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Halina Szejnwald Brown

Brian J. Cook

Robert Krueger
Jo Anne

Shatkin

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Introduction

Congress designed the strict joint and several liability provision of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA or Superfund)[1] to provide incentives for private cleanups at Superfund sites and to deter improper disposal of hazardous wastes. The provision also generated an explosion of litigation as government and private sectors, including the insurance industry, confronted the potentially massive costs of assessing and cleaning up hazardous waste disposal sites and restoring contaminated groundwater. The latter, in turn gave rise to efforts to reform the liability provision in CERCLA.

In the midst of confrontations and efforts to reassign blame, opposing parties have nevertheless developed a consensus that the worst sites were created by mostly legal activities that, given the state of the scientific knowledge and technological development during three post-war decades of rapid U.S. economic growth, the magnitude of consequences for groundwater could hardly have been foreseen.

Students of environmental policy have generally assumed that the decade of the 1970's marked a turning point in the development of

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* Dr. Brown, Professor of Environmental Health and Director, Environmental School, Clark University, holds a Ph.D. (Chemistry) from New York University. Email: *hbrown@clark.edu*. Dr. Cook, Assoc. Professor of Government, Clark University, holds a Ph.D. (Political Science) from the University of Maryland, College Park. Mr. Krueger, doctoral candidate in the Graduate School of Geography, Clark University, holds a B.S. (political science) Oklahoma State University, Still Water, and M.S.L. from Vermont Law School. Dr. Shatkin, Senior Scientist at Menzie-Cura Associates, an environmental consulting firm, holds a Ph.D. (Environment, Technology and Society) from Clark University.

1 Pub. L. 96-510, Dec. 11, 1980, 94 Stat. 2767, codified at 42 U.S.C. §§ 9601 et seq. (1994).

knowledge about the potentially disastrous effects of land-based disposal of industrial waste. Assessing the "policy learning" associated with the passage and further development of Resource Conservation and Recovery Act of 1976 (RCRA),[2] for example, Richard Barke has argued that at the time RCRA became law:[3]

> technologies for disposal of hazardous waste were... undeveloped. Landfill was the most common technique but no one knew all of its side effects, and alternatives... had received little attention.

In recent years, this general assumption has been challenged, most notably by Colten who has, in great detail, traced the development of scientific knowledge about environmental effects of waste disposal, and the history of hazardous waste treatment and disposal technologies during several decades before creation of the Environmental Protection Agency (EPA.)[4] Building on Colten's work, we take a closer look at the role of technical and professional communities in the emergence of a comprehensive national policy for managing industrial waste.

Specifically, in the first part of the paper we show that during the 1940's, 1950's and 1960's, segments of the scientific and technical communities actively debated the advisability of land-based disposal of municipal and industrial waste, were cognizant of toxic properties of industrial waste, reached a consensus about the link between the degradation of groundwater and land-based hazardous waste disposal, and issued strong advisories about threats to soil and groundwater. Yet, this understanding never found its way into the process that eventually created RCRA.

Our approach to explaining this apparent paradox is to compare, in the second part, the history of development of hazardous waste policy with the history of national air pollution control policy. The reason, we conclude, for the slow penetration of a mature technical and scientific body of knowledge into the national policy agenda, was: (1) the nature

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2 Pub. L. 94-580, Oct. 21, 1976, 90 Stat. 2795 (enacted no currently effective sections).

3 R. Barke, *Policy Learning and the Evolution of Federal Hazardous Waste Policy*, 14 Policy Studies J. 123, 125 (1985).

4 C. E. Colten, *A Historical Perspective on Industrial Wastes and Groundwater Contamination*, 81 Geogr. Rev. 215, 217 (1991) and C. E. Colten & P. N. Skinner, The Road to Love Canal: Managing Industrial Waste before EPA (1996).

of the hazardous waste problem, in which the causal links between the management of technology and adverse consequences to human health and the environment were not self-evident and (2) the absence of a policy actor who could link knowledgeable recognition of the problem with the initiation of political action.

Policy Theories and Hazardous Waste Policy

Empirical research and theory development concerning policy initiation, development and change over an extended time are at the cutting edge of public policy studies. John Kingdon and Paul Sabatier led in this effort. Kingdon's work has stressed the complexity and fluidity of policy making.[5] He has conceived of three independent but sometimes, at a given time, intersecting "streams" of policy activity involving identification and definition of problems, development of alternative solutions, and a particular arrangement of electoral, partisan, and interest group forces (the problem, policy and political streams, respectively). Sabatier and his collaborators have emphasized the importance of examining policy change and learning over a decade or more.[6] Their advocacy coalition framework takes into account how contention and compromise among coalitions of policy actors have shaped policy formulation and implementation within the context of major systemic features and institutional structures.

Both conceptual frames have stretched time spans and broadened systematically the range of actors relevant for assessing how and why a policy did or did not develop. Ideas and knowledge generated by "communities of specialists" or "professional fora" made up of governmental and nongovernmental actors, are prominent in both, and scholars have applied each in analyzing hazardous waste policy.

As already noted, Richard Barke concluded that very little was known about the hazardous waste problem at the time of RCRA's passage. Employing elements of the Sabatier approach, he saw a great deal of policy learning occurring over the first eight years of RCRA's

[5] *See e.g.,* J. W. Kingdon, Agendas, Alternatives, and Public Policies (2d Ed. 1995). *See also,* F. R. Baumgartner & B. D. Jones, Agendas and Instability in American Politics (1993) and D. A. Rochefort & R. W. Cobb, The Politics of Problem Definition: Shaping the Policy Agenda (1994).

