ENVIRONMENTAL IMPLICATIONS 44 (T.D. Cook ed., American Association of Petroleum Geologists, Tulsa, Oklahoma 1972) [hereinafter Donaldson, *Injection Wells and Operations Today*].

the costs necessary to achieve an acceptable level of waste control.⁷⁶ This is due to a variety of factors, including:

- 1) lack of consensus about what constitutes comparable levels of control across technology alternatives, 2) the regulatory uncertainties of the evolving Federal program, 3) cost information that is generally specific to an application of a particular technology to a particular waste, and 4) the dynamic nature of costs as industry gains experience in responding to the regulatory requirements.⁷⁷

The costs of deep-well injection of hazardous wastes are consistently influenced by the above factors, making accurate long-range cost estimation difficult. Periodically, various deep-well construction and operating cost estimates have been attempted based on experience with oil and gas wells, brine injection-wells and with the limited data available concerning industrial waste injection-wells.⁷⁸

"The capital cost of some waste-injection systems may exceed the cost of surface treatment facilities."⁷⁹ Thus, the economic margin is closed by the wide difference in operating costs of the two systems because waste-injection systems require less intensive supervision.⁸⁰ The operating costs of injection-wells have shown a savings of \$80,000 to \$500,000 per annum over other treatment methods.⁸¹ Fixed costs for well construction such as drilling, testing and completion, pumping equipment, and pre-injection waste treatment facilities account for 50 to 80 percent of the total cost of an injection unit.⁸² The fixed cost of an injection-well can vary greatly with the need for preinjection treatment facilities and with

76. See TECHNOLOGIES AND MANAGEMENT STRATEGIES FOR HAZARDOUS WASTE CONTROL, *supra* note 16, at 195.

77. *Id.*

78. See R.D. ROSS, INDUSTRIAL WASTE DISPOSAL, *supra* note 65, at 252.

79. Donaldson, *Injection Wells and Operations Today*, *supra* note 75, at 44.

80. *See id.*

81. *See id.*

82. *See id.*

the mineralogical composition and depth of the injection zone.⁸³

The major factor in the cost of an injection-well is its depth.⁸⁴ Engineering principles dictate that "for safety no industrial disposal well be completed in a subsurface formation less than 3,000 feet deep."⁸⁵ The depth factor imposes an immediate capital cost of \$50,000, which is then added to any special drilling needs for a specific type of geologic formation and the costs of specialized design and alloys to match the corrosion properties of the injectant.⁸⁶

While it is currently impossible to predict the future costs of deep-well injection, studies of costs for all forms of treatment and disposal methods point to two major trends that will affect the economic desirability of deep-well injection:

1. the post-closure, liability, and corrective action requirements will have a greater effect on land-based disposal options relative to treatment or incineration, and
2. the costs for any treatment option is affected by the waste type. Costs are most sensitive to waste characteristics for chemical and thermal destruction and less sensitive for landfills.⁸⁷

Many industries are attempting to cut back their use of deep-well injection practices involving high concentration/low volume wastes due to the cost advantages of recycling, regen-

83. See *id.* "The principle factors that determine the cost of preinjection treatment are 1) the pH of the waste, 2) the tendency of the waste to form precipitates at some pH ranges, 3) the size and amount of suspended solids, 4) the corrosiveness of the waste, and 5) the physical and chemical characteristics of the disposal formation." *Id.*

84. See Donaldson, *Injection Wells and Operations Today*, *supra* note 75, at 45.

85. *Id.*

86. See *id.* The average cost of drilling and completing an injection well in the United States has been estimated to be over \$17.50 per foot of depth. See *id.* at 44. "Actual figures range from a low of \$4.26 in Nebraska to \$28.99 in California." *Id.*

87. TECHNOLOGIES AND MANAGEMENT STRATEGIES FOR HAZARDOUS WASTE CONTROL, *supra* note 16, at 195.

eration, and destruction techniques.⁸⁸ Further cut backs of traditional disposal techniques seem inevitable, as new methods of handling high concentration hazardous waste develop and become cost-effective for a broader spectrum of the most toxic wastes.⁸⁹ For the foreseeable future, however, deep-well injection will continue to be the most cost-effective disposal method for the ever-increasing amount of low concentration/high volume wastes.⁹⁰

III. History of Federal Regulation of Deep-Well Injection

Congress has addressed many aspects of hazardous waste disposal in a piecemeal fashion in the Clean Water Act, the Clean Air Act, other statutes and policy statements.⁹¹

88. See Ronald Begley, *TRI Releases Down Sixth Year In A Row*, *supra* note 19, at 7. Chemical manufacturers reported that in 1992 total chemical by-product volumes had fallen by almost 40% over a 5 year period and 54% of all chemical by-products were recycled. See *id.* Cost savings from waste reduction efforts by some corporations have been substantial. For example, "AlliedSignal saved \$500,000 in hazardous waste disposal costs by installing a \$265,000 chromium recovery unit at its Baton Rouge, [Louisiana] plant." *Id.*

89. See *Performance And Costs Of Alternatives To Land Disposal Of Hazardous Waste*, (APCA/International Specialty Conference, New Orleans, La.), Dec. 1986, at 137. Many innovative approaches to treating the most toxic forms of hazardous waste are either under development or in commercial use, and may result in a decreasing dependence on techniques such as deep-well injection. See *id.* Some of these new techniques are molten glass, which at high heat permanently encases waste for safe storage; plasma arc, infrared, electric reactor and circulating bed combustion techniques, which may be used to incinerate materials; crystallization technology, where the waste stream is frozen to effect material separation; and deep shaft oxidation, which is used to oxidize organics. See *id.* at 138.

90. See Ronald Begley, *TRI Releases Down Sixth Year In A Row*, *supra* note 19, at 7 (noting 1% increased injection rate). See also, Rick Mullin, *New Direction On Hazwaste*, *supra* note 21 (noting increased industrial waste volumes and 5% to 10% injection growth). See generally *Generators Told: Get Rid Of Wastes Now, Before Third-Third Rules Go Into Effect*, *Environmental Reporter* (BNA) Vol. 21, No. 8, at 367 (June 22, 1990) ("deep-well injection is best option for hazardous waste generators [facing] compliance with waste treatment rules under [RCRA].").

91. See generally *The Federal Water Pollution Control (Clean Water) Act Amendments of 1972*, Pub. L. No. 92-500, 86 Stat. 816 (codified as amended at 33 U.S.C. §§ 1251-1387 (1988)); *Clean Air Amendments of 1970*, Pub. L. No. 91-604, 84 Stat. 1676 (codified as amended at 42 U.S.C. §§ 7401-7671 (1988)), amended by Act of Nov. 15, 1990, Pub. L. No. 101-549 (1990).

For example, in an early response to a growing recognition of the degradation of the subsurface environment through the practice of deep-well injection, the Federal Water Quality Administration (FWQA) established a policy, in October 1970, regarding the disposal of wastes by deep-well injection.⁹² The policy "opposed the disposal or storage of wastes by subsurface injection without strict controls and a clear demonstration that such [injected] wastes will not interfere with present or potential use of subsurface water supplies, contaminate interconnected surface waters or otherwise damage the environment."⁹³ The policy broadly provided for the critical evaluation by the FWQA of all proposals for subsurface injection of wastes in order to determine that:

- (1) Alternative measures have been explored . . . ;
- (2) Appropriate preinjection tests have been made to allow prediction of the fate of wastes to be injected;
- (3) [It has been] . . . demonstrate[d] that such injection will not interfere with present or potential use of water resources nor result in other environmental hazards;
- (4) [The] [b]est practical measures for pretreatment of wastes have been applied;
- (5) The subsurface injection system has been designed and constructed using the best available techniques . . . ;
- (6) Provisions for adequate and continuous monitoring . . . have been made; and
- (7) Appropriate provision[s] will be made for plugging such [injection] wells . . . when their use for disposal is discontinued.⁹⁴

Finally, the FWQA declared that subsurface injection of wastes should be recognized as merely a temporary means of ultimate disposal to be discontinued when alternatives providing for greater environmental protection become available.⁹⁵

92. See FEDERAL WATER QUALITY ADMINISTRATION: POLICY ON DISPOSAL OF WASTES BY SUBSURFACE INJECTION, COM 5040.10 (Oct. 15, 1970).

93. *Id.*

94. *Id.*

95. See *id.*

Noting the FWQA policy, a 1972 technical studies report by the EPA stated that "[m]any of the problems of deep well injection could be eliminated or avoided if it were possible to monitor the fate of wastes that have been injected."⁹⁶ Further, the EPA report found that other major problems needed to be solved to ensure the adequate control of deep-well injection, including "identifying and classifying areas for safe injection, determining what volumes of waste can be safely injected and establishing chemical standards for wastes to minimize the dangers of incompatibility with the minerals and fluids of the injection [zone]."⁹⁷ Finally, the EPA report called for the control of deep-well disposal of wastes through a system of laws and regulations requiring the issuance of permits based upon information received about the injection site and the types of waste to be injected.⁹⁸

96. SUBSURFACE POLLUTION PROBLEMS IN THE UNITED STATES, Technical Studies Report: U.S. EPA Office of Water Programs TS-00-72-02, at 8-9 (May 1972). The EPA report notes the problems associated with monitoring are substantial: What is to be monitored, in what manner, and for how long? *See id.* The pressures and flows in the injection-wells must be known, along with monitoring done at some distance from the well in order to supply sufficient information to halt contamination of fresh water supplies. *See id.* For monitoring requirements for Class I wells under the UIC, see 40 C.F.R. § 146.13(b)(1988).

The primary well monitoring devices are Mechanical Integrity Tests (MITs), well operator reports, and periodic inspections. *See id.* Mechanical integrity tests are a series of tests used to determine leaks in the casing, injection tubing, and packer, and channels in the cement seal encasing the outer pipe. *See id.* For a definition of "MIT", see 40 C.F.R. § 146.8(1988). *See also* HAZARDOUS WASTE: CONTROLS OVER INJECTION WELL DISPOSAL OPERATIONS, *supra* note 4, at 14, 24-25. Generally, wells that fail mechanical integrity tests are closed until repairs can be made. *See id.* Monitoring wells have been used successfully to determine the extent of contamination in the immediate vicinity of known contamination, but are limited in their ability to assess large underground areas. *See id.* Further, deep monitoring wells themselves are a potential route of contaminants which may allow waste to reach drinking water aquifers. *See id.* As a result of monitoring limitations, the actual extent of contaminated sources of drinking water are unknown. *See id.* For a discussion of the EPA regulations regarding logging, sampling, and testing of injection wells, see Underground Injection Control Program: Hazardous Waste Disposal Restrictions, Final Rules, 53 Fed. Reg. 28,137 (1988)(codified at 40 C.F.R. § 146). For further discussion of monitoring, see *supra* note 66.

97. SUBSURFACE POLLUTION PROBLEMS IN THE UNITED STATES, *supra* note 96, at 9-10.

98. *See id.* at 21.

It was not until April 9, 1974 that the EPA officially set forth its policy on deep-well injection, which both complemented and superseded the FWQA policy guidelines opposing the disposal of contaminants by subsurface injection without strict controls.⁹⁹ The EPA, in concert with the objectives of the Federal Water Pollution Control Act "to restore and maintain the chemical, physical and biological integrity of the Nation's water," issued an internal policy on the *Subsurface Emplacement of Fluids by Well Injection* to provide guidance to federal agencies, the states, and other interested parties.¹⁰⁰ In agreement with the FWQA's October 1970 policy statement, the EPA's "policy considers waste disposal by [deep] well injection to be a temporary means of disposal . . . approved only for the life of an issued permit."¹⁰¹ In its statement, the EPA recognized that in individual industries, at certain locations, the disposal or storage of wastes in the subsurface environment through injection techniques may be the "most environmentally acceptable practice available."¹⁰² Moreover, in recognition of the need for deep-well injection in some industries, the EPA policy stated that "should a more environmentally acceptable means of disposal become available, change to such technology would be required."¹⁰³

Accompanying the 1974 EPA policy statement were "Recommended Data Requirements [RDRs] For Environmental Evaluation Of Subsurface Emplacement Of Fluids By Well

99. See *Subsurface Emplacement of Fluids by Well Injection*, 39 Fed. Reg. at 12,922.

100. *Id.*

101. *Id.* "The term 'temporary' [under the EPA guidelines] is not intended to imply subsequent recovery of injected waste for processing by another technology." *Id.*

102. *Id.* For example, "the EPA policy [specifically] recognizes the need for injection wells in certain oil and mineral extraction and fluid storage operations." *Id.* Specifically, the Solid Waste Disposal Act Amendments of 1980, Pub. L. No. 96-482, at sections 3001(b)(2) and 8002(m) provides an exemption to oil, gas, and geothermal production wastes, and at section 3001(b)(3) provides an exemption to high-volume/low toxicity mining wastes, fossil fuel combustion wastes, and cement kiln dust. See generally *Mining Waste Exclusion*, 54 Fed. Reg. 15,319, (Apr. 17, 1989).

