

Annotated Bibliography of Literature Relating to the Public Acceptability of Bioremediation Technologies

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Introduction

This document is a product of research funded by the U.S. Department of Energy's Natural and Accelerated Bioremediation Research (NABIR) Program, specifically its Bioremediation and its Societal Implications and Concerns (BASIC) Program Element. Our project addresses the dimensions of societal acceptability of using genetically engineered microorganisms (GEMs) to remediate hazardous waste. In the course of developing a conceptual framework called PACT (Public Acceptability of Controversial Technologies), we reviewed literature in such diverse areas as risk perception and communication, conflict resolution and negotiation, environmental values, public participation and stakeholder involvement, and technology acceptance (see A. K. Wolfe, D. J. Bjornstad, and M. Russell, forthcoming, "Public Acceptability of Controversial Technologies (PACT): An Application to Genetically Engineered Microorganisms [GEMs]").

We prepared this annotated bibliography to enable other researchers to preview some of the literature pertinent to the social acceptability of controversial technologies, with a special emphasis on bioremediation technologies including GEMs. The annotations briefly describe the content of the documents; we include no judgments of the documents' quality. To provide an organizational structure to help us cope with the quantity and diversity of publications, we grouped them into one of a dozen categories. Categorization is fairly loose, since many documents are relevant to more than one category. The categories are as follows:

- Biotechnology Regulation/Public Policy
- Public Participation in Risk Assessment/Management
- Risk Communication/Media
- Public Acceptance and Biotechnology
- Conflict Resolution
- Environmental Dialog/Discourse
- Risk Perception
- Environmental Values
- Attitude/Value Theory
- Ethical/Social Issues
- Organizational/Environmental Interest Group Theory and Practice
- Remediation/Bioremediation Technology

Though extensive, the bibliography is not exhaustive. We will add to it regularly. Partly because it is an evolving document, and to make the bibliography available to a wide audience, we are publishing it on the web. Our intent is to update the annotated bibliography periodically as we continue with our research. It can be accessed on the NABIR web site at http://www.lbl.gov/NABIR/gen_eng.pdf.

Annotated Bibliography of Literature Relating to the Public Acceptability of Bioremediation Technologies

Biotechnology Regulation/Public Policy

Beringer, J. (1991) The Release of Genetically Modified Organisms. In *Innovation and Environmental Risk*. Roberts, L. and Weale, A. (eds.) London: Belhaven Press, 57–63.

Discusses the question of what constitutes novelty in organisms, and regulatory responses in the UK.

Cantley, M. (1992) Public Perception, Public Policy, the Public Interest and Public Information. In *Biotechnology in Public: A Review of Recent Research*. Durant, J. (ed.), London: Science Museum, 18–27.

Describes institutional efforts in Europe to address biotechnology issues. Recounts the history of public distrust of industry. Argues that overcoming distrust is a greater issue than overcoming ignorance.

Hoyle, R. (1995) Biotechnology is Still Searching for a Bioethics Forum. *Biotechnology* 13, 735–737.

Provides an overview of the social and regulatory responses to the ethical issues raised by biotechnology, and of the inadequate approach taken by industry.

Kappeli, O. and Auberson, L. (1997) The Science and Intricacy of Environmental Safety Evaluations. *Technology Impacts of Biotechnology* 15, 342–349.

Argues that an objective safety analysis—a method that focuses on the definition of realistic hazards through impact analysis, scenario elaboration, and comparative appraisal—can be more effective than more traditional risk assessments in responding to public concerns about biotechnology.

Krimsky, S. (1982) *Genetic Alchemy: the Social History of the Recombinant DNA Controversy*. Cambridge: The MIT Press.

Summarizes the political, regulatory, scientific, and social history of genetic engineering. Provides an in-depth discussion of attempts at oversight by the NIH and attempts at public involvement.

Lester, J. (ed.) (1989) *Environmental Politics and Policies: Theories and Evidence*. Durham, NC: Duke University Press.

Presents a collection of essays covering numerous topics including: (1) the history of environmental movements; (2) public opinion; (3) interest groups; and (3) government regulation.

Masood, E. (1999) Britain Opens Biotech Regulation to Greater Public Involvement. *Nature*. 399: 6734, 287–288.

Announces the creation of two new British oversight bodies, the Human Genetics Commission and the Agricultural and Environment Biotechnology Commission, that include experts, representatives of interest and environmental groups, and the public.