[6] *See, e.g.,* P. A. Sabatier & H. C. Jenkins-Smith, Policy Change and Learning: An Advocacy Coalition Approach (1993).

existence. What most distinguished the early life of RCRA, Barke concluded, were "changes in knowledge about the scope and nature of the hazardous waste problem."[7]

In assessing the establishment of RCRA, Charles Davis found the Kingdon approach readily appropriate.[8] The legislation "was put together by 'hidden specialists' within the EPA and congressional committees with expertise in environmental policy rather than [by] nongovernmental political actors."[9] Davis also found centrally relevant Kingdon's observations about the importance of recombination in policy making — "repackaging older ideas into a new format"[10] — with respect to the design of the regulatory framework in RCRA.

We agree that both the Kingdon and Sabatier approaches are useful for analyzing hazardous waste policy initiation and development. Indeed, much greater discernment on the matter can be gained by combining the Barke and Davis analyses. Doing so would produce insight into how (1) the body of technical knowledge relevant to the policy problem developed over time, (2) the policy actors who took the initiative to address the problem tapped that body of knowledge and (3) the body of knowledge developed further in the context of the established policy subsystem. The first two of these dimensions constitute the primary focus of the research and analysis we discuss here. In particular, by extending the frame for analysis farther back in time, we have discovered that a considerable degree of policy learning about the hazardous waste problem had already accumulated long before RCRA appeared on the national agenda. Understanding the contours of that body of knowledge, especially from the perspective of its contribution to the stimulation of policy formulation, is critical to gaining further insight into hazardous waste policy development.

The Body of Knowledge about Industrial Waste Disposal

From the 1940's to 60's, scientists and engineers developed an extensive body of theory and empirical findings concerning the hazardous properties of industrial waste, groundwater hydrology and

7 Barke, *supra* note 3, at 130.

8 C. E. Davis, The Politics of Hazardous Waste (1993.)

9 *Id.* at 19.

10 *Id.* at 20.

links between land disposal of industrial waste and groundwater contamination. Colten has summarized the state of knowledge:[11]

> Before 1900, sanitary scientists and chemists, who were familiar with the basics of groundwater movement, identified several important processes relating to the transport of foreign matter by groundwater.... By 1910, sanitation experts were aware of the hazards of toxic metals, brines, and acids from mines on groundwater supplies.... By 1940, ... a substantial literature on groundwater processes existed. Hydrologists had a definite understanding of the basic theoretical physics of fluid movement through porous media, experimental data on water movement through various soil and rock types, and practical measurements derived from field investigations. The accumulated wisdom of hydrology enabled investigators to act quickly in identifying sources of contamination during the 1940's.

By the 50's, hydrological analysis was a well recognized tool in identifying disposal sites.[12]

> In the issuance of orders governing disposal of wastes the Commission will give due consideration to the degree of isolation, terrain, geology, drainage, land and underground water use and the quantities and qualities of waste involved....

> Present day knowledge of hydrology makes it readily possible to affix blame once an injury has occurred, and the long held view of the courts that underground water movement is not susceptible to scientific analysis has gone forever.

> The new part of underground waste disposal is the discovery, in recent months, of a way to test these underground rock formations in advance of any injection of wastes. The test will make certain that the waste waters will be controlled, that they will not interfere with valuable underground fresh water and that they will not create a hazard for surrounding property, either now or in the years to come.

The hazardous properties of industrial wastes, as a distinct class of waste, were also widely acknowledged. Textbooks and research articles also offered methods for treatment and disposal of chemical wastes.[13]

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11 Colten (1991), *supra* note 4.

12 N. V. Olds, *Legal Aspects of Ground Water Contamination,* in Proc. 7th Ann. Industrial Waste Conf. 244, 267 (1952); N. F. Billings, *Some Geological Factors in Underground Waste Disposal,* in Proc. 9th Ann. Industrial Waste Conf. 132, 136 (1954) and W. B. Black, *Underground Waste Disposal,* 30 Sewage & Ind. Wastes 669, 669 (1958), respectively.

For example:[14]

> Eldridge has classified industrial wastes as organic, toxic and inert.... Under toxic he places wastes from metal plating, metal manufacturing,.... There are four classes of matter harmful to waters available for public use: (1) organic; (2) active inorganic; (3) inert substances; (4) bacteria.... Active inorganic chemicals consist of acids, alkalies, oxidizable salts, toxic substances and a wide variety of chemicals of every character....
>
> The industrial waste pollution problem today is greater and more crucial than the problem of our domestic sewage.... Some industrial wastes are much more deleterious than sewage. Aside from poisonous and corrosive characteristics... certain wastes destroy more of the normal oxygen content required by plant and animal life in the water than human wastes.
>
> Health agencies... now are becoming increasingly concerned with the health aspects of non-living contaminants from the manufacture and use of new chemical products, the tremendous increase of pollution of all kinds, and with managing water quality so all needs can be met.

During the 40's and 50's, cases of groundwater contamination by waste were increasingly documented, although city- or county-based[15] and often narrowly focusing on industrial sectors or classes of compounds. For example, a national survey of disposal practices at sanitary landfills by the Society of Civil Engineers focused primarily on flammable substances.[16]

By the early 60's several comprehensive reports were published — based on extensive surveys by the U.S. Public Health Service (PHS) and other agencies — documenting the effects of industrial and domestic waste disposal on groundwater quality.[17] Stanley and Eliassen's work

13 *See, e.g.,* E. B. Besselievre, Industrial Waste Treatment (1952) and N. Nemerow, Theories of Industrial Waste Treatment (1963).