103. *Subsurface Emplacement of Fluids by Well Injection*, 39 Fed. Reg. at 12,922.

Injection."¹⁰⁴ These requirements were designed as parameters for information to be offered by an injector to give "regulatory agencies sufficient information to evaluate the environmental acceptability of any proposed well injection."¹⁰⁵ The RDRs provided a detailed list of requirements from which a regulatory agency could specify in order to build a data base for a proposed injection-well.¹⁰⁶ The regulatory agency involved could request detailed information in the following areas: (1) proposed location of the injection-well, (2) location of water wells, (3) maps of current and potential water supplies, (4) geologic maps, (5) characteristics of injection fluids, (6) formation and fluid pressures, (7) well engineering data, and (8) monitoring plans.¹⁰⁷ The RDRs also provided for the preparation of contingency plans to cope with well failure, including the preparation of a report assessing alternative disposal schemes, projection of fluid pressure response with particular attention to aquifers that might be used for water supplies in the future, and a review of possible problems associated with chemical reactions between injected wastes, formation fluids, and mineralogical constituents.¹⁰⁸

IV. The Safe Drinking Water Act

Shortly after the release of the EPA policy on the subsurface emplacement of fluids, Congress passed the Safe Drinking Water Act (SDWA) of 1974.¹⁰⁹ The stated purpose of SDWA is to "assure that water supply systems serving the public meet minimum national standards for protection of public health."¹¹⁰ The SDWA was enacted in response to a congressional finding that "legislative authority [is] inadequate to assure that the water supplied to the public is safe to

104. *Id.* at 12,923.

105. *Id.*

106. *See id.*

107. *See id.*

108. Subsurface Emplacement of Fluids by Well Injection, 39 Fed. Reg. at 12,923.

109. *See* Safe Drinking Water Act, Pub. L. No. 93-523, 88 Stat. 1660 (codified as amended at 42 U.S.C. §§ 300f to 300j-26 (1986)).

110. SAFE DRINKING WATER ACT, LEGISLATIVE HISTORY, H.R. REP. NO. 93-1185 (1974) reprinted in 1974 U.S.C.C.A.N. 6454.

drink."¹¹¹ To assure the safety of public drinking water sources, the SDWA "authorizes the EPA to establish federal standards applicable [to public water systems] for protection from all harmful contaminants, . . . and establish a joint Federal-State system for assuring compliance with these standards and for protecting underground sources of drinking water."¹¹²

Of particular relevance to the protection of underground sources of drinking water is the regulation of injection-wells under Part C of the SDWA, the Underground Injection Control (UIC) program, which implemented the EPA's deep-well policy and mandated specific controls on injection practices.¹¹³ The SDWA was an attempt to address the growing concern caused by the increase in the injection of contaminants by municipalities, industries, energy production companies, and government agencies.¹¹⁴ Additionally, the SDWA

111. *Id.* at 6456. Prior to the SDWA, the EPA was only authorized under the Public Health Service Act to prescribe federal drinking water standards for water supplies used by interstate carriers with respect to contaminants capable of communicable disease. *See id.* "Section 361 of the Public Health Service Act authorized the Secretary of the Department of Health, Education, and Welfare to 'make and enforce such regulations as in his judgment [which] are necessary to prevent the introduction, transmission, or spread of communicable diseases'." *Id.* Pursuant to this provision, the Secretary of the Department of Health, Education, and Welfare promulgated regulations establishing standards for drinking water supplied to and by interstate carriers. *See id.* The authority to establish and "revise drinking water standards for interstate carriers was transferred to the Administrator of the EPA." *Id.* (citing 42 C.F.R. § 72, Subpart H; Reorganization Plan No. 3 of 1970). It could be argued that existing authority under Section 361 of the Public Health Service Act could be interpreted in a broader manner. Standards in order to deal with contaminants "which could cause chemical poisoning or other non-communicable disease were held by the Office of General Counsel not to be enforceable." *Id.* The EPA Office of General Counsel has not reversed this opinion. *See id.*

112. *Id.* at 6454-6455.

113. *See* Safe Drinking Water Act, *supra* note 109, §§ 1421-1430, Part C - Protection of Underground Sources of Drinking Water.

114. *See* SAFE DRINKING WATER ACT, LEGISLATIVE HISTORY, *supra* note 110, at 6481. A 1972 study on subsurface pollution problems conducted by the EPA, Office of Water Programs, detailed an increase in the growth of the use of waste disposal wells between 1950 and 1972. *See* SUBSURFACE POLLUTION PROBLEMS IN THE UNITED STATES, *supra* note 96, at fig. 2. In 1950 it was estimated that there were less than 5 industrial waste disposal wells in operation in the United States. *See id.* By the early 1960s the number had increased to over 30

was the first federal statute to address the practice of deep-well injection in detail by providing for a joint system of both state implementation and federal oversight.¹¹⁵ In promulgating the SDWA, Congress intended for the EPA to implement policy guidelines previously set forth by the federal govern-

active industrial waste injection-wells and by the early 1970s the estimated number of waste injection wells had jumped to over 270. *See id.* The estimated number of new waste injection wells placed in operation between 1968 and 1972 was over 140. *See id.* Further, the EPA study indicated that by far the largest injection practice in terms of the number of wells and volumes of wastes injected, is the "return of brines or other fluids to the aquifers from which they were extracted. This is a very common practice in the oil and gas industry where approximately 10,000 acre-feet of wastes are injected yearly through many thousands of wells in the oil producing States." *Id.* (citing ARTHUR M. PIPER, U.S. DEP'T OF INTERIOR, DISPOSAL OF LIQUID WASTES BY INJECTION UNDERGROUND: NEITHER MYTH NOR MILLENNIUM, Geological Survey Circular 631 (1969)). The contamination of shallow ground water around oil fields is widespread and well recognized. The oil and gas industry has utilized injection-wells for more than 50 years to dispose of salt water as well as to reinject it for production purposes. *See id.* "Of the approximately 253,000 active and temporarily inactive injection-wells [of all types] in the United States in 1987, . . . 160,265 [were] . . . oil and gas injection wells." GENERAL ACCOUNTING OFFICE, UNDERGROUND WASTE DISPOSAL, GAO/RCED 89-97 at 12 (1989). In practice, as oil and gas are removed during production they are replaced by salt water, or brine that occurs in underground rock formations. *See id.* at 9. Early in the century, "brine [was] . . . disposed of in surface pits . . ." *Id.* at 10. However, due to drinking water contamination, states banned the practice and the petroleum industry turned to underground brine injection. *See id.* Recently, oil producers have used brine injection to enhance recovery by "injecting it into oil-bearing formations to create pressures to force greater quantities of oil from the ground." *Id.* The "[A]merican Petroleum Institute . . . [estimated that the domestic petroleum] industry generated 20.9 billion barrels of brine in 1985, more than 5 barrels for each barrel of oil produced." *Id.* at 10-11.

115. *See* SAFE DRINKING WATER ACT, LEGISLATIVE HISTORY, *supra* note 110, at 6481. In promulgating the SDWA, Congress noted that amendments to the Federal Water Pollution Control Act (FWPCA) (§ 402(b)(1)(D)(as amended by Pub. L. No. 92-500) had made some progress in protecting underground sources of drinking water by requiring states seeking to operate their own discharge permit programs to "control the disposal of pollutants into wells." *Id.* Further, EPA review of State applications for such permit systems was viewed as an additional control to assure that the requirements of the FWPCA were met. *See id.* However, Congress feared that the FWPCA's restrictive definition of pollutant might prevent any Federal control system from effectively protecting underground drinking water sources. *See id.* at 6457. Finally, Congress feared that the FWPCA might not authorize the regulation of deep-well injection of wastes not carried out in conjunction with a discharge into navigable waters. *See id.* (citing U.S. EPA, Opinion of Acting Deputy General Counsel, #590 (Dec. 13, 1973)).

ment to establish a basis for setting minimum requirements for effective state programs.¹¹⁶

Through Part C of the SDWA, Congress required the EPA to establish guidelines for state UIC programs that, at a minimum, required states to:

- (1) prohibit unauthorized underground injection effective three years after enactment of the . . . [SDWA]; (2) require applicants for underground injection permits to bear the burden of proving to the State that its injection will not endanger drinking water sources; (3) refrain from adopting regulations which . . . authorize underground injection which endangers drinking water sources; (4) adopt inspection, monitoring, recordkeeping and reporting requirements . . . ; and (5) apply their injection control programs to underground injections by Federal agencies¹¹⁷

Through the SDWA, Congress intended to have several major policies implemented in regard to deep-well injection. "First, potential as well as presently-used drinking water sources are to be protected. Second, the protection [under the Act] is to apply to any injected substance (or derivative thereof), whether or not that substance is a contaminant subject to national primary drinking water regulations."¹¹⁸ Thus, the intent of Congress was to regulate or prohibit injection "if the injected substance may cause or contribute to non-compliance with a national primary drinking water regulation or if it may otherwise adversely affect the public

116. See *id.* at 6482. The UIC program is intended to be administered by the individual states, with oversight by the EPA. By 1992 EPA granted primary enforcement responsibility (primacy) for administering the UIC program to 25 of the 32 oil and gas producing States. See OFFICE OF TECHNOLOGY ASSESSMENT, MANAGING INDUSTRIAL SOLID WASTES FROM MANUFACTURING, MINING, OIL AND GAS PRODUCTION, AND UTILITY COAL COMBUSTION, OTA-BP-O-82, at 85 (Feb. 1992). There are currently, 32 state-administered permit programs, as well as the District of Columbia, having primacy over the regulation of Class I wells and 17 such EPA-administered federal programs. See 40 C.F.R. § 147 (July 1, 1995).

117. SAFE DRINKING WATER ACT, LEGISLATIVE HISTORY, *supra* note 110, at 6481.

118. *Id.*

health, including causing or contributing to the water's unfitness for human consumption."¹¹⁹

"In order to implement these controls to protect drinking [water] sources with minimum administrative redtape, [Congress] decided to allow EPA discretion to require States to utilize a permit system, rulemaking, or a combination of the two to control underground injection."¹²⁰ "In adopting this approach, [Congress] . . . was intent on allowing the [EPA] sufficient leeway to adopt a program which would be administratively compatible with . . . the permit provisions of the Federal Water Pollution Control Act."¹²¹ The EPA published its final technical UIC regulations on June 24, 1980.¹²² Several salient points of the regulations are: (1) the definition of an Underground Source of Drinking Water (USDW) as an aqu-

119. *Id.* "Primary drinking water regulation" under section 1401(1) of the SDWA is generally defined, in brief, as a national

regulation which—(A) applies to public water systems; (B) specifies contaminants which, . . . may have any adverse effect on the health of persons; (C) specifies for each such contaminant either—(i) a maximum contaminant level, if . . . it is economically and technologically feasible to ascertain the level of such contaminant in water in public water systems; and (D) contains criteria and procedures to assure of drinking water which dependably complies with maximum contaminant levels;

Safe Drinking Water Act *supra* note 109, 42 U.S.C. § 300f. "[A] contaminant need not have the adverse effect directly in order . . . to be regulated . . . [under the Act]." SAFE DRINKING WATER ACT, LEGISLATIVE HISTORY, *supra* note 110, at 6463. "If it is a precursor to a contaminant which . . . may contribute to . . . [an adverse] effect . . .," it was the intent of Congress that it be controlled under primary regulations. *Id.* The EPA "noted that more than 12,000 chemical compounds are being used commercially, . . . [with] 500 new chemical compounds added each year." *Id.* Recognizing that it was impossible for the EPA to regulate such a large group of compounds individually, Congress anticipated the establishment of group-wide primary drinking water regulations for some contaminants. *See id.* Finding a need for regulation of groups of contaminants which are hazardous at low concentrations, the EPA was expected to include substances listed under section 307 of the FWPCA, along with those contained in the World Health Organization, *Maximum Permissible Concentrations of Harmful Substances in the Water of Watercourses Used for Hygienic and Domestic Purposes* (1970); and the National Institute of Occupational Safety and Health annual list of toxic substances. *See id.* at 6464.