Miller, H. (1997) The EPA's War on Bioremediation. *Nature Biotechnology* 15:6, 486.

Argues that the Toxic Substances Control Act (TSCA) inhibits biotechnology. Regulations target recombinant DNA without concern for whether organisms are truly new and without regard for risk (some naturally occurring organisms in use—unregulated—are far more risky).

Regal, P. (1987) Meeting Legitimate Public Concerns over Biotechnology: the Need for a Special Infrastructure. *Journal of the Minnesota Academy of Science* 53:1, 28–32.

Summarizes concerns raised in other literature about biotechnology. Asserts that interdisciplinary coordination is necessary to face those concerns. Examines socioeconomic obstacles in creating the necessary interdisciplinary coordination.

Toft, J. (1996) Denmark: Seeking a Broad-Based Consensus on Gene Technology. *Science and Public Policy* 23:3, 171–174.

Describes Denmark's public policy on Genetically Modified Organism (GMO) releases. Argues that flexibility, public consultation, and consensus-seeking procedures contribute to the legitimacy of decisions and public trust.

Vidaver, A. (1989) Public Policy on the Introduction of Genetically Engineered Microorganisms. *Journal of the Iowa Academy of Science* 96:2, 74–77.

Discusses the conceptual distinction between genetically engineered modifications and other modifications to biological organisms. Argues that proper understanding of genetically engineered modifications will help gain public acceptance. Offers guidelines that should be met before a planned release.

Wrubel, R., Krinsky, S., and Anderson, M. (1997) Regulatory Oversight of Genetically Engineered Microorganisms: Has Regulation Inhibited Innovation? *Environmental Management* 21:4, 571–586.

Asserts that the slow pace of the development of GEM field applications results more from the technology itself than from meeting regulatory requirements.

Public Participation in Risk Assessment/Management

Ashmos, D. P., Duchon, D., and McDaniel, R. R. (1998) Participation in Strategic Decision Making: The Role of Organizational Predisposition and Issue Interpretation. *Decision Sciences* 29:1,25–51.

Examines empirically the effects of managerial past performance, rule orientation, and issue interpretation on internal stakeholder participation. Concludes that both past performance and rule orientation have a negative correlation with participation, but that issue interpretation did not affect participation at all. Explains that an organization will rely on overlearned past responses unless managers take steps to create new patterns for participation.

Carnes, S. A., Schweitzer, M., Peelle, E. B., Wolfe, A. K., Munro, J. F. (1996) *Performance Measures for Evaluating Public Participation Activities in DOE's Office of Environmental Management*. ORNL-6905. Oak Ridge National Laboratory, Oak Ridge, TN.

Asserts that expansion and improvement of the Department of Energy's Office of Environmental Management public participation activities will result in substantial cost savings as well as other improvements for both the DOE and the nation. Provides a set of performance-based indicators for use in such programs, with special emphasis on activities implemented in the field.

Goldberg, T. (1987) Moving Toward Public Participation in Biotechnology. In *Application of Biotechnology: Environmental and Policy Issues*. Fowle, J. (ed.) Boulder: Westview Press, 165–173.

Provides a history of government agency/organizational involvement in technology assessment. Offers suggestions for means to more enhanced public involvement.

Krimsky, S. (1984) *Beyond Technocracy: New Routes for Citizen Involvement in Social Risk Assessment*. In *Citizen Participation in Science Policy*. Peterson, J. (ed.) Amherst: University of Massachusetts Press, 43–61.

Provides an overview of different modes of public involvement in risk assessment/management. Assesses some of the failures and successes of public participation, and provides suggestions for more effective public involvement.

Laird, F. (1993) *Participatory Analysis, Democracy, and Technological Decision Making*. *Science, Technology, & Human Values* 18:3, 341–361.

Presents a comparative overview of two democratic theories (direct participation and pluralism) and develops a revised set of democratic criteria. Evaluates several participation mechanisms. Argues for participatory analysis, a participation category that focuses on meeting the democratic criteria and a participant learning process.

McComas, K. A. and Scherer, C. W. (1999) *Providing Balanced Risk Information in Surveys Used as Citizen Participation Mechanisms*. *Society & Natural Resources*. 12, 107–119.

Examines empirically the effects of providing balanced risk information about different waste management options on survey respondents' attitudes and opinions about waste management. Concludes that balanced information leads to more positive attitudes and opinions when opinions are not already strongly formed. Suggests that balanced information surveys may help make the dialog process between the public and policymakers more productive when conducted early, before opinions have become rigid.