14 E. Hurwitz, *Industrial Stream Pollution Problems and their Solution,* 14 Sewage Works J. 925, 926 (1942); US PHS, Excerpts from A Water Policy for the American People 189 (1951); *id.* and US PHS, The Water Pollution Control Program of the U.S. Public Health Service: A Report on Progress under the Federal Water Pollution Control Act for 1957–1958 4 (1958), respectively.

15 A. Pickett, *Protection of Underground Water from Sewage and Industrial Wastes,* 19 Sewage Works J. 464, 467 (1947).

16 Committee on Sanitary Engineering Research, ASCE, *A Survey of Sanitary Landfill Practices,* 87 J. San. Eng. Div. 65 (1961).

alone, commissioned by the Federal Housing Authority, contained 712 references and documented hundreds of cases of groundwater contamination by radionuclides, biological agents, and inorganic and organic chemicals (including pesticides, detergents, industrial waste, sewage, and petroleum products). They concluded:[18]

> Groundwater for water supplies in residential projects may be contaminated by physical, chemical, biological or viral contaminants. The older concept of sanitaria which gave special attention to bacterial contamination, using coliform organisms as an indicator of bacterial contamination, must be widened to include not only biological and chemical pollution due to sewage, but also contamination by physical, chemical, biological, and viral contaminants.... An increasing number of contaminants and a higher frequency of groundwater contamination are related to industrial development, particularly dispersal of industries.... Also, increasing dispersal of population densities in fringe areas and a substantially greater draft on groundwater resources are important factors.

The scientific and technical aspects of groundwater protection and industrial waste disposal crossed multiple disciplinary and professional boundaries, ranging from hydrology, geology, chemistry, physics, to civil and chemical engineering, and land-use planning. Publications from the 50's and 60's indicate that, apart from being familiar with the scientific and technical aspects of the issue, these professions made repeated attempts to develop standard industrial practices for handling industrial waste. Lively intercourse regarding the technical and normative aspects of this issue took place through professional journals, conferences, and committees. See Table 1.

The PHS was among the organizations actively involved in education, technical assistance and consciousness raising directed at state and local public health authorities. According to Colten, in the 1910's and 20's, PHS researchers began to point out the serious threat of nonbiological pollutants to water supplies.[19]

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17 W. A. Stanley & R. Eliassen, Status of Knowledge of Groundwater Contamination (MIT, Dept. Civil & Sanit. Eng.1960) and G. Meyer, *Geological and Hydrologic Aspects of Stabilization Ponds,* 32 J. Water Pollution Control Fed'n 820, 820 (1960).

18 Stanley & Eliassen, *supra,* at 11-12.

19 Colten (1991), *supra* note 4.

The American Water Works Association regularly sponsored workshops and conferences focused on protecting water supplies from industrial waste contamination. Its 1947 Conference in San Francisco was held concurrently with the Annual Meeting of the Federal Sewage Works Association, bringing together the largest ever gathering of sanitary and other engineers and water/sewage/industrial waste experts. Its journal reported that "land methods for disposing of, or treating, our solid and liquid wastes are being widely used. Therefore, a potential health hazard exists for those that use the nearby groundwater as a source of supply."[20]

Table 1
Public Fora and Channels of Information Dissemination on Industrial Waste 1940's – 60's

Publications
- Sewage Works Journal
- Proceedings of Annual Industrial Waste Conferences
- Sewage and Industrial Waste
- Publications by the USPHS, Water Pollution Control Program
- Journal of the American Water Works Association
- Sewage and Industrial Wastes
- Journal of Water Pollution Control Federation
- Civil Engineering Journal
- Plating
- Journal of American Electroplaters Society
- Journal of Sanitary Engineering
- Industrial and Engineering Chemistry

Organizations
- Annual Purdue Industrial Waste Conference
- US Public Health Service, Water Pollution Control Division
- American Electroplaters Society
- Federation of Sewage and Industrial Waste Associations
- Water Pollution Control Federation
- The Federation of Sewage Works Association
- American Water Works Association
- American Society of Civil Engineers
- American Chemical Society
- Manufacturing Chemicals Association

The Federation of Sewage and Industrial Wastes Associations (established during the 20's) was particularly active in consciousness

20 O. Butler, *Underground Movement of Biological and Chemical Pollutants,* 46 J. Am. Water Works Assn. 97 (1954).

raising, although it focused at the time mostly on threats to surface water:[21]

> The objects of this Federation shall be: The advancement of fundamental and practical knowledge concerning the nature, collection, treatment and disposal of sewage and industrial wastes.... The Federation is the acknowledged medium for exchange of information on stream standards, pollution survey methods and on interpretation of stream survey data and results.... Federal, interstate, state and local stream pollution control agencies are universally represented in the membership of the Federation.

Beginning in 1944, the Purdue Industrial Waste Conferences provided a unique annual forum for members of diverse professional societies, industry, academia and government agencies to interact. Their proceedings chronicle development of the theoretical and empirical knowledge of the fate of surface disposal of industrial waste as well as trends in debates over technological and policy issues.

For example, the formation in 1949 of the Metal Finishing Industry Action Committee of the Ohio River Valley Waste Sanitation Commission (ORSANCO) was announced at the 7th conference.[22] ORSANCO was the first interagency government-industry cooperative effort to gather information on industrial waste treatment and[23]

> consideration of waste liquors derived from chemical and electrochemical surface treatment of metals and related cleaning procedures... including such manufacturing operations as electroplating, electrotyping, anodizing, electropolishing and phosphating of metals and also the metallizing of plastics.