120. *Id.* at 6482.

121. *Id.* *See also* Federal Water Pollution Control Act § 402(b)(1)(D)(as amended by Pub. L. No. 92-500) (requiring state discharge permit programs).

122. *See* 40 C.F.R. Part 146 (June 24, 1980).

uifer that contains fewer than 10,000mg/l of total dissolved solids;¹²³ (2) the categorization of injection-wells into five classes;¹²⁴ and (3) the establishment of minimum requirements to assure the safe siting, construction, operation, monitoring, and plugging of injection-wells.¹²⁵

V. Resource Recovery and Conservation Act of 1976

Soon after the passage of the SDWA, Congress attempted to deal comprehensively with the problems brought about by hazardous waste disposal through the passage of the Resource Conservation and Recovery Act of 1976 (RCRA).¹²⁶ RCRA was enacted in response to the public's concern regarding the harms caused by the "improper disposal, storage and treatment of hazardous waste."¹²⁷ With the passage of RCRA,

123. See 40 C.F.R. § 146.3 (definition of USDW). According to UIC regulations, water containing up to 10,000 ppm (parts per million) total dissolved solids is considered an Underground Source of Drinking Water (USDW). See *id.*

Generally, the concentration of total dissolved solids (TDS), increases with depth [of the aquifer]. Usually water is considered potable when it contains less than 500 mg/l TDS, while the upper limit for irrigation and stock watering is 2500 to 3000 mgs/l TDS. (EPA protects water with a TDS content of 10,000 mgs/l or less since there is evidence that this water can be used as a portable source after treatment). By way of comparison, brines associated with oil and gas production generally contain 30,000 to 100,000 mg/l TDS, and seawater contains 35,000 mgs/l TDS.

REPORT TO CONGRESS: INJECTION OF HAZARDOUS WASTE, *supra* note 18, at 3.

124. See 40 C.F.R. § 146.5. For an explanation of the five classes of wells under the UIC regulations, see *supra* note 43. See also REPORT TO CONGRESS: INJECTION OF HAZARDOUS WASTE, *supra* note 18, at 4.

125. See 40 C.F.R. §§ 146.10—146.52.

126. See RCRA, *supra* note 2. Congress, concerned with the risk that solid waste disposal posed to the environment and health, recognized in enacting RCRA that "[l]and is too valuable a national resource to be needlessly polluted by discarded materials . . ." and that the "disposal of solid waste and hazardous waste in or on the land without careful planning and management can present a danger to human health and the environment." *Id.* at 42 U.S.C. § 6901(b)(1), (2).

127. *Resource Conservation And Recovery Act Reauthorization Hearings*, *supra* note 5, at 258. Since the passage of RCRA, highly publicized incidents, such as Love Canal and the Valley of the Drums, have graphically underscored the drastic consequences of poor hazardous waste practices. See *id.*

Congress declared it to be the national policy that wherever feasible, the generation of hazardous waste is to be reduced or eliminated as expeditiously as possible. Waste that is nevertheless generated should be treated, stored, or disposed of so as to minimize the present and future threat to human health and the environment.¹²⁸

To implement the national hazardous waste policy, Congress mandated, through RCRA, the development of what has been termed a "cradle-to-grave" waste tracking and regulatory program that provides for the authority to control hazardous waste from the point of generation to its ultimate disposition.¹²⁹ This program traces waste from generator to disposer through the maintenance of a manifest system.¹³⁰ RCRA also delegated to the EPA the responsibility for "promulgat[ing] regulations establishing . . . performance standards applicable to owners and operators of hazardous waste treatment, storage and disposal facilities."¹³¹

As defined under RCRA, injection-wells for hazardous waste are also hazardous waste disposal facilities subject to regulation under the Act. As originally enacted, however, the injection of hazardous waste is mentioned only in this limited context.¹³² Lacking background in hazardous waste regulation, Congress intentionally did not set forth detailed per-

128. RCRA, *supra* note 2, at 42 U.S.C. § 6902(b). The objectives of RCRA are to "promote the protection of health and the environment and to conserve valuable material and energy resources." *Id.* § 6902(a). Generally, these objectives are to be accomplished through a "Federal-State partnership to carry out the purposes" of RCRA. *Id.* § 6902(a)(7).

129. See RCRA, *supra* note 2, at 42 U.S.C. §§ 6921-6933.

130. See *Resource Conservation and Recovery Act Reauthorization Hearings*, *supra* note 5, at 258. The term "manifest" is defined as "the form used for identifying the quantity, composition, and the origin, routing, and destination of hazardous waste during its transportation from the point of generation to the point of disposal, treatment, or storage." RCRA, *supra* note 2 at 42 U.S.C. § 6903(12).

131. 42 U.S.C. § 6924(a).

132. See 42 U.S.C. § 6924(d), (f). The term "disposal" is defined as "the discharge, deposit, *injection*, dumping, spilling, leaking, or placing of any hazardous solid waste or solid waste into or on any land or water so that such solid waste or hazardous waste or any constituent thereof may enter the environment or be emitted into the air or discharged into any waters, including ground waters." 42 U.S.C. § 6903(3) (emphasis added).

formance standards in RCRA, but instead gave the EPA general directives to promulgate regulations for its implementation.¹³³ Faced with a Congressional mandate to develop hazardous waste regulations within 18 months,¹³⁴ but with little information and experience in the area, the EPA was unable to meet the deadline.¹³⁵ It was not until December 1978 that the EPA proposed uniform design standards for hazardous waste disposal facilities. However, almost two years later, in October 1980, the EPA instead decided to consider a site-specific risk assessment standard.¹³⁶ Finally, thirty months after its initial proposal, the EPA decided to adopt the site-specific approach. Even then, the EPA still did

133. See 42 U.S.C. § 6924(a). Under RCRA, Congress, lacking experience in the area of hazardous waste, gave the EPA only general directives to promulgate regulations respecting:

- 1) the maintaining of records of all hazardous wastes identified or listed under [the Act] . . . ;
- 2) satisfactory reporting, monitoring, inspection and compliance with the manifest system . . . ;
- 3) treatment, storage, or disposal of all such waste received by a facility pursuant to such operating methods, techniques, and practices as may be satisfactory to the Administrator;
- 4) the location, design and construction of such hazardous waste treatment, disposal, or storage facilities;
- 5) contingency plans for effective action to minimize unanticipated damage . . . ;
- 6) the maintenance of operation of such facilities, and requiring such additional qualifications as to ownership, continuity of operation, training for personnel, and financial responsibility . . . ; and
- 7) permits for treatment, storage, or disposal.

Id. § 6924(a)(1) - (7).

134. See *id.* § 6924(a). Within 18 months of October 21, 1976, after public hearing and consultation with federal and state agencies, the EPA was required to promulgate performance standards for "owners and operators of facilities for the treatment, storage, or disposal of hazardous waste . . ." *Id.*

135. See Hazardous Waste Management Systems, 47 Fed. Reg. 32,274 (1982). For example, regulations for generators, transporters and disposal facilities were to be promulgated under RCRA within 18 months after the enactment of the statute, yet it would not be until January 26, 1983 that final standards for land disposal facilities went into effect. See *id.*

136. See Standards Applicable to Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities, 45 Fed. Reg. 66,816 (1980). This proposed method would have required the EPA to evaluate the potential risks of an individual facility to human health and the environment based upon that facility's location, design, construction and operation. See *id.*

not intend to promulgate such standards until the Fall of 1983.¹³⁷ Final standards for land disposal facilities were issued in July 1982, after a November 1981 court order denied the EPA Administrator's request for an additional two-year extension.¹³⁸

VI. The 1982 EPA Regulations

The 1982 regulations did little to alter the status of the large majority of land disposal facilities, since they continued to allow these facilities, including injection-wells, to operate unregulated under "interim status" if they simply notified the EPA that they were in operation on the date of enactment.¹³⁹ The promulgation of the EPA regulations did not impose any immediate requirements on all land disposal facilities until a "final permit" was sought by the facility.¹⁴⁰ There was little motivation for facilities to improve waste disposal practices, because facilities were not required to submit final permit applications until requested by a reluctant EPA.¹⁴¹

137. See Hazardous Waste Management Systems; Standards Applicable to Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities and EPA Administered Programs, Reproposal of Proposed Rule and Proposed Amendments, 46 Fed. Reg. 11,126 (1981)(codified at 40 C.F.R. §§ 122, 260, 264).

138. See *Illinois v. Gorsuch*, 530 F. Supp. 340 (D.D.C. 1981). This suit was initiated in the Fall of 1978 after the EPA failed to perform its nondiscretionary duty to issue regulations under RCRA. In a report filed with the court on October 8, 1981, the EPA Administrator requested an additional two year extension to promulgate regulations. See *id.* "In her report the Administrator state[d] that regulations governing land disposal of hazardous waste raise technical and policy issues of great complexity and the Agency's prior research and analysis, . . . [did] not provide an adequate basis for resolving the issues." *Id.* at 341. In denying the Administrator's request and setting a February 1, 1982 deadline, the court noted that the Agency could fulfill its mandate to issue regulations, as well as to satisfy its technical and policy concerns, by issuing regulations and later revising them as needed. See *id.* See also 47 Fed. Reg. 32,274 (1982).

139. See RCRA, *supra* note 2, at 42 U.S.C. § 6925(e)(3).

140. See 40 C.F.R. § 270.10(e)(4)(1983).

141. See *id.* It was not until early 1983 that the EPA began to call in disposal permit applications, and even then, only slowly. Since January 26, 1983, only 150 permits had been called in. See also *Hazardous Waste Control and Enforcement Act of 1983: Hearings on H.R. 2867 Before the Subcomm. on Commerce, Transportation, and Tourism of the House Comm. on Energy and Commerce*, 98th Cong. 351, 360 (1983).