Renn, O., Webler T., and Wiedemann, P. (eds.) (1995) *Fairness and Competence in Citizen Participation: Evaluating Models for Environmental Discourse*. Boston: Kluwer Academic.

Describes a normative ideal for citizen participation in environmental decision making, focusing on the process (not outcomes) of dialog/discourse. Presents eight models of participation (citizen advisory committees, citizen panels, citizens juries, negotiated rule making, mediation, compensation and benefit sharing, Dutch study groups) and evaluates them using Habermas's normative theory of communication, which seeks to evaluate communication against the standard of non-coerced mutual understanding.

Taylor, D. (1999) *Mobilizing Resources to Collect Municipal Solid Waste: Illustrative East Asian Case Studies*. *Waste Management and Research* 17:263–274.

Provides four case studies to illustrate interactions among four categories of municipal solid waste stakeholders (public sector, formal private sector, informal private sector, and community-based, non-governmental organizations). Discusses constraints to their interactions as well as ways to overcome those constraints

Tuler, S. and Webler, T. (1999) Voices from the Forest: What Participants Expect of a Public Participation Process. *Society & Natural Resources* 12:437–453.

Examines the Northern Forest Land Council to develop a set of principals inductively for the process of public participation. Concludes that the principals fit into seven categories: access to the process, power to influence process and outcomes, access to information, structural characteristics, facilitation, analysis, and enabling future processes.

Wondolleck, J., Manring, N., and Crowfoot, J. (1996) Teetering at the Top of the Ladder: The Experience of Citizen Group Participants in Alternative Dispute Resolution Processes. *Sociological Perspectives* 39:2, 249–262.

Summarizes research designed to understand the issues citizen group participants and traditional participants deal with in collaborative problem-solving processes that include both types of individuals. Describes three additional challenges citizen group participants should strategically consider: (1) the choice to participate; (2) adapting the process structure to the specific needs of involved parties; and (3) continued involvement beyond formal agreement to ensure implementation.

Risk Communication/Media

Dixon, B. (1986) The Effect of the Media on Public Opinion and Public Policy. In *Industrial Biotechnology in Europe: Issues for Public Policy*. Davies, D. (ed.) Dover, NH: Frances Pinter, 114–120.

Criticizes the media for being anti-biotechnology and for polarizing issues. Argues that public ignorance lies behind public opposition.

Fischer, G. W., Morgan, M. G., Fischhoff, B., Nair, I., and Lave, L. B. (1991) What Risks are People Concerned About? *Risk Analysis*. 11:2, 303–314.

Develops and tests empirically a questionnaire and categorization structure that identify and characterize the risks of public concern. Concludes that (a) environmental risks are more salient than health and safety risks; (b) gender and age affect concern (females and students were more concerned about the environment than males and older subjects); (c) willingness-to-pay is greater when the risk is perceived as a personal threat; and (d) subjects assign responsibility for managing environmental risks to government and industry. Suggests ways in which the questionnaire and categorization structure may be modified and used in risk communication efforts.

Gunter, B., Kinderlerer J., and Beyleveld D. (1999) The Media and Public Understanding of Biotechnology. *Science Communication*. 20:4, 373–394.

Discusses the different professional cultures of scientists and journalists. Presents and explains survey results concerning each groups' perceptions and expectations for themselves and one another. Concludes that journalists and scientists differ most profoundly in their opinions of the quality and accuracy of reporting; however, they agree on the purposes and expectations of reporting.

Krimsky, S. and Plough, A. (1988) *Environmental Hazards, Communicating Risks as a Social Process*. Dover, MA: Auburn House Publishing.

Provides several case studies of risk communication including the release of genetically engineered organisms into the environment.

Lange, J. (1993) The Logic of Competing Information Campaigns: Conflict Over Old Growth and the Spotted Owl. *Communication Monographs* 60:3, 239–257.

Analyzes the direct and indirect interactions between two competing information campaigns, one sponsored by industry representatives and the other by environmentalists. Develops and describes five communication strategies used by the competing groups.

National Research Council (1989) *Improving Risk Communication*. Washington DC: National Academy Press.

Offers a new paradigm of risk communication focusing on a two-way process between the producer and recipient of the message. Discusses purposes, problems of, and misconceptions about risk communication. Provides recommendations for improving risk communication.