The Proceedings also indicate that the conferences served as an important catalyst for the professional and trade organizations towards self-regulation through development of commonly accepted practices for evaluating, categorizing, treatment and disposal of wastes.[24]

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21 W. H. Wisely, *Industrial Wastes Activity in the Federation* (editorial), 18 Sewage Works J. 1217, 1217 (1946).

22 W. L. Pinner, *Metal Finishing Industry Action Committee of the Ohio River Valley Waste Sanitation Commission,* in Proc. 7th Ann. Industrial Waste Conf. 429, 430 (1952).

23 *Id.*

24 Hurwitz, *supra* note 14, at 928 (emphasis added); F. W. Mohlman, *Waste Disposal Problems in Wartime,* 50 Chem. & Metall. Eng. 78 (1943), summarized, 15 Sewage Works J. 588, 815 (1943) (emphasis added); R. F. Goudey, *The*

The first expedient which should be employed by a manufacturer in solution of any pollution problem is the reduction in the quantity of waste water.... The second step *should* be segregation of strong wastes from those weak enough to be discharged without any treatment. The final step should be a study of the best method of treatment for the particular waste and careful examination for means of economical recovery of useful materials before discharge to the treatment plant or the stream.

Excuses usually offered for failure to provide suitable disposal methods are lack of methods for treating their particular waste or lack of funds. A more sensible basis of procedure would be for the *industries to face their waste problem* squarely and undertake careful studies of them in cooperation with consultants familiar with pollution problems.

Certain wastes *must* be particularly treated to prevent poisoning of surface and underground water supplies.... Land disposal depends on the proper isolation and the adaptability of the soil, coupled with the proper type of treatment works, so that no underground water supply is spoiled by underground travel of organic pollution or poisons.... Some types of liquid wastes discharged into an underground water supplies result in far-reaching damage.

Trade waste treatment and disposal must be considered at any time a plant location is being selected or a particular manufacturing process is contemplated.... In any individual study of waste treatment, investigation of the plant process *should* be the first step.... In any case, internal plant studies will be most effective if made by chemical engineers experienced in waste treatment work in cooperation with engineers familiar with the particular plant and its process problems.... In [some] cases either primary or complete *treatment will be required.*

With the present economic importance of fresh underground waters..., no introduction of wastes into freshwater formations *should* be considered. Use of underground disposal *should* be limited to formations

Industrial Waste Problem, Symposium: Disposal of Liquid Industrial Wastes, 16 Sewage Works J. 1177, 1179 (1944) (emphasis added), R. P. Lowe *The Chemical Engineer's Approach to Industrial Waste Problems,* 19 Sewage Works J. 1109 (1947) (emphasis added); Billings, *supra* note 12, at 134 (emphasis added) and W. C. Webb, *Limitations in the Use of Sanitary Landfill as a Method of Solid Waste Disposal,* in Proc. 9th Ann. Industrial Waste Conf. 138, 140 (1954) (emphasis added), respectively.

> whose waters are already so highly mineralized as to be unsuited for any conceivable use.... Once an injury [to groundwater] has occurred it may be expected to persist for a long time, and the lawsuits which may stem therefrom *should* give pause to any careless underground waste disposal.
>
> A sanitary landfill *must* not be used if there is any possibility of polluting either surface or ground water supplies.... Soluble chemicals will add their properties to leaching water.... The industry contemplating a sanitary landfill *would do well* to check with... the Geological Survey... as to the possibilities of water contamination.

In summary, numerous professional societies and trade organizations were actively involved in debating the issue of industrial waste disposal during the 40's, 50's and 60's (Table 1). It was a well-informed debate that included technical and policy dimensions, and it was conducted in a range of professional fora widely accessible to various technical and policy communities. As we demonstrate next, however, this extensive knowledge, essentially constituting the "problem stream" for the hazardous waste issue, never crossed over to, or combined with, an identification of the political implications of the problem or the development of solutions to shape public policy on hazardous waste. Indeed, the concept of hazardous waste as a special class of disposable materials posing threats to the environment and human health, originated elsewhere in the legislation and was propelled by distinctly different forces.

Legislative History of RCRA

RCRA was designed to regulate the handling and disposal of hazardous byproducts from industrial activities. The main provisions of the act define hazardous waste, specify standards for waste treatment and disposal facilities, stress the importance of protecting groundwater from land-based industrial activities, and recognize the need for waste generators to assume responsibility for tracking its fate from cradle-to-grave.[25] RCRA was the first comprehensive national law providing for a significant federal role in the regulation of hazardous waste, especially concerning effects on groundwater.

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25 Barke, *supra* note 3.

Conceptually, RCRA can be traced to two lines of federal legislative activity concerning environmental quality: regulation of solid waste disposal and regulation of surface water pollution. By the end of the 60's, these had been codified in two federal laws: the Solid Waste Disposal Act (SWDA)[26] and the Water Quality Improvement Act of 1970 (WQIA).[27] The two lines converged in the Resource Recovery Act of 1970 (RRA)[28] that established most of the legal and conceptual framework for RCRA.

Solid Waste Disposal

U.S. regulation of solid waste disposal has always been a local issue. Municipal and regional plans usually called for burial and/or burning of household and commercial waste at landfills convenient distances from urban centers. During the prosperous post-war period, the rapid rise in national consumption and suburban growth exposed their limitations. By the mid-60's, Congress stated that:[29]

> [s]olid waste collection and disposal activities create one of the most serious and most neglected aspects of environmental contamination affecting public health and welfare . . . . The efforts now being made to deal with this problem are clearly inadequate . . . . In the opinion of the committee, immediate action must be taken to initiate a national program directed toward finding and applying new solutions to the waste disposal problem.