Although by July 1982, the EPA had issued the bulk of the RCRA regulations allowing for the permitting of both new or existing facilities that treated, stored, or disposed of hazardous waste, injection-well disposal was not covered. Since RCRA and SDWA overlap, the EPA had sought to coordinate its implementation of the two statutes by regulating above-ground and ancillary facilities and activities associated with hazardous waste injection under RCRA, and injection-wells under SDWA. In its attempt to coordinate the two statutes, the EPA did not require those facilities permitted under the UIC program to obtain a RCRA permit. The rationale for this permitting scheme came from the central concept of RCRA that a state program, upon authorization from the EPA, operates "in lieu of" the federal hazardous waste program.¹⁴² The EPA interpreted this language to mean that federal program regulations did not apply in an authorized state.¹⁴³

Unfortunately, the effects of the "in lieu of" approach removed RCRA protection from underground injection activities, thereby leaving a regulatory gap because permitting under SDWA did not begin until the EPA authorized the states to issue UIC permits. In order to fill this gap, the EPA made "interim status" requirements applicable to Class I and IV hazardous waste injection-wells until state programs were authorized by the EPA.¹⁴⁴ Under these guidelines, Class I and IV hazardous waste wells in hazardous waste management facilities were deemed to have "permits by rule" under RCRA if they were permitted under the UIC program.¹⁴⁵ Existing Class I hazardous waste wells were authorized by rule

142. See 42 U.S.C. § 6926(b), (c) (1976).

143. See 45 Fed. Reg. 33,377 (1980) (discussing EPA control over state programs).

144. See RCRA, *supra* note 2, at 42 U.S.C. § 6925.

145. See 40 C.F.R. § 270.60(b)(1982). The EPA did not entirely relinquish control of hazardous waste facilities over to state hazardous waste programs. The EPA may impose conditions on hazardous waste management facilities by making "comments" on state issued permits. Even if the state fails to incorporate the EPA "comments" into the permit, they are still enforceable by the EPA. See 40 C.F.R. § 123.24 (1976). EPA also retains back-up enforcement authority over state hazardous waste programs under section 3008 of RCRA through the enforcement of compliance orders. See RCRA § 3008, 42 U.S.C. § 6928, 90 Stat. 2811 (1976). Further, The EPA has authority to conduct inspections of state

in the UIC program until they were formally permitted under 40 C.F.R. Parts 144, 146 and 147 (UIC Regulations).¹⁴⁶ Title 40 of the Code of Federal Regulations, Subpart C - Authorization of Underground Injection by Rule, specifically provided authorization for injection into existing Class I wells.¹⁴⁷ Authorization for Class I wells under section 144.21 expired upon the effective date of the permit if the permit was filed in a timely manner under section 144.31(c)(1), or the effective date of the permit denial, if the permit was not filed in a timely manner.¹⁴⁸ Class I wells were authorized by rule "in

regulated hazardous waste management facilities under RCRA § 3007, 42 U.S.C. § 6927.

146. See 40 C.F.R. Parts 144, 146, 147. Other hazardous waste treatment, storage, or disposal units located at a hazardous waste disposal site remain subject to full permitting under RCRA and must have a separate permit. See REPORT TO CONGRESS: INJECTION OF HAZARDOUS WASTE, *supra* note 18, at VI-3. By 1984, there were a total of 195 active Class I wells under RCRA interim status with 48 wells permitted under the UIC program. See *id.* Currently, there are 32 state Underground Injection Control Programs for Class I injection wells, along with the District of Columbia. See *id.* There are presently 17 EPA-administered programs for Class I wells. See 40 C.F.R. Part 147 (July 1, 1995). In order to be approved by the EPA, the state-administered programs listed under Part 147 must have legal authority to implement various permitting provisions listed under 40 C.F.R. Part 145. Those provisions include the ability to administer specified areas such as; establishing permit conditions, permit application, modification and termination, emergency permits, permit duration and transfer. Along with the permitting provisions, a state program must also provide for: classification of wells, identification of underground sources of drinking water, elimination of Class IV wells, prohibition of movement of fluids into underground sources of drinking water, and monitoring. See 40 C.F.R. § 145.11 (July 1, 1995). Permits for Class I and Class V wells are effective for a fixed term of ten years. See 40 C.F.R. § 144.36(a) (July 1, 1995). Compliance with a permit for a Class I well during its term, also constitutes compliance with Part C of the SDWA governing underground injection. See 40 C.F.R. § 144.35 (July 1, 1995).

147. See 40 C.F.R. § 144.21 (July 1, 1993).

148. See *id.* 40 C.F.R. section 144.31(c)(1) provided timeliness requirements for applications for authorization by-permit for existing wells: "[f]or existing wells, as expeditiously as practicable . . . but no later than 4 years from the approval or promulgation of the UIC program, or as required under 144.21(b) for wells injecting hazardous waste."

By May 1984, section 144.21 provided for the duration of permits-by-rule for existing Class I wells in EPA-administered programs. See *id.* It allowed for a period of "one year after promulgation of the UIC program unless a complete permit application [was] pending." *Id.* With some exceptions, Class IV wells were prohibited under section 144.13 of the 1984 amendments to the regula-

approved state programs, five years after approval or promulgation of the UIC program unless a complete permit application [was] pending."¹⁴⁹ "Injection into existing Class IV wells [was] authorized for up to six months after approval or promulgation of a UIC program" under the SDWA.¹⁵⁰

EPA claims that the overlapping statutory programs under RCRA and SDWA, which provided stringent protection for drinking water sources, were challenged during Congressional hearings considering RCRA reauthorization.¹⁵¹ Not all parties agreed with the EPA's assessment. During the Congressional hearings, Jane Bloom of the Natural Resources Defense Council¹⁵² noted an earlier General Accounting Office report that questioned the effectiveness of the EPA's coordination of SDWA and RCRA: "A charitable assessment of this purportedly coordinated regulatory program is that it

tions. See 40 C.F.R. § 144.13. This section provides for the prohibition of Class IV wells, in relevant part:

- (1) The construction of any Class IV well; (2) The operation or maintenance of any Class IV well not in operation prior to July 18, 1980; (3) The operation or maintenance of any Class IV well that was in operation prior to July 18, 1980, after six months following the effective date of a UIC program approved or promulgated for the state; (4) Any increase in the amount of hazardous waste or change in the type of hazardous waste injected into a Class IV well.

Id. Not prohibited, are "wells used to inject contaminated groundwater that has been treated and [are] being reinjected into the same formation" pursuant to an authorized CERCLA cleanup. 40 C.F.R. § 144.13(4)(c). Clarification under section (d) of the regulations provides that the following wells are not prohibited:

- (1) wells used to inject hazardous waste into aquifers . . . that have been exempted . . . if the exempted aquifer . . . underlies the lowermost formation containing a USDW; (2) wells used to inject hazardous waste where no USDW exists within one quarter mile of the well bore in any underground formation, provided [it is determined that] . . . the formation [is] sufficiently isolated to ensure [no migration from the injection zone].

40 C.F.R. § 144.13. All such wells are considered Class I wells and are subject to compliance with the regulations governing Class I wells. See 40 C.F.R. § 144.13.

149. *Id.*

150. 40 C.F.R. § 144.23 (July 1, 1993).

151. See *Resource Conservation and Recovery Act Reauthorization Hearings*, *supra* note 5.

152. The Natural Resources Defense Council is a national nonprofit environmental organization of some 40,000 members. *Id.* at 255.

has resulted in little, if any, protection of drinking water, primarily because the interim status regulations are administrative and do not provide environmental protection."¹⁵³ Nor did the issuance of regulations under RCRA serve to reduce Congressional annoyance with inaction by the EPA in implementing RCRA. In March 1982, during House subcommittee hearings designed to deal with the reauthorization of RCRA, the Honorable James Florio (Chairman) questioned the impact and direction of the EPA's decisions under RCRA:

As everyone knows by this time, the RCRA program has taken longer to implement than Congress or the American people ever imagined. Many people are beginning to ask themselves: Are we any better off today than we were 6 years ago with the enactment of RCRA, and where are we headed to deal with this problem, particularly the problem of inappropriate disposal of hazardous waste. The record of recent implementation does not give much cause to be optimistic.¹⁵⁴

During the subcommittee hearings, there was concern that the presence of dangerous chemicals found in underground sources of drinking water was the result of improper disposal through improperly regulated hazardous waste injection-wells.¹⁵⁵ Further, "the EPA [acknowledged that once] ground water is . . . contaminated, it is prohibitively expensive or technologically impossible to clean up."¹⁵⁶ While

153. *Resource Conservation and Recovery Act Reauthorization Hearings*, *supra* note 5, at 263 (Statement of Jane Bloom, NRDC) *citing* GENERAL ACCOUNTING OFFICE, HAZARDOUS WASTE FACILITIES WITH INTERIM STATUS MAY BE ENDANGERING PUBLIC HEALTH AND THE ENVIRONMENT (1981).

154. *Resource Conservation And Recovery Act Reauthorization, Hearings*, *supra* note 5, at 1 (Statement of Hon. James J. Florio, Chairman) (1982).

155. *See id.* at 255 (Statement of Jane Bloom, NRDC). Testimony cited an EPA announcement that volatile organic chemicals, many of which are carcinogenic or carry life threatening diseases in humans, had "been detected in 45% of public water systems that draw on ground water" which has been contaminated. *Id.* The presence of this contamination was generally believed to be the result of improper hazardous waste disposal practices in two key areas: underground injection and landfill practices. *See id.* at 255-56. *See also* 47 Fed. Reg. 9351 (Mar. 4, 1982).

156. *Resource Conservation And Recovery Act Reauthorization, Hearings*, *supra* note 5, at 1 (Statement of Hon. James J. Florio, Chairman) (1982).

RCRA directed the EPA to develop standards for all types of land disposal without distinction between methods, deep-well injection of hazardous waste into aquifers containing potable or potentially potable water became a topic of debate during the 1982 reauthorization hearings.¹⁵⁷ Concerns over the potential for ground water damage through the practice of deep-well injection of hazardous waste were not new. For example, a 1974 EPA study stated that "underground migrations of injected waste can not be determined accurately; therefore highly toxic compounds . . . should not be injected."¹⁵⁸ Despite such warnings, by 1983, the EPA estimated that active wells were injecting 11.5 billion gallons of hazardous waste annually.¹⁵⁹ Even though there was a long standing disagreement as to the appropriateness of deep-well injection as a

157. See *id.* at 262-265. As enacted in 1976, RCRA referred to the injection of waste only in the definition of disposal, which included "discharge, deposit, injection, dumping, spilling, leaking, or placing of any solid waste or hazardous waste into or on any land or water. . . ." RCRA, Pub. L. No. 94-580, § 6903(3), 90 Stat. 2799 (1976)(emphasis added). During the 1982 RCRA Reauthorization Hearings, concern was voiced concerning the continued underground injection of hazardous waste, particularly through Class IV injection wells, into aquifers containing current or potential drinking water, while the practice was under joint RCRA and SDWA interim status. See *Resource Conservation And Recovery Act Reauthorization Hearings*, *supra* note 5, at 256-257.

An EPA report released in June of 1980 estimated that between 5,000 and 10,000 Class IV hazardous waste injection-wells exist in the United States. See *id.* at 256. At the time of the report, Class IV injection-wells injecting wastes directly into drinking water aquifers were considered by the EPA to represent a serious threat to ground water resources that should be banned entirely. See *id.* However, bowing to industry pressures the EPA abandoned this position in its 1980 final regulations. See *Production Impact*, 45 Fed. Reg. 42,497 (June 24, 1980). See *supra* note 43 for an explanation of the classification of injection-wells. By May, 1984, with limited exceptions, Class IV wells were prohibited under section 144.13 of the 1984 regulations as amended. See *supra* note 146.

158. WASTE DISPOSAL PRACTICES AND THEIR EFFECTS ON GROUND WATER, *supra* note 3, at 363.

159. See REPORT TO CONGRESS: INJECTION OF HAZARDOUS WASTE, *supra* note 18, at 8. See also HAZARDOUS WASTE: CONTROLS OVER INJECTION WELL DISPOSAL OPERATIONS, *supra* note 4, at 11. "Hazardous waste must be liquefied before it can be injected. Of the 11.5 billion gallons of hazardous waste injected in 1983 less than 4% (423 million gallons) was waste: the remainder being water that it was mixed with." *Id.* Approximately half of the disposed of waste was composed of hazardous compounds with the remainder being nonhazardous inorganic compounds. See *id.* "Most hazardous waste injection-wells are owned by the waste generators themselves and are located at the site of [generation]."

method of disposal, it was not until the 1984 amendments to RCRA (1984 Amendments) that substantive sections covered this technique.¹⁶⁰

VII. The 1984 Amendments to RCRA

Despite the promulgation of final standards for land disposal facilities in July 1982, little progress was made towards improving the safety of hazardous waste disposal practices, mostly because the regulations placed no immediate requirements upon those facilities. Since most facilities were operating under "interim permits,"¹⁶¹ they were allowed to continue functioning without regard to the new regulations until the EPA requested them to submit final permit applications.¹⁶² The EPA's progress in requesting submission of final permit applications was exceptionally slow, effectively delaying any change in the treatment of hazardous waste under RCRA for years beyond the time foreseen by Congress.¹⁶³ Noting an estimated 40 million tons of hazardous waste escaping control through regulatory loopholes and inadequate enforcement efforts by the EPA, Congress again voiced a growing dissatisfaction.¹⁶⁴

Under RCRA's current regulatory system, the evidence shows that land disposal of hazardous waste is not protecting the groundwater against contamination, and in many cases it also increases the risk of threat to the public health and environment.¹⁶⁵ This problem is exacerbated by the lengthy pro-

Id. "Only 4 percent of the total injected volume is handled by commercial disposers who operate 9 percent of [hazardous waste injection-] wells." *Id.*

160. See The Hazardous and Solid Waste Amendments of 1984 [hereinafter 1984 Amendments], Pub. L. No. 98-616, §§ 201(a), 405(a), 98 Stat. 3221, 3229, 3273 (codified at 42 U.S.C. §§ 6924(f), 6939(b) (1988 & Supp. IV 1992)).