Morgan, M. G. (1993) Risk Analysis and Management. *Scientific American* 269:1, 32–41.

Summarizes the basic tenets of risk analysis: exposure/effects studies, fault tree development, public vs. expert risk rankings, and mental models. Argues that effective risk communication includes researching what the public already knows, creating a message accordingly, and testing that message empirically.

Patterson, J. and Allen, M. (1997) Accounting for Your Actions: How Stakeholders Respond to the Strategic Communication of Environmental Activist Organizations. *Journal of Applied Communication Research* 25, 293–316.

Presents survey results indicating how 3 groups (activists, government officials, and students) responded to 8 different strategies (bolstering, diffusion of responsibility, denouncement, justification, aestheticizing, necessitating, transcendence, and intimidation) employed by radical environmental activists who violated social norms in their actions.

Ruhrmann, G. (1992) Genetic Engineering in the Press: a Review of Research and Results of a Content Analysis. In *Biotechnology in Public: A Review of Recent Research*. Durant, J (ed.) London: Science Museum, 169–201.

Summarizes a variety of published studies of press coverage of genetic engineering, some of which are unavailable in English.

Schanne, M. and Meier, W. (1992) Media Coverage of Risk Results from Content Analysis. In *Biotechnology in Public A Review of Recent Research*. Durant, J (ed.) London: Science Museum, 142–168.

Provides a meta-study of 52 studies of media coverage of environmental risk. Analyzes studies along 44 variables related to media coverage content.

Turner, G. and Wynne, B. (1992) Risk Communication: A Literature Review and Some Implications for Biotechnology. In *Biotechnology in Public: A Review of Recent Research*. Durant, J. (ed.) London: Science Museum, 109–141.

Presents an extensive survey of risk communication literature, distinguishing different theoretical frameworks for understanding risk communication (i.e., cognitive, psychometric, revealed preference, social psychology, and cultural). Offers practical lessons for risk communication.

Williams, B., Brown, S., and Greenberg, M. (1999) Determinants of Trust Perceptions Among Residents Surrounding the Savannah River Nuclear Weapons Site. *Environment and Behavior*. 31:3, 354–371.

Examines empirically how social, economic, psychological, demographic, and political factors affect public trust of the DOE in communities surrounding the Savannah River Nuclear Weapons Site. Explains that, based on past research and the current study, personal experience, needs, and perceptions, rather than demographic characteristics (age, race, gender, education level, etc.), correlate with level of trust. Concludes that (1) higher economic dependence, living with few environmental stressors, and a perception of high personal control leads to greater public trust while living downriver, and (2) active involvement in public activities, and a perception of low personal control, leads to diminished public trust. Suggests questions for further research.

Public Acceptability and Biotechnology

Boulter, D. (1997) Scientific and Public Perception of Plant Genetic Manipulation—A Critical Review. *Critical Reviews in Plant Sciences* 16:3, 231–251.

Summarizes some of the technical issues, risk perception literature, and ethical issues associated with genetic engineering (GE). Describes how scientists should present their work to the public for greater acceptance of that work.

Burke, D. (1991) Public Acceptance of Innovation. In *Innovation and Environmental Risk*. Roberts, L. and Weale, A. (eds.) New York: Belhaven Press, 75–79.

Explores public opposition to biotechnology, its manifestations, and possible causes. Pays particular attention to the importance of media and risk communication.

Cabirac, D. and Warmbrodt, R. (1993) *Biotechnology: Public Perception January 1985–December 1992*. Quick Bibliography Series QB 93015. Beltsville, MD: National Agricultural Library.

Presents a comprehensive bibliography of literature published from 1985–1992 that deals with public perceptions of biotechnology.

Davison, A., Barns, I., and Schibeci, R. (1997) Problematic Publics: A Critical Review of Surveys of Public Attitudes to Biotechnology. *Science, Technology, & Human Values* 22:3, 317–348.

Examines the use of survey methods for assessing public acceptance of biotechnology from both a descriptive and normative point of view. Raises questions concerning the descriptive accuracy of survey results and the values underlying survey approaches. Asserts the need to move beyond representative democracy and suggests several mechanisms for attaining discursive democracy.

Dixon, B. (1993) Is Public Opposition to Biotechnology Real? *Bio/Technology* 11, 1090.

Argues that there is little evidence to support the claim of public opposition to biotechnology.

Evans, G. and Durant, J. (1995) The Relationship Between Knowledge and Attitudes in the Public Understanding of Science in Britain. *The Public Understanding of Science* 4, 57–74.