Congress thus adopted the SWDA to:[30]

> (1) initiate and accelerate a national research and development program for new and improved methods of proper and economic solid-waste disposal...; and (2) provide technical and financial assistance to state and local governments and interstate agencies in the planning, development, and conduct of solid-waste disposal programs.

Notably, while the SWDA recognized that land-based waste

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26 Pub. L. 89-272, Title II (of the CAA Amendments), Oct. 20, 1965, 79 Stat. 997, codified at 42 U.S.C.A. §§ 6901 et seq. (1994).

27 Pub.L. 91-224, Title I, Apr. 3, 1970, 84 Stat. 91 (enacted no currently effective sections).

28 Pub.L. 91-512, Oct. 26, 1970, 84 Stat. 1227 (enacted no currently effective sections).

29 House Committee on Interstate and Foreign Commerce, H.R. Rep. No. 899, 89th Cong., 1st Sess. (1965), *reprinted in* 1965 U.S.C.C.A.N. 3608, 3614.

30 SWDA § 202(b).

disposal was hazardous to the environment, its definition of the problem was fairly traditional: Landfills were a nuisance mostly because of odors, vermin and costs. Legislators gave little recognition to toxic properties of wastes and made no distinction between municipal and industrial wastes.[31] They also left local and state jurisdiction unchanged.

Surface Water Pollution Control

Like the solid waste disposal on land, discharges of industrial and municipal effluents into the nation's surface waters have been a concern throughout much of the 20th Century. However, the physical feature of that phenomenon — a measurable movement of materials from their point of discharge — led to earlier recognition of the need for regional and national coordination of regulations.

During the first quarter Century, the legal approach to water pollution shifted from the common law nuisance to regulation. While state authorities handled the matter, its transboundary nature called for increased federal involvement. In the 30's, the National Resources Committee oversaw efforts to foster cooperation among state agencies in developing consistent laws, conduct surveys and studies, and provide loans and grants for sewage treatment. The PHS Stream Pollution Control Division was also created.[32]

The Water Pollution Control Act (WPCA)[33] was the first national legislation addressing water pollution.[34] It provided for federal research and technical assistance to state and regional authorities developing water pollution control programs. It also authorized the PHS to survey rivers and streams and to negotiate with polluters.

The WPCA Amendment of 1956[35] reaffirmed the federal role in research, monitoring and technical assistance to state and regional water

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31 *See, e.g.*, John C. Chambers & Mary S. McCullough, *From the Cradle to the Grave: An Historical Perspective of RCRA*, Nat. Resources & Envt., Fall 1995, at 21 (visited July 1997) <http://www.mckennacuneo.com/practice/Environmental/ENV01219950901.html>.

32 H. W. Streeter, *National Legislation of Stream Pollution*, 8 Sewage Works J. 1025 (1963).

33 Federal Water Pollution Control Act (Clean Water Act) (FWPCA), June 30, 1948, ch. 758, 62 Stat. 1155, codified at 33 U.S.C.A. §§ 1251 et seq.

34 Streeter, *supra* note 32.

35 July 9, 1956, ch. 518, 70 Stat. 498 (enacted no currently effective sections).

pollution commissions.[36] That role became stronger yet through the 1965 Water Quality Act,[37] which required states to set water quality standards and to report on these activities to the federal government. The Clean Water Restoration Act of 1966, provided for a continuing federal role through technical and financial assistance.[38]

By the mid-60's the hazards of uncontrolled disposal of industrial effluents into surface water were well recognized, as was the need for federal intervention.[39] However, specific reference to hazardous waste as a distinct category of waste appears for the first time in the legislative history of the 1970 WQIA. A major oil spill at Santa Barbara, precipitated passage of the WQIA. The spill was treated through application of large quantities of chemicals, which as it turned out, were highly toxic to aquatic organisms (and raised the question of human toxicity). This shaped the initial definition of hazardous wastes as "such compounds other than oil which, when discharged in any quantity onto or upon navigable waters... present an imminent and substantial danger to public health or welfare."[40]

The Emergence of RCRA

In 1969, Congress debated the reauthorization of the SWDA concurrently with the WQIA. When SWDA finally emerged as the RRA, some of the WQIA language appears to have been directly incorporated. Two features point to RRA as an offspring of SWDA and WQIA as well as a blueprint for RCRA. First, in § 212 the term "hazardous" is first used in the RRA separate from the term "solid" waste, and the need for sorting out and disposing of each class of waste is acknowledged. Hazardous waste is also defined similarly in the two

36 G. E. McCallum, *Water Supply and Water Pollution Control Program, Bureau of State Services, USPHS, Progress in Abatement of Water Pollution Under Public Law 660,* in Proc. 13th Ann. Industrial Waste Conf. 428 (1958) and J. L. Agee & A. Hirsch, *Water Quality Standards: The Role They Will Play in Administering Water Pollution Control Programs,* in Proc. 22d Ann. Industrial Waste Conf. 12 (1967).

37 Pub. L. 89-234, Oct. 2, 1965, 79 Stat. 903 (enacted no currently effective sections).

38 Pub. L. 89-753, Nov. 3, 1966, 80 Stat. 1246 (enacted no currently effective sections); *see* McCallum, *supra* note 36 and Agee, *supra* note 36.