161. See *supra* Part VI for a detailed explanation of "interim permit" status.

162. See 40 C.F.R. § 270.10(e)(4) (1983).

163. It was not until early 1983 that the EPA began to call in disposal permit applications, and even then, only slowly. By March 1983 over 150 permits had been called in. See *Hazardous Waste Control and Enforcement Act of 1983: Hearings on H.R.2867 Before the Subcomm. on Commerce, Transportation, and Tourism of the House Comm. on Energy and Commerce*, 98th Cong. 1st Sess. 351, 360 (1983).

164. See *id.* at 1496.

165. See *id.*

cess and slow pace at which new facility permits for the treatment and safe disposal of hazardous waste are issued.¹⁶⁶ Congress particularly pointed to the EPA's delay in carrying out its statutory mandate to fully promulgate minimum requirements for injection of hazardous wastes, noting that the EPA had not even succeeded in ascertaining the extent of underground injection of hazardous waste.¹⁶⁷

As the 98th Congress began the reauthorization process for RCRA, it became clear that delays by the EPA would no longer be tolerated. Highly publicized incidents, such as Love Canal and the Valley of the Drums, brought to an increasingly aware public the drastic consequences of poor hazardous waste practices.¹⁶⁸ With growing public concern, Congress was compelled to act in order to control the input of hazardous waste and to clean up contaminated sites.¹⁶⁹ Accordingly, Congress reauthorized RCRA with a maze of statutory deadlines and requirements.¹⁷⁰ The 1984 Amendments also reflected Congressional findings that certain classes of land disposal facilities are not capable of assuring long-term containment of hazardous wastes.¹⁷¹ As a result, Congress determined that "reliance on land disposal should be minimized or eliminated, and land disposal, . . . [including injec-

166. *See id.*

167. *See id.* at 1496, 1505. The Committee On Energy and Commerce found that the injection of hazardous wastes directly into underground sources of drinking water was inadequately regulated. *See id.* Showing its lack of faith in the EPA, "the Committee has therefore provided for immediate regulation of underground injection of hazardous wastes above or into underground sources of drinking water under RCRA." *Id.* at 1505.

168. *See Resource Conservation And Recovery Act Reauthorization Hearings*, *supra* note 5, at 258 (statement of Jane Bloom).

169. *See id.* Under increasing public pressure to react to highly publicized incidents at Love Canal, New York (1978) and Valley of The Drums, Brooks Kentucky (1979), Congress also saw fit to pass The Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA), 42 U.S.C. §§ 9601-9675. *See id.* While RCRA is a prospective regulatory program designed to prevent future contamination, CERCLA came into existence as a retroactive response program intended to clean up inactive hazardous waste disposal sites. *See id.*

170. *See supra* note 160.

171. *See generally*, *Resource Conservation and Recovery Act Reauthorization Hearings*, *supra* note 5.

tion,] should be the least favored method for managing hazardous wastes."¹⁷²

With the enactment of the 1984 Amendments, Congress evidenced a change in attitude towards the EPA. The language of RCRA, as enacted in 1976, gave the EPA freedom to determine what measures were needed to regulate deep-well injection along with the other forms of land based disposal.¹⁷³ The 1984 Amendments allowed for no such freedoms. Congress demonstrated its lack of faith in the EPA in implementing hazardous waste policy by enacting specific directives.¹⁷⁴ By requiring the EPA to prepare a detailed inventory of all wells injecting hazardous waste in the United States,¹⁷⁵ and through the imposition of bans on deep-well injection that

172. 42 U.S.C. § 6901(b)(7) (1988 & Supp. IV 1992).

173. Under RCRA, the EPA is free to determine the appropriate technology for the disposal of solid wastes. See 42 U.S.C. § 6924 (1976).

174. See *supra* Part VII for a discussion of the 1984 Amendments.

175. See WASTE DISPOSAL PRACTICES AND THEIR EFFECTS ON GROUND WATER, *supra* note 3. An early EPA report to Congress found few local agencies systematically collect data on contamination incidents with few reports concerning contamination by industrial and municipal wells injecting into saline aquifers. See *id.* Further, the monitoring of injection operations was found to be grossly inadequate. See *id.* This study also led the EPA to express a major concern over the limited extent of technical knowledge of subsurface conditions and high pressure hydraulics. See *id.* A detailed inventory concerning hazardous waste injection was to be compiled within 6 months of enactment of the 1984 Amendments and was to include the following information:

- 1) the location and depth of each well;
- 2) engineering and [well] construction details . . . ;
- 3) the hydrogeological characteristics of the . . . strata . . . ;
- 4) the location and size of all drinking water aquifers penetrated by the well, or within a one-mile radius of the well or within two hundred feet below the well injection point;
- 5) the location, capacity and population served by each [drinking water] well . . . within a five-mile radius of the injection well;
- 6) the nature and volume of waste . . . ;
- 7) the dates and nature of [well] inspection . . . ;
- 8) the name and address of all owners and operators . . . ;
- 9) the identification of all wells . . . [subject to] enforcement actions; and
- 10) such other information . . . deemed necessary . . . [by the EPA Administrator].

REPORT TO CONGRESS ON INJECTION OF HAZARDOUS WASTE, *supra* note 18, at 2-3.

could only be avoided by the rapid promulgation of regulations,¹⁷⁶ Congress prodded the EPA to move quickly.¹⁷⁷

The EPA's ability to act, however, was limited by the Congressional mandate that land disposal occur only if it is protective of human health and the environment.¹⁷⁸ Land disposal can be deemed protective only if hazardous waste receives treatment prior to disposal, or if an applicant for a permit could show no migration of waste would occur.¹⁷⁹ The 1984 Amendments further limited the EPA's discretion by placing an outright ban on all deep-well injection of hazardous wastes into or above a formation that contains an underground source of drinking water.¹⁸⁰

VIII. The 1988 EPA Regulations

In July 1988, the EPA finally promulgated its approach toward implementing the statutorily mandated regulations on the deep-well injection of hazardous waste.¹⁸¹ This action was taken in response to the amendments to RCRA as enacted by Congress through the Hazardous and Solid Waste Amendments of 1984.¹⁸² In addition, the EPA also amended the existing UIC regulations pertaining to hazardous waste

176. See 1984 Amendments, *supra* note 160, § 201(a).

177. See generally James A. Power, *The D.C. Circuit, RCRA, And Migration Of Hazardous Wastes: No Does Not Mean No*, 59 GEO. WASH. L. REV. 1145, 1152 (1991).

178. See 1984 Amendments, *supra* note 160, § 201, 98 Stat. 3227 (codified at 42 U.S.C. § 6902).

179. See 1984 Amendments, *supra* note 160, § 201(a), 98 Stat. 3229 (codified at 42 U.S.C. § 6924(g) (1988 & Supp. IV 1992)). "[T]here will be no migration of hazardous constituents from the disposal unit or injection zone for as long as the wastes remain hazardous." 42 U.S.C. § 6924(g)(5) (1988 & Supp. IV 1992).

180. See 1984 Amendments, *supra* note 160, § 405(a) (Interim control of hazardous waste injection). The prohibition took effect May 8, 1985, leaving only Class I wells (which go beneath the lowest usable underground source of drinking water) able to lawfully dispose of hazardous waste. See *id.* See *supra* note 43 for a detailed description of well classification.

181. See Underground Injection Control program: Hazardous Waste Disposal Injection Restrictions, 53 Fed. Reg. 28,118 (1988)(codified at 40 C.F.R. Parts 124, 144, 146 and 148).

182. See 1984 Amendments, *supra* note 160.

injection.¹⁸³ Generally, the regulations promulgated by the EPA provided that underground injection of hazardous waste would be prohibited unless a permit was obtained under the

183. See Underground Injection Control program, 53 Fed. Reg. 28,118, *supra* note 181. The regulations promulgated under the 1988 regulations contained changes to 40 C.F.R. Parts 124, 144, and 146 - the Class I injection well regulations. See *id.* Part 124 describes the procedures the EPA will use for issuing permits under the covered programs. See *id.* Section 144 sets forth the minimum requirements that each state must meet in order to obtain primary enforcement authority for that state's UIC program. See *id.* This section sets forth the five classes of wells under Section 144.6. All owners and operators of these injection wells must be authorized either by permit or by-rule. See 40 C.F.R. § 144.8 (1993). Importantly, in carrying out the mandate of the SDWA, this subpart provides that no injection shall be authorized by permit or rule if it results in the movement of fluid containing contaminant into Underground Sources of Drinking Water (USDW), "[i]f the presence of that contamination may cause a violation of any primary drinking water regulation under 40 C.F.R. Part 142 or may adversely affect the health of persons." 40 C.F.R. § 144.12. Further, existing Class IV wells which inject hazardous waste directly into an underground source of drinking water were to be eliminated over a period of six months with the construction of new Class IV wells to be prohibited. See 40 C.F.R. § 144.13. Finally, Section 144.1(h) provides that "the issuance of a UIC permit does not automatically terminate RCRA interim status." 40 C.F.R. § 144.1(h). However, a "Class I well's interim status [does] automatically terminate upon [the] issuance . . . of a RCRA permit or permit-by-rule under § 270.60(b) of this chapter." *Id.* "Thus, until a Class I well injecting hazardous waste receives a RCRA permit or RCRA permit by-rule, the well's interim status requirements are the applicable requirements imposed pursuant to . . . sections 146, 147 and 265 . . . including any requirements imposed in the UIC permit." *Id.* Part 146 "sets forth [detailed] technical criteria and standards for the [UIC program]." 40 C.F.R. § 146.1. Part 147 "sets forth the applicable [UIC] programs for each of the states, territories, and possessions identified pursuant to the SDWA as needing a UIC program." 40 C.F.R. § 147.1(a). Currently, all 50 states, Guam, Puerto Rico, the Virgin Islands, American Samoa, the Commonwealth of the Mariana Islands, along with the Osage Mineral Reserve, Lands of the Navajo, Ute, Mountain Ute, and all Other New Mexico Tribes, as well as the Lands of Certain Oklahoma Indian Tribes, have an applicable UIC program. See 40 C.F.R. § 147.1. These programs are "either a State-administered program approved by EPA, or a federally-administered program promulgated by EPA." 40 C.F.R. § 147.1(b). "In some cases, the UIC program may consist of a State-administered program applicable to some classes of wells and a federally-administered program applicable to other classes of wells." *Id.* Part 148 "identifies hazardous wastes that are restricted from disposal into Class I . . . wells and defines those circumstances under which a waste, otherwise prohibited from injection, may be injected." 40 C.F.R. § 148.1.