Presents survey results that indicate a greater understanding does not necessarily lead to more positive attitudes towards science. While attitudes towards science in general were

more positive with greater understanding, attitudes towards specific scientific studies (especially ones with complex moral issues) were more negative.

Hagedorn, C. and Allender-Hagedorn, S. (1997) Issues in Agricultural and Environmental Biotechnology: Identifying and Comparing Biotechnology Issues from Public Opinion Surveys, the Popular Press and Technical/Regulatory Sources. *Public Understanding of Science* 6, 233–245.

Presents a statistical comparison of issues dealt with in public opinion surveys, the popular press, and technical/regulatory sources. Concludes that members of the public tend to highlight ethical, safety, and value issues, in comparison with technical experts, who generally deal only with scientific issues

Hoban, T. (1995) The Construction of Food Biotechnology as a Social Issue. In *Eating Agendas: Food and Nutrition as Social Problems*. New York: Aldine de Gruyter, 189–209.

Reviews some of the major factors involved in the social construction of technological issues: risk perception, risk amplification, and social arena theory. Offers two biotechnology case studies to illustrate the complexity of the social issues associated with food biotechnology raised by organizations such as the media, government, industry, and interest groups.

Hoban, T., and Katic, L. (1998) American Consumer Views on Biotechnology. *Cereal Foods World* 43:1, 20–22.

Presents survey results of public awareness and acceptance of biotechnology in the food industry. Notes a correlation between acceptance and gender, age, income, and education. Stresses the importance of information/education in promoting acceptance.

Kemp, R. (1991) Institutional Innovation to Generate the Public Acceptance of Radioactive Waste Disposal. In *Innovation and Environmental Risk*. Roberts, L and Weale, A. (eds.) New York: Belhaven, 95–112.

Presents case studies of several institutional approaches to gaining public acceptance in various nations. Concludes that developing public trust in the decision-making process is the most important factor in achieving acceptance.

Kemp, R. (1992) Social Implications and Public Confidence: Risk Perception and Communication. In *The Release of Genetically Modified Microorganisms—REGEM 2*. Stewart-Tull, D. and Sussman, M. (eds.) New York: Plenum Press, 99–114.

Examines the risk perception literature, public opinion surveys, and risk communication techniques with regard to genetically modified organisms. Distinguishes five areas of concern about biotechnology: socio-economics, environmental, health, ethics, and trust. Offers one case study to illustrate risk amplification.

Martin, S. and Tait, J. (1992) Attitudes of Selected Public Groups in the UK to Biotechnology. In *Biotechnology in Public A Review of Recent Research*. Durant, J (ed.) London: Science Museum, 28–41.

Presents survey results from several groups (general public, non-biotechnology technologists, biotechnology industry, biotechnology researchers, and environmentalists) concerning knowledge of biotechnology, attitudes toward different applications of biotechnology, and the acceptability of various sources of biotechnology information. Concludes that groups with an interest in biotechnology have better defined attitudes and tend to seek information from sources that support their attitudes compared with groups that do not have an interest in biotechnology.

Mikl, M. and Torgersen, H. (1996) Austria's Biotechnology Regulation: From 'Virtual Releases' to Public Protest. *Science and Public Policy* 23:3, 195–200.

Chronicles the development of a regulatory process for biotechnology releases in Austria and its first application to a proposed agricultural GMO (genetically modified organism) release. Suggests that public opposition may come more from distrust of the industry than from the technology itself.

Miller, H. (1993) Perception of Biotechnology Risks: The Emotional Dimension. *Bio/Technology* 11:9, 1075–1076.

Summarizes psychological ploys used by anti-biotechnology groups, media misinformation, and the resulting public (mis)perceptions. Suggests ways to circumvent these influences.

Nelkin, D. (1986) Changing Attitudes Towards Technology in the United States. In *Public Acceptance of New Technologies: An International Review*. Williams, R. and Mills, S. (eds.) Wolfeboro, NH: Croom Helm, 46–65.

Cites survey evidence of public attitudes toward technology in the 1960s, 1970s, and 1980s. Discusses the following policy efforts to enhance public acceptance: (1) the creation of technology assessment organizations; (2) increasing public participation; and (3) marketing. Postulates that moral and religious values played a more prominent role in the 1980s than previously in determining technological acceptability.

Sinsheimer, R. (1987) Biotechnology: The Public Concerns