39 L. W. Weinberger, *Industry and Water Pollution: New Research and Development Programs,* in Proc. 22d Ann. Industrial Waste Conf. 553 (1967).

40 Pub.L. 91-224, Title I, Apr. 3, 1970, 84 Stat. 91 (enacted no currently effective sections).

acts, as containing hazardous, toxic and biological substances that carry risks to human health and welfare.

Like its predecessors, the RRA does not mention groundwater as a key target for chemical contamination and/or a pathway for human exposure to toxic agents. This lack of attention on the national level to groundwater stands in sharp contrast to innovative, though isolated, state efforts to protect groundwater from industrial waste. Michigan was a leading state, passing as early as 1949 a law providing for groundwater protection.[41] Also, in the mid-40's both the city and county of Los Angeles issued regulations prohibiting disposal of industrial effluents to recharge public water supply aquifers.[42] Several additional state and local regulations emerged during the 50's and 60's regarding groundwater protection, but those were exceptions rather than the rule. The RRA also left the regulation and enforcement of solid waste disposal, including its hazardous waste component, to local and state authorities.

RRA § 212 directed the Secretary of Health, Education, and Welfare to:

> submit... no later than two years after the date of enactment... a comprehensive report and plan for the creation of... sites for the disposal of hazardous waste....

However, these functions were transferred to the newly created Environmental Protection Agency.[43] The report, apparently belatedly issued in June 1973, defined hazardous waste as a human health and environmental problem because of the intrinsic toxicity of its components, its potential to spread from disposal sites, and its projected growth in volume. The report cited multiple pathways to exposure and three cases of groundwater contamination and subsequent outbreaks of human illness.

Believing that technology for hazardous waste treatment and safe disposal was readily available, EPA also recommended development of regional facilities for treatment and disposal of hazardous waste, with the federal government bearing[44]

41 *See* Olds, *supra* note 12.

42 Colten (1991), *supra* note 4; Pickett, *supra* note 15.

43 Reorg. Plan No. 3 of 1970, *reprinted in* 1970 U.S.C.C.A.N. 6322. *See also,* President's Message to Congress transmitting the plan; *id.* at 6329.

44 US EPA, Report to Congress: Disposal of Hazardous Wastes 23 (1973).

> the responsibility for setting process and performance standards applicable to all.... [such] facilities, while qualified State governments would be responsible for administering federally approved programs and enforcing Federal standards.

Simultaneously, the EPA proposed the Hazardous Waste Management Act, eventually incorporated as Subtitle C of RCRA.[45]

RCRA, then in 1976, using the stage set by the EPA, fully articulated the need to protect the environment — including groundwater — from adverse impacts of hazardous waste disposal on land, and to prevent attendant exposure. There is little indication, however, even at that step in the evolution of problem definition, that the authors of the EPA report and proposed legislation were aware of the substantial body of scientific and technical knowledge on the hazardous waste problem that had existed in mature form for close to two decades. Only three relatively minor cases of groundwater contamination are documented in the EPA report, and all case reports and references date to the early 70's.

RCRA thus established that the management of industrial waste and the protection of the environment from its hazards had achieved a relatively permanent place on the national policy agenda. The process by which it came into existence, through the merging of provisions from two separate statues, largely under the guidance of EPA and congressional committee staff, is consistent with the Kingdon and Sabatier models and their illumination of the role of "hidden specialists" and professional and expert groups. Although these behind-the-scenes actors recognized the threats from hazardous waste, by not drawing on substantial existing knowledge, they could not fully recognize the magnitude of the problem. It would take several years and another statue — CERCLA — to recognize and address more fully the severity of groundwater contamination problems.

Clues useful for understanding why policy makers of the 70's failed to employ the body of knowledge that was mature by the end of the 50's can be found, first, by comparing the developmental history of the 1970 Clean Air Act (CAA)[46] with that of RCRA.

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45 *Supra* note 2.

46 Pub. L. 91-604, Dec. 31, 1970, 84 Stat. 1676, codified at 42 USCA §§ 7407 et seq. (1995).

RCRA and the Clean Air Act

RCRA and the CAA share important basic characteristics. Both were part of the larger developmental sequence of environmental policy making of the late 60's and early 70's. This featured the gradual expansion of the federal role, beginning with technical support, moving to research and grants, and eventually reaching direct regulation. This reflects an incremental shift from local and state to federal authority. Both laws also reflected the risk-based, command-and-control approach to pollution predominant at the time. Finally, both proved to be the founding statutes for the federal regulation of pollution in their respective problem areas.

By comparing the development of national air pollution with hazardous waste policy, however, we can illuminate important differences between the two that are useful in understanding policy development more generally. In particular, we argue that the emergence of the CAA was a step in the evolution of policy for managing a public health problem that had been consensually defined and documented by technical experts, political leaders and the public decades earlier — for which certain technological solutions were readily identifiable. In contrast, hazardous waste policy was initially developed upon rather tenuous documentation of public health problems and an equally tenuous selection of technological solutions. Although a technical consensus did exist for hazardous industrial waste as a problem, the character of the relevant technical community did not lend itself to transfer of expert consensus to the political arena. The conception of hazardous waste as a public health and ecological threat, as manifested in RCRA, came about as almost a last minute shift in problem definition and consensus building disconnected from technical knowledge and consensus.