UIC permit program or unless a well was covered by the RCRA permit-by-rule.¹⁸⁴

Shortly after promulgation of the regulations, industry and environmental groups in *Natural Resources Defense Council, Inc. v. United States EPA*¹⁸⁵ (*NRDC v. EPA*) petitioned the United States Court of Appeals for the District of Columbia to find the regulations concerning the disposal of hazardous waste by injection inconsistent with the 1984 Amendments.¹⁸⁶ In contention were the EPA's regulatory interpretation of important statutory terms regarding the disposal of waste through deep-well injection.¹⁸⁷

A. Site-specific Permitting

The land disposal prohibitions of the 1984 Amendments only allow land disposal by a disposal method determined to be "protective of human health and the environment for as long as the waste remains hazardous."¹⁸⁸ Subsections (d), (e) and (g) of 42 U.S.C. section 6924 prohibit land disposal (other than by injection) of specified wastes unless an applicant for a permit demonstrates that "there will be no migration of hazardous constituents from the disposal unit or injection zone

184. See 53 Fed. Reg. 28,147 (1988). See also 40 C.F.R. § 270.60 providing for RCRA permits-by-rule, which have remained unchanged since its promulgation by EPA under the 1988 regulations. RCRA permit conditions for injection-wells are met if the owner or operator of an injection-well disposing of hazardous waste: (1) has a permit for underground injection issued under Parts 144 or 145 (requirements for state programs); and (2) complies with the conditions of the requirements of § 144.14 (requirements for wells managing hazardous waste); or (3) for UIC permits issued after November 8, 1984: (i) complies with 40 C.F.R. § 264.101 [corrective actions]; and (ii) where the UIC well is the only unit at a facility which requires a RCRA permit, complies with 40 C.F.R. § 270.14(d). See 40 C.F.R. § 270.60 (1995). See also EPA Administered Permit Programs: The Hazardous Waste Permit Program, 48 Fed. Reg. 14,228 (Apr. 1, 1983).

185. 907 F.2d 1146 (D.C. Cir. 1990) (per curiam), *reh'g en banc denied*, 907 F.2d at 1173 (D.C. Cir. 1990).

186. See *id.*

187. See *id.*

188. *Id.* at 1152 (citing 1984 Amendments, *supra* note 160, 42 U.S.C. § 6924). An applicant may avoid the safety requirements of 42 U.S.C. § 6924 by complying with the pretreatment provisions promulgated under subsection (m) of this section. See *id.*

for as long as the wastes remain hazardous.”¹⁸⁹ Subsection (f), governing disposal by injection, requires no such demonstration. Despite the protests of industry, “the EPA decided to apply the ‘no-migration’ standard to waste disposal [by injection] governed by subsection (f).”¹⁹⁰ The effect was to ban injection of hazardous wastes without a site-specific “no migration” demonstration.¹⁹¹ Industry argued that the EPA failed to meet the requirements of section 6924(f)(2) by not determining that, absent a site-specific permitting process, deep injection of hazardous waste “may not be protective of human health and the environment for as long as the waste remains hazardous.”¹⁹²

In rejecting industry’s argument, the United States Court of Appeals found that the EPA had in fact determined “that deep-well injection might not protect human health and the environment without a permit petition process.”¹⁹³ To support its decision, the court looked to the preamble of the regulations where the “EPA stated its belief that the regulations’ new substantive standards for hazardous waste injection wells provided an appropriate level of protection for the injection of hazardous waste.”¹⁹⁴ “The EPA concluded [however,] that it could determine whether hazardous waste injection would protect human health and the environment only in the context of site-specific permit proceedings.”¹⁹⁵ From the preamble, the court found it reasonable to infer that the

189. *NRDC v. EPA*, 907 F.2d at 1152.

190. *Id.*

191. *See id.*

192. *Id.* at 1152. With regard to deep-well injection of hazardous wastes, 42 U.S.C. § 6924(f)(2) directs the EPA Administrator to “promulgate final regulations prohibiting the disposal of such wastes into such wells if it may reasonably be determined that such disposal may not be protective of human health and the environment for as long as the waste remains hazardous.” 42 U.S.C. § 6924(f)(2).

193. *NRDC v. EPA*, 907 F.2d at 1154.

194. *Id.* (citing Underground Injection Control program: Hazardous Waste Disposal Injection Restrictions; Amendments to Technical Requirements for Class I Hazardous Waste Injection Wells; and Additional Monitoring Requirements Applicable to all Class I Wells, 53 Fed. Reg. 28,131 (1988)).

195. *Id.* at 1155 (citing Underground Injection Control program, 53 Fed. Reg. 28,121 (1988)).

EPA determined "(1) that deep-well injection could, under appropriate circumstances, be protective of human health and the environment, and (2) that deep-well injection might not be protective of human health and the environment unless . . . governed by agency regulations," particularly the requirement of a site-specific permit before injecting hazardous waste.¹⁹⁶ In determining that the EPA had met its obligation under section 6924(f)(2), the court affirmed the site-specific permitting requirement.¹⁹⁷

B. The No-migration Standard

Industry groups in *NRDC v. EPA* challenged the application of the no-migration standard of the 1984 Amendments to sections 6924(d) - (g) wastes.¹⁹⁸ The EPA had "decided that

196. *NRDC v. EPA*, 907 F.2d at 1155.

197. *See id.* at 1154.

198. *See id.* at 1156. Sections 6924(d)(specified wastes), 6924(e)(solvents and dioxins), and 6924(g)(additional prohibitions), all have "no migration" requirements. However, section 6924(f)(injection of specified wastes) does not contain the "no migration" standard. *See id.* Since the 1988 EPA regulations, the list of waste specific prohibitions from underground injection has steadily increased. *See id.* *See also* Subpart B - Prohibition on Injection, 40 C.F.R. §§ 148.10 - 148.17 (July 1, 1995), which identifies hazardous wastes that are restricted from disposal into Class I wells. Waste specific prohibitions for newly listed wastes are identified under section 148.17. Section 148.17 sets forth specific deadlines for the prohibition of newly listed wastes specified in 40 C.F.R. Part 261. Section 148.20 defines those circumstances under which a waste, otherwise prohibited from injection, may be injected. *See* Subpart C - Petitions and Procedures, 40 C.F.R. § 148.20. In order to obtain such an exemption from a prohibition under Subpart B, there must be a demonstration showing that, there will be no migration of hazardous constituents from the injection zone for as long as the waste remains hazardous. *See* 40 C.F.R. § 148.20. Among other requirements which currently must be demonstrated under Subpart C, it must be proven that reliable predictions can be made showing that:

(i) Fluid movement conditions are such that the injected fluids will not migrate within 10,000 years:

(A) Vertically upward out of the injection zone; or

(B) Laterally within the injection zone to a point of discharge or interface with an Underground Source of Drinking Water (USDW) . . . ; or

(ii) Before the injection fluids migrate out of the injection zone or to a point of discharge or interface with USDW, the fluid will no longer be hazardous because of attenuation, transformation, or immobilization of hazardous constituents within the injection zone by hydrolysis, chemical interactions or other means.

the term 'the wastes' in the statutory no-migration standard referred to those wastes that migrate out of the injection zone, and that the no-migration standard is therefore satisfied if the injector demonstrates that no hazardous waste will migrate out of the injection zone."¹⁹⁹ Further, the EPA "decided that the term 'migration' encompasses not only fluid migrations, but also [encompasses] migrations by molecular diffusion."²⁰⁰ In upholding the EPA's interpretation of the 1984 Amendments, a divided District of Columbia Circuit Court applied the *Chevron* test to the EPA's application of the no-migration clause found in section 3004(g)(5) of the Amendments.²⁰¹ Although the majority of the court found that the

Id.

199. NRDC v. EPA, 907 F.2d at 1152.

200. *Id.*

201. *See id.* at 1153. *See also* *Chevron U.S.A., Inc. v. NRDC, Inc.*, 467 U.S. 837 (1984). The *Chevron* test is a two part analysis applied to review an agency's construction of a statute. The first step of the *Chevron* test specifically reviews a statutes language, "[i]f the intent of Congress is clear, that is the end of the matter; . . . as well as the agency, must give effect to the unambiguously expressed intent of Congress". *Id.* at 842, 843. If however, "the statute is silent or ambiguous with respect to the specific issue, the question for the court is whether the agency's answer is based on a permissible construction of the statute." *Id.* at 843. This second step assumes that Congress has provided the agency with alternatives from which the agency may choose, acting reasonably and consistent with the statute. Further, "a court may not substitute its own construction of a statutory provision for a reasonable interpretation made by the administrator of an agency." *Id.* at 844. In a 1996 decision, the Court of Appeal of Louisiana set forth the standard of review that its state environmental agency must apply in granting an exemption from a statutory prohibition against deep-well injection of hazardous waste. In the case *In re Rubicon, Inc.*, the Court of Appeal of Louisiana reversed and remanded the State Department of Environmental Quality (DEQ) approval of an exemption from that states' land disposal restrictions. *In re Rubicon, Inc.*, 670 So. 2d 475 (La.App. 1st Cir. 1996). The court held that, in rendering its decisions the DEQ must at least present: "1) a general recitation of the facts as presented by all sides; 2) a basic finding of facts as supported by the record; 3) a response to all reasonable public comments; 4) a conclusion or conclusions on all issues raised which rationally support the order issued; and 5) any and all other matters which rationally support the DEQ's decision." *Id.* at 483. Citing earlier Louisiana decisions, the court of appeal held, that any written "decision must satisfy the issues of whether: 1) the potential and real adverse environmental effects of the proposed project have been avoided to the maximum extent possible; 2) a cost-benefit analysis of the environmental impact costs balanced against the social and economic benefits of the project demonstrates that the latter outweighs the former; and 3) there are alternative projects or alternative sites or mitigating

no-migration standard was ambiguous,²⁰² it determined that the EPA Administrator had acted reasonably and in a manner consistent with the statute in deciding "that a [particular] disposal method must meet the Congressionally sanctioned no-migration standard in order to protect human health and the environment."²⁰³

Industry groups also failed in their challenge of the EPA's interpretation of the no-migration standard when they argued that the standard in the 1984 Amendments should be identical to the standard in the SDWA.²⁰⁴ In support of the EPA's interpretation of the no-migration standard, the court reasoned that the texts of RCRA and SDWA are not supportive of the industry's argument.²⁰⁵ "The SDWA protects sources of drinking water; and RCRA protects human health and the environment."²⁰⁶ SDWA requires that underground injection must not endanger drinking water sources, and RCRA requires that there must be no migration of hazardous constituents from the injection zone for as long as the constituents remain hazardous; there is no reference to anything

measures which would offer more protection to the environment than the proposed project without unduly curtailing non-environmental benefits to the extent applicable." *Id.* at 483 (citing *Blackett v. Louisiana Department of Environmental Quality*, 506 So. 2d 749 at 754 (La.App. 1st Cir. 1987) and *Save Ourselves v. Louisiana Environmental Control Commission*, 452 So. 2d 1152 (La. 1984)).

202. See *NRDC v. EPA*, 907 F.2d at 1159.

203. *Id.* at 1156.

204. See Safe Drinking Water Act (SDWA), 42 U.S.C. § 300h(b)(1) (1988 & Supp. IV 1992). See also *NRDC v. EPA*, 907 F.2d at 1156-1157. 42 U.S.C. § 300h(b)(1) provides that the EPA's regulations "shall contain minimum requirements for effective programs to prevent underground injection which endangers drinking water sources within the meaning of subsection (d)(2)." 42 U.S.C. § 300h(d)(2) provides that underground injection endangers drinking water sources "if such injection may result in the presence in underground [drinking] water which supplies or can reasonably be expected to supply any public water system of any contaminant, and if the presence of such contaminant may result in such system's not complying with any national primary drinking water regulation or may otherwise adversely affect the health of persons."