The Development of Air Pollution Control Policy

The recognition of air pollution as a health hazard and public nuisance has a long social and public health history, with strong roots in England during the industrial revolution. The Public Health Act of 1848 created, under the leadership of the prominent physician Chadwick, the General Board of Health in England. This Board became a champion for of oversight by local boards of sewage and garbage disposal, water supplies free of infectious agents, and better housing and air quality in industrial cities.[47]

In the U.S., attention to local air pollution also gained momentum, and toward the end of the 19th Century the legal context of air pollution abatement also shifted to regulation, initially on the local level. Municipalities increasingly adopted ordinances to control air pollution, and, as it became increasingly apparent that air pollution was a transboundary problem, county- and state-level control laws multiplied.[48]

Another notable trend was the emergence of precise technical definitions of air pollution. During the first quarter Century, severity of visible smoke was classified using the percent opacity index. New technologies for determining particle size of fly ash, measuring gaseous and particulate emission rates from various sources and reducing the emissions from fuel combustion, led to adoption of pollutant-specific standards. Thus, by 1966, 53 cities and twelve counties had regulations on solid particulate emission rates; three cities regulated sulfur dioxide emissions, and two counties regulated organic chemical emissions. Increasingly communities also adopted ambient air quality standards for particulates.[49]

Over time, public tolerance for air pollution clearly declined. For example, while in the 40's the majority of local regulations prohibited emissions of smoke in excess of 40-60% opacity, by 1975 the acceptable level dropped to 20% in most areas, and some localities banned all visible smoke. The acceptable level of ambient suspended particles also declined. Before 1949 all sixteen community standards then in existence were at 10–30 mg/m^3 or higher, but by 1965 the majority of ambient standards were significantly below that.[50]

The problem of urban air pollution also came to national attention during the 40's as a result of a well-publicized episode in Donora, Pennsylvania, as well as recurrent smog episodes in Los Angeles, during which thousands of people became ill and dozens died. The

47 G. Rosen, A History of Public Health 166 (Exp'd Ed. 1993).

48 A. C. Stern, *History of Air Pollution Legislation in the United States,* 32 J. Air Pollution Control Assn. 44 (1982).

49 *Id.*

50 *Id.*

transboundary nature of the problem also became increasingly evident. In 1950, at the request of President Truman, the first Technical Conference on Air Pollution was held. In the aftermath the Secretary of Health, Education, and Welfare became a leading champion of national air pollution legislation, drawing into that effort other prominent members of the cabinet and the federal bureaucracy. Throughout the 50's and 60's they were frequently represented at conferences, workshops, congressional hearings and other public events focused on air pollution and health.

The first national air pollution legislation, the Air Pollution Control Act,[51] came fifteen years before the first national hazardous waste legislation. It defined the federal role modestly: Assist local and state agencies by technical assistance research. The 1963 CAA[52] continued to keep regulation and enforcement at local and state levels but strengthened the federal role, instituting grants-in-aid to states and localities. In the next stage of evolution of air pollution legislation, the CAA of 1967[53] expanded federal participation: The Secretary of Health, Education and Welfare was to provide the scientific and technical basis for states to set air quality standards, and states were to submit to the Secretary their implementation plans. The Act also provided for establishing interstate commissions. The modern era of a national system was introduced with the 1970 CAA, which fully established federal authority for setting ambient air quality and emission standards for stationary and mobile sources.

Air Pollution and Hazardous Waste Compared

National hazardous waste disposal and air pollution policies are compared in Table 2. In both cases, the federal role was initially confined to research and technical assistance and was incrementally expanded to development of scientific and technological bases for standard setting, to providing a focus for states' accountability and, finally, to becoming the key authority in regulating waste management and air emissions.

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51 Clean Air Act, July 14, 1955, ch. 360, 69 Stat. 322; codified at 42 U.S.C.A. §§ 7401 et seq.

52 Pub.L. 88-206, Dec. 17, 1963, Stat. 392.

53 Pub.L. 90-148, Nov. 21, 1967, 81 Stat. 485.

Table 2
Air Pollution and Hazardous Waste Cases Compared

Problem Dimension	*Air Pollution*	*Hazardous Waste*
Scientific evidence of harm	Extensive mortality and morbidity statistics	No evidence of adverse human health effects
Link between observed harm and technological activity	Commonly understood	Not intuitively obvious; speculative
Occurrence of harm	Well documented and disseminated; problem of the present	No systematic documentation of pollution episodes until the 1960; poorly disseminated; problem of the future
Language for problem definition	Well established; technically precise; quantitative	Vague; descriptive
Political content	Transboundary and transjurisdictional problem	Largely a local problem
Political advocacy community	Public health scientists and policy makers; public opinion leaders; united group; long tradition of political advocacy	Mostly engineers; few policy makers; heterogeneous group with little tradition of political advocacy for public health
Pollution monitoring technology	Well developed	Poorly developed
Preventive and remedial technology	Some available; some under development	Poorly developed

A fundamental difference between the two cases rests in the evolution of problem definition and in the formation of strong problem advocacy. Regulation of air pollution was always justified on the grounds of protection of human health and quality of life, and science provided ample documentation of the widespread problem and its effects on human health. For example, mortality and morbidity statistics from the major air pollution episodes in Liege, Belgium in 1930, Donora in 1948, Poza Rica, Mexico in 1950, London in 1952 and others were meticulously kept. This was readily reinforced because air pollution posed a problem in which the connection between human activities and undesirable effects on environment and health were easy to understand and verify. Also, common technical language existed to describe both the nature of the problem (concentrations of individual component of pollution) and its adverse effects (morbidity and mortality rates).

Politically, the increasingly transboundary and interjurisdictional nature of the problem favored national intervention. Also the major technical and political advocacy community was well defined and characterized by deep roots in the public health community, going back to the 19th Century. The problem of air pollution also enjoyed a long tradition of advocacy at the local community level and strong support from the public. In addition, technological alternatives for monitoring and reducing air emissions (such as air pollution control devices and technology for altering the composition and volume of pollution generated at the source) were relatively easy to identify and develop, the difficulties of technology forcing notwithstanding.[54]

In contrast, for land-based industrial waste impacts, public health did not become clearly emphasized and prominent until very late in policy development, sometime between the 1970 RRA and the 1976 RCRA. Fragmented across both time and subject matter, hidden governmental and nongovernmental specialists were never able to link and develop a comprehensive picture. Drawing on solid waste and surface water pollution orientations, the behind-the-scenes policy actors of the late 60's and early 70's defined the problem as almost exclusively in terms of of resource degradation, public nuisance, and increasing costs and logistic complexity. Even with the transformation of problem conception represented by RCRA, the magnitude of the threat to the environment and public health, especially through groundwater contamination, did not come fully to light until the likes of Love Canal. By then, the problem had reached crisis proportions and was not conducive to development of a measured attack. The public policy

[54] *See, e.g.,* B. A. Ackerman & W. T. Hassler, Clean Coal/Dirty Air (1981).

response instead was reactive, remedial and punitive, in a manner that would later spawn a host of problems associated with Superfund.

It is, of course, impossible to know whether greater use by policy makers of knowledge about the hazards of industrial waste disposal practices might have altered the trajectory of hazardous waste policy development. Certainly, characteristics of the problem and the technical community's recognition of it posed several obstacles. Even if broadly recognized, the connection between industrial waste disposal and groundwater contamination represented a problem of the future, for example, not intuitively apparent to the general public and public health officials. The link between groundwater contamination and human health was also much more abstract than was the case with air pollution, with little evidence of harm to health and the environment. In addition, a common language for describing the severity of the problem, such as environmental concentrations of well recognized agents and their human health and environmental effects, e.g., as morbidity and mortality rates, did not exist. Finally, technology for reducing hazardous waste at the source and for alternative disposal, was poorly developed. Thus, although much policy and technical knowledge existed, the extent of policy learning may still have been insufficient to have earlier produced RCRA-like policy.

The problem of hazardous waste also had much less political urgency than air pollution. Contamination of groundwater, to the extent it was acknowledged at all, did not appear to be either transboundary or interjurisdictional. Unlike access to clean air, which could only be obtained by reducing emissions, contaminated groundwater could be replaced with clean water from another well; the problem was highly localized, even privatized.

More importantly, the key reason that the technical consensus on the environment hazards of industrial waste disposal did not find its way into the policy and political streams was the lack of a well defined and united policy advocacy community. The technical community that was actively concerned about industrial waste disposal was in some ways fairly heterogeneous. Grounded mostly in the engineering professions (including PHS personnel), that community represented a wide range of engineering specialties but, in toto, lacked a shared tradition of political advocacy. It is quite telling that Stanley and Eliassen produced their detailed inventory of groundwater contamination at the request of the Federal Housing Authority, strongly suggesting concerns other than public health or the environment.[55] Again, industrial waste disposal was viewed as a resource management and system design problem: How to protect a major resource — groundwater — from degradation through contact with industrial waste? Not surprisingly, powerful health-oriented leaders, e.g., the Surgeon General, were not mobilized.

The absence of shared tradition of political advocacy on the part of the technical and scientific community that understood the severity and magnitude of the hazardous waste problem cannot be underestimated. They were the only group who could speak authoritatively. Their non-participation would have made it impossible for policy entrepreneurs to create the necessary policy coalition, even if some were aware of the problem's severity.

Conclusions

Our analysis confirms that problem definition, and the linkage of the problem stream with the policy and political streams as conceived by Kingdon, requires a powerful theme to propel an issue to the national agenda. In the U.S. environmental arena, public health has been such a theme, perhaps the most powerful. During the 50's, 60's, 70's and 80's, it clearly made a difference in determining whether hazardous waste would attain a position of relative permanence on the environmental policy agenda. More important, our analysis strongly suggests that whether and how a problem is defined and carried to the policy and political arenas depends on the character and extent of the involvement of the community of technical and scientific experts.

Compared with the period before about 1970, it is unlikely that any scientific or technical group continues to be politically detached. Most are intensely involved through an elaborate system of consultancy, advisory committees and participation as legal expert witnesses.[56]

Also, interest groups, legislators, executive officials and the general public have much greater access to scientific and technical knowledge,

55 Stanley & Eliassen, *supra* note 17.

56 S. Jasanoff, The Fifth Branch: Science Advisors as Policy Makers (1990).

as well as the sophistication to apply it to problem definition and policy entrepreneurship.[57] In addition, the policy-making system moves at a much higher velocity than two or three decades ago and is more activist. Activism, and the promise of access to research funds via greater visibility and political influence, draws professional groups into intense competition that tends to infuse all streams of agenda-setting with their ideas, knowledge and norms.

These factors would favor a situation quite opposite what we describe but of no less concern: A tendency toward premature problem definition and formulation of advocacy coalition, policy and political streams before the technical and scientific aspects of problems are reasonably well understood. Therefore, there is a need for a systematic and critical analysis of the role of scientists and technical experts in shaping today's public policy agenda. In particular, a closer look at the extent of commitment to public advocacy, and the governmental and nongovernmental interconnections of scientists and technical experts, is warranted.

57 *Id.* at 90.