205. See *NRDC v. EPA*, 907 F.2d at 1156.

206. *Id.* at 1157.

outside the injection zone that might be threatened by such a migration.²⁰⁷

C. Molecular Diffusion

The Court in *NRDC v. EPA* also addressed industry's challenge to the EPA's requirement "that there be no migration of hazardous constituents outside the injection zone via molecular diffusion."²⁰⁸ In upholding the EPA's finding that molecular diffusion may result in the migration of hazardous constituents, the Court pointed to a study entitled *Modeling of Representative Injection Sites*, supporting the methodology as appropriate in such a context.²⁰⁹

D. The 10,000 Year Standard

Next, the court ruled that the EPA had not abused its discretion in requiring injectors to show that there would not be any migration of hazardous constituents outside the injection zone for 10,000 years or until the wastes become non-hazardous.²¹⁰ First, the court noted that Congress never decided a period of less than 10,000 years was adequate for keeping hazardous waste within the injection zone.²¹¹ Industry was unable to support its claim that less than 10,000 years confinement enjoyed either statutory, textual, or historical support.²¹² The court further noted that even if industry

207. See *NRDC v. EPA*, 907 F.2d at 1157. The court noted that there was nothing in the statutory texts to indicate that Congress intended that RCRA and SDWA standards be identical. See *id.*

208. *Id.* "Molecular diffusion is constituent movement not caused by the pressures built up during injection but by the physical tendency for molecules to move from an area of greater concentration to an area of lower concentration." *Id.* at n.11, (citing Underground Injection Control program, 52 Fed. Reg. at 32,446, 32,452-53 (preamble to proposed rules)).

209. See *NRDC v. EPA*, 907 F.2d at 1158.

210. See *id.*

211. See *id.*

212. See *id.* In support of its position, industry relied upon legislative reports speaking of the decomposition time of hazardous waste in terms of centuries instead of millennia. See *id.* (quoting S. REP. No. 284, 98th Cong., 1st Sess. 15 (1983)) ("Wastes chemically decompose in a land disposal facility, although often this decomposition occurs very slowly stretching over centuries."); H.R. REP. No. 198, 98th Cong., 1st Sess. 33,

was correct in its position that some injected hazardous wastes will cease to be hazardous in less than 10,000 years, "the regulations specifically allow the injector to seek relief on the basis of such a showing."²¹³ "The regulations require an injector to show that there will be no migration so long as the wastes remain hazardous, or for 10,000 years, whichever time period is [less]."²¹⁴

In rejecting industry's challenge to the 10,000 year standard, the court agreed with the rationality of EPA's choice of the standard "because it would be long enough to insure that the 'no-migration' standard would be met, and yet short enough to come within the limitations of predictability."²¹⁵ Therefore, the EPA's regulation properly placed its emphasis on the statutory requirement of preventing migration of hazardous waste for as long as it remains hazardous. The regulation does not require injectors to control wastes for a longer period.²¹⁶ Therefore, the EPA's choice was reasonable and consistent with the statutory purpose of preventing migration of hazardous constituents as long as they remain hazardous.²¹⁷

reprinted in 1984 U.S.CODE CONG.& AD. NEWS 5592 ("land disposal of wastes . . . might be appropriate if there is a reasonable certainty that wastes will be contained in the very long-term (i.e., at least several hundred years.")).

213. NRDC v. EPA, 907 F.2d at 1158. See 1984 Amendments, § 3004(g)(5), 42 U.S.C. § 6924(g)(codified as amended 1988 & Supp. IV 1992). The no-migration standard can be avoided through pretreatment, as defined under section 3004(m), 42 U.S.C. § 6924(m)). Such pretreatment must immobilize or render the wastes non-hazardous. See 42 U.S.C. § 6924(g)(5). If the waste is not pretreated or a showing of no-migration is not made, land disposal, including deep-well injection, is prohibited. See *id.* If such a prohibition occurs, the only alternative action an injector has is to obtain an extension through a variance granted after a case-by-case review under section 3004(h), 42 U.S.C. § 6924(h)(1988).

214. NRDC v. EPA, 907 F.2d at 1158. See 40 C.F.R. § 148.20(a)(1)(i), Subpart C - Petition Standards and Procedures: "Fluid movement conditions are such that the injected fluids will not migrate within 10,000 years."

215. NRDC v. EPA, 907 F.2d at 1158. See also 53 Fed. Reg. 28,126 (1988).

216. See NRDC v. EPA, 907 F.2d at 1158.

217. See *id.* But see S. REP. NO. 284, 98th Cong., 1st Sess. 15 (1983) cited in NRDC v. EPA, 907 F.2d at 1158 ("Wastes chemically decompose in a land disposal facility, although often this decomposition occurs very slowly stretching over centuries.").

E. The Definition of Injection Zone

Finally, the court considered NRDC's challenge to EPA's definition of "injection zone."²¹⁸ Although RCRA does not contain a statutory definition of the term, "both EPA and NDRC agree[d] that Congress intended to incorporate the pre-existing regulatory definition from EPA's Safe Drinking Water Act."²¹⁹ Under RCRA, the term "injection zone means a geological 'formation', group of formations, or part of a formation receiving fluids through a well."²²⁰

However, NRDC argued that when EPA adopted this definition for the regulations, it added a new interpretation to it.²²¹ At the heart of this argument was the question of whether the existing definition of injection zone included "confining layers."²²² Additionally, NRDC argued that fluid penetration into such material is necessarily migration from an injection zone.²²³ Under EPA's interpretation, "the injection zone could extend across both the porous formations into which fluid is actually injected and the confining material,

218. *See* NRDC v. EPA, 907 F.2d at 1162.

219. *Id.* *See* Underground Injection Control program, 53 Fed. Reg. 28,121 (1988).

220. 40 C.F.R. § 146.3. *See also* S. REP. NO. 284 at 16 (citing regulations); Underground Injection Control program, 53 Fed. Reg. at 28,121 (1988).

221. *See* NRDC v. EPA, 907 F.2d at 1162.

222. *See* Underground Injection Control program, 53 Fed. Reg. at 28,122. Under the definition of injection zone in 40 C.F.R. § 146.3, "permit writers must [utilize] their expertise and knowledge of local hydrogeology [in order] to determine the size and characteristics of injection zones." However, the "regulations place [limits] on [the] permit writer's discretion." Underground Injection Control Program, 53 Fed. Reg. at 28,121, 28,122. "First, under 40 C.F.R. §§ 144.3 and 146.3, hazardous waste injection must take place below the lowermost formation containing within one-quarter mile of a well bore an Underground Source of Drinking Water (USDW)." Underground Injection Control Program, 53 Fed. Reg. at 28,122. "There must also be a confining zone which is capable of limiting fluid movement above an injection zone." *Id.* (citing 40 C.F.R. § 146.3). "The function of a confining zone is to oppose the upward pressures of injection and prevent fracturing of the geologic system. Nothing in this definition [] states that even an injection zone may not contain confining material or that a confining zone may not include part of an injection zone. Only the functional ability to oppose upward migration is necessary." *Id.*

223. *See* NRDC v. EPA, 907 F.2d at 1162.

which is composed of less permeable layers of rock and clay."²²⁴

The result of this interpretation is that hazardous constituents which leak into confining material will not be considered as "forbidden migration" in those cases where the particular confining material is part of the injection zone.²²⁵ "NRDC argue[d] that confining material cannot be included in an injection zone because it does not 'receiv[e] fluids through a well'."²²⁶ "NRDC suggest[ed] that EPA's construction has created an improper overlap between 'injection zone' and 'confining zone,' another term defined in the pre-existing SDWA regulations: [as] a geological formation, group of formations, or part of a formation that is capable of limiting fluid movement above an injection zone."²²⁷ Additionally, NRDC alleged that the "EPA's new reading allows the injection zone to extend into what should properly be considered [as] only the confining zone."²²⁸

In rejecting NRDC's position, the court noted that the language of the two definitions is not mutually exclusive.²²⁹ In fact, "fluids from an injection well can seep into the confining material, and when they do that material will 'receiv[e] fluids through a well'."²³⁰ Importantly, because some seepage is inevitable,²³¹ the court found that "NRDC's interpretation

224. *Id.* (quoting Underground Injection Control program, 53 Fed. Reg. at 28,121).

225. *See id.*

226. *Id.*

227. *Id.* at 1163 (quoting 40 C.F.R. § 146.3 (1988)).

228. *Id.* (emphasis added).

229. *See* NRDC v. EPA, 907 F.2d at 1163.

230. *Id.*

231. *See id.* *See also* Underground Injection Control program, 53 Fed. Reg. 28,118, 28,122 (1988). During promulgation of Final Rules, the EPA commented that those opposing the definition of "injection zone" improperly believe that there is always a discrete boundary where permeable material meets impermeable material which will not allow injection fluid to penetrate. *See* Underground Injection Control program, 53 Fed. Reg. 28,122. The EPA noted that this belief does not conform with physical reality since "within a formation, there is often not a line where a large permeable strata meets a less permeable strata." NRDC v. EPA, 907 F.2d at 1163. For example, "geologic formations, such as . . . the Gulf Coast Basin are often several hundred feet thick . . . [with varying] lithology resulting in variations in permeability, porosity and hydrau-

of injection zone, coupled with the 'no migration' standards of Section 6924 [of the 1984 Amendments,] would result in an absolute ban on deep well injection of wastes," which is a result clearly not intended by Congress.²³² The court ultimately upheld the EPA's interpretation of "injection zone", finding that "[t]he definitional issue here is highly technical, and [there was] no legal fault in the EPA's solution."²³³ By upholding the EPA's regulations, the court confirmed the EPA's continuing ability to interpret the meaning of the "protective of human health and the environment," as applied to the no-migration standard mandated by Congress, "so far as injection of subsection (g) wastes is concerned."²³⁴

IX. Dilution Rule for Deep-Well Injection Facilities

On April 30, 1992, industry trade associations, waste treatment companies, and environmental groups petitioned the United States Court of Appeals, District of Columbia Circuit, in *Chemical Waste Management, Inc. v. United States Environmental Protection Agency*.²³⁵ Petitioners sought review of orders of the EPA promulgating regulations implementing the land disposal ban of hazardous wastes mandated by RCRA.²³⁶ In its review, the court of appeals focused, in

lics." Underground Injection Control program, 53 Fed. Reg. 28,122. Further, confining material might not actually repel fluids; they oppose upward movement, and where adequate, stop it. *See id.* Thus, the EPA determined that "some amount of penetration into confining material within the injection zone can occur, but should not be considered migration for the purposes of RCRA Sections 3004(f) and (g), [42 U.S.C. § 6924], provided the penetration occurs within the injection zone." *Id.*

232. NRDC v. EPA, 907 F.2d at 1163.

233. *Id.*

234. *See id.* at 1155, 1156 (defining the "protective" standard to be applied to injection wells). The court in NRDC v. EPA found that the 1984 Amendments required the EPA to separately consider and promulgate regulations for salt dome repositories in order to give the NRDC an opportunity to challenge the regulations. *See id.* at 1165. The issue was remanded to the EPA for reconsideration. *See id.*

235. 976 F.2d 2 (D.C. Cir. 1992). [hereinafter *Chemical Waste Management v. EPA*].

236. *See id.* at 2. The regulations under review in *Chemical Waste Management v. EPA* implement the land-ban program for the last third of the ranked list of wastes known as the 'third-third' wastes. They largely consist of treat-

part, upon the "final 'third-third' rule, [in which] the EPA promulgated a dilution rule for deep injection well[s]." ²³⁷

Under 40 C.F.R. § 148.1(d)(1991), operators of Class I deep injection wells were permitted to dilute *characteristic* wastes to remove the characteristic prior to injecting those wastes.²³⁸ Unlike the Clean Water Act (CWA), which does not allow a waste to be diluted in a CWA system, operators of deep injection wells could dilute all characteristic wastes, including those for which a specific treatment method is required.²³⁹ In *Chemical Waste Management v. EPA*, NDRC petitioners argued that the EPA rule violated RCRA because it resulted in the land disposal of hazardous wastes before being treated to section 3004(m)(1) standards.²⁴⁰ "[T]he EPA

ment standards for characteristic wastes. See *id.* at 6. See also Land Disposal Restrictions for Third-Third Scheduled Wastes, 55 Fed. Reg. 22,520-720 (1990). At the outset of the RCRA program, the EPA identified "four characteristics as hazardous: ignitability, corrosivity, reactivity, and Extraction Procedure (EP) toxicity." *Chemical Waste Management v. EPA* at 8. "For example, a waste is considered corrosive . . . if it is aqueous and has a pH less than two or greater than 12.5." *Id.* at 9.

237. *Id.* at 24. Before promulgation of the 'third-third' rule, "many deep injection wells handled characteristic wastes without being subject to Subtitle C requirements." *Id.* at 25. In promulgating section 148.1(d), the EPA claimed that the rule was needed to protect existing SDWA systems. See *id.* The EPA argued that such a rule was needed since a dilution prohibition would require the restructuring of large facilities accustomed to mixing waste streams to remove a characteristic prior to disposal. See *id.* The EPA "also argued that treatment to RCRA standards would provide no environmental benefit over dilution and injection." *Id.*

238. See *Chemical Waste Management v. EPA*, 976 F.2d at 24, 25.

239. See *id.* at 25. For example, high total organic compound ignitable wastes, which must otherwise be incinerated or used as a fuel substitute, may be diluted by operators of deep injection wells. See *id.* But see 40 C.F.R. § 268.3(b)(1995) ("waste may not be diluted in a CWA system if 'a method has been specified as the treatment standard in section 268.42 . . .'").

240. See *Chemical Waste Management v. EPA*, 976 F.2d at 9. Under the 1984 Amendments to RCRA "the Administrator [was required to] promulgate treatment standards, compliance with which would authorize land disposal, at the same time he publishe[d] the land ban." *Id.* The final regulations under RCRA § 3004(g)(5) provide, in relevant part, that:

"[a] method of land disposal may not be determined to be protective of human health and the environment (except with respect to [] hazardous waste which has complied with the pretreatment regulations promulgated under subsection (m) of this section) unless, upon application by an interested person, it has been demonstrated

argue[d] that the rule meets RCRA because no 'hazardous' wastes are injected."²⁴¹

Further, the EPA argued that the rule was necessary to comply with the SDWA governance of deep-well injection.²⁴² Consistent with its finding that sections 3004(g)(5) and (m), in combination, authorized the EPA to mandate treatment of wastes to reduce the risks beyond those presented by the characteristics themselves, the court of appeals reasoned "that dilution followed by injection . . . is permissible only where dilution itself [] meets section 3004(m)(1) [treatment] standards or where the waste will subsequently [fully] meet section 3004(m)(1) standards."²⁴³ Since "deep-well injection is permanent land disposal, [the court's reasoning] permits diluted decharacterized wastes to be [] injected only when dilution meets the section 3004(m)(1) standard or where the deep-well secures a no-migration variance."²⁴⁴

Section 148.1 of the regulations identifies "hazardous wastes that are restricted from disposal into Class I hazardous waste injection wells and defines those circumstances under which a waste, otherwise prohibited from injection, may be injected."²⁴⁵ Currently, under section 148.1(d),

[w]astes that are hazardous only because they exhibit a hazardous characteristic, and which are otherwise prohibited [under Part 148] are not prohibited or hazardous if the wastes: (1) Are disposed into a nonhazardous injection well . . . and do not exhibit any prohibited characteristic of hazardous waste . . . at the point of injection; or (2) Do not

to the Administrator, to a reasonable degree of certainty, that there will be no migration of hazardous constituents from the disposal unit or injection zone for as long as the wastes remain hazardous."

Id. (citing RCRA, 42 U.S.C. § 6924(m)(1)).

The treatment regulations under section 3004(m)(1), 42 U.S.C. § 6924(m)(1) shall specify that "those levels or methods of treatment, if any, which substantially diminish the toxicity of the waste or substantially reduce the likelihood of migration of hazardous constituents from the waste so that short-term and long-term threats to human health and the environment are minimized." *Id.*

241. *Id.*

242. See *Chemical Waste Management v. EPA*, 976 F.2d at 25.

243. *Id.*

244. *Id.*

245. 40 C.F.R. § 148.1(a).

exhibit any prohibited characteristics of prohibited waste . . . at the point of injection and are disposed into a hazardous injection well . . . that receives only non-prohibited hazardous wastes.²⁴⁶

Presently, dilution is prohibited as a substitute for treatment and may not be utilized to circumvent a land disposal prohibition imposed by RCRA section 3004.²⁴⁷

X. Conclusion

As a result of overlapping regulation and the EPA's foot-dragging through the 1970s and early 1980s, the regulation of hazardous waste disposal by deep-well injection has been a slow and stuttering process. To be fair, much of the EPA's tardiness during this early period of regulation can be attributed to the lack of scientific knowledge of geologic formations and their nature, extent, and reaction with the toxic waste to be injected. It is not difficult to understand the lack of adequate scientific knowledge when one considers that the answers lie thousands of feet underground and over vast areas.

Although there are few documented cases of aquifer contamination through deep-well injection of hazardous wastes, much undiscovered harm to the environment may already have inadvertently taken place through uncontrolled injection of hazardous wastes over the last 70 years. The magnitude of this undiscovered contamination will likely never become readily apparent and, even if discovered, may be impossible to clean up. In order to prevent the risk of potential damage in the future, there must be scientific research into the fate of each specific hazardous substance that is to be disposed of by deep-well injection. The possible reaction of the hazardous substance with the host rock or clay repository

246. 40 C.F.R. § 148.1(d)(1), (2).

247. See 40 C.F.R. § 148.3 (July 1, 1995). Dilution is now prohibited as a substitute for treatment. See *id.* Presently, under section 148.3, "the prohibition of 40 C.F.R. § 268.3 applies to the owners or operators of Class I hazardous waste injection wells." *Id.* Section 268.3(a) provides, in pertinent part, "no generator, transporter, handler, or owner or operator of a treatment, storage, or disposal facility shall in any way dilute a restricted waste . . . to circumvent a land disposal prohibition imposed by RCRA § 3004." 40 C.F.R. § 268.3(a).

and possible short- and long-term migration to sensitive areas must be determined.

There has been some decrease in the injectable amounts of low volume/high concentration hazardous material, as a result of drastic changes in industrial processes, recycling and modifying the waste by chemical, physical, and biological treatment techniques. However, deep-well injection remains best suited to the disposal of high volume/low concentration wastes. Moreover, there is no better or more cost efficient technology for the disposal of these wastes on the horizon.

Many industries have found it cost-effective to apply what has recently come to be called "cradle to cradle" waste management, which may serve to reduce the injection of some high concentration wastes through reduction rather than disposal. Voluntary source reduction throughout industry has become a major factor in the hazardous waste market. Reduction of waste is the top rung in the waste management hierarchy, generally followed by recycling, destruction, and disposal. Many companies have been motivated to implement changes in waste management as it has become cost-effective to reduce the volume of wastes resulting from manufacturing processes.

Always image conscious, industry is sensitive to the concerns of environmental activists and plant neighbors, as well as to the high Toxic Release Inventory (TRI) numbers that go hand-in-hand with injection-well use. In order to reduce deep-well injections, companies have employed techniques such as chemical recovery, neutralization, and acid regeneration.²⁴⁸ As a result, many companies have expressed a desire to reduce deep-well injection practices in favor of reduction and control. For example, DuPont was able to shut down a 27-million lbs/year deep-well located in Louisville, Kentucky in late 1992 and plans to be able to shut all its wells by the year 2000.²⁴⁹

248. See Elisabeth Kirschner, *An Anxious Industry Sees New Limits To Its Options*, *supra* note 19, at 23.

249. See *id.* Materials once considered wastes may now be sold successfully. See *id.* An example of such salable materials are; gypsum from neutralized sulfuric acid, hydrochloric acid after purification, and a flocculating agent from ti-

While the trend toward recycling, process control, and regeneration is encouraging as methods to reduce waste volume, they do not eliminate the need for a repository of some of the most hazardous chemical waste products. Since all hazardous wastes are not amenable to treatment or destructive processes, it is important that deep-well injection remain an alternative method of disposal until such time as better waste control practices exist.²⁵⁰ As such, serious efforts should be made toward preserving invaluable, but limited, deep-well injection zones for our most difficult hazardous waste disposal problems.

Since deep-well injection is likely to continue as a method of hazardous waste disposal into the foreseeable future,²⁵¹ it behooves Congress and the EPA to make sure it meets the statutory mandate to "protect human health and the environment" through careful and scientifically supported regulation along with enforcement of existing regulations. Unfortunately, a report by the U.S. General Accounting Office (GAO) found that in states for which EPA headquarters had direct responsibility for oversight evaluations of the EPA's UIC program, the program was not working.²⁵² The GAO found that, although states having primary enforcement responsibilities met minimum EPA requirements, periodic inspections were not performed by the EPA regional offices where they had program responsibility.²⁵³

tanium dioxide wastes. *See id.* DuPont estimates that its waste-to-sales program has yielded \$70 million. *See id.*

250. *See id.* "Most injected wastes are mixtures of salts, organics and water [which can be] very difficult to deal with by any other [disposal] method." *Id.* Some companies feel that "source reduction through new reactor designs, process controls, new catalysts and better neutralization [are the first line of attack in reducing a dependence on deep-well injection]." *Id.* Moreover, "treatment options that would extract or oxidize solvents, crystallize salts and biologically treat leftover wastewater [are being studied to further reduce waste]." *Id.*

251. *See* Ronald Begley, *TRI Releases Down Sixth Year In A Row*, *supra* note 19, at 7. Despite substantial reduction in the volumes of hazardous wastes cited by industry officials, the EPA's 1992 TRI figures noted an increase in the use of deep-well injection of 1% when off-site transfers for treatment and disposal were counted in the EPA figures. *See id.*

252. *See* HAZARDOUS WASTE: CONTROLS OVER INJECTION WELL DISPOSAL OPERATIONS, *supra* note 4, at 36.

253. *See id.* at 35-36.

Further, "EPA headquarters did not perform oversight evaluations of the regional office program . . . [to make sure] that well inspections were performed."²⁵⁴ Finally, Quarterly Non-Compliance Reports (QNCRs) were not prepared and submitted to EPA headquarters.²⁵⁵ The GAO report noted that without periodic inspections and QNCRs submitted, the possibility of violations not being identified and corrected remains.²⁵⁶

The GAO's findings point to an ongoing need for strong EPA oversight to guarantee that regulatory functions under "the UIC program for hazardous waste injection wells are in fact being performed. . . ."²⁵⁷ To strengthen EPA's oversight functions, the Administrator should require EPA headquarters to evaluate their regional offices yearly, confirming that inspections as well as testing and operator reports are being carried out.²⁵⁸ Additionally, ensuring that EPA regional offices perform and document inspections and report noncompliance incidents to EPA headquarters will improve EPA's oversight ability.²⁵⁹

Along with weak EPA oversight of regional office programs, the GAO found enforcement of EPA regulations concerning deep-well injection extremely low. EPA performance in this area was described by some members of Congress as underwhelming.²⁶⁰ Recent studies have determined that actions taken by state agencies are "generally commensurate with the seriousness of the violation" and most violations are resolved in a timely manner under agency auspices.²⁶¹ In order to guarantee public safety, there must be a strict enforce-

254. *Id.* at 5.

255. *See id.* at 36.

256. *See id.*

257. HAZARDOUS WASTE: CONTROLS OVER INJECTION WELL DISPOSAL OPERATIONS, *supra* note 4, at 36.

258. *See id.*

259. *See id.*

260. *See Resource Conservation And Recovery Act Reauthorization, Hearings, supra* note 5, at 6, (Opening statement of The Honorable Toby Moffett, Mar. 31, 1982).

261. REPORT TO CONGRESS ON INJECTION OF HAZARDOUS WASTE, *supra* note 18, at VI-17.

ment regime headed by the EPA. To be effective, this regime must be linked to a continuous flow of information from inspections, testing, and reporting by both the primacy states and EPA regional offices.²⁶²

Until better, more cost-effective methods of handling hazardous wastes come to the forefront, deep-well disposal will remain in use. As such, it is important that scientific research into the practice of deep-well injection continue. The results of such scientific research need to remain the impetus for timely legislative and regulatory action, followed by a policy of strict oversight and enforcement. Only in so doing, can the EPA ensure the protection of "human health and the environment" from the known hazards of deep-well injection in a responsive and consistent manner.

262. See generally, HAZARDOUS WASTE: CONTROLS OVER INJECTION WELL DISPOSAL OPERATIONS, *supra* note 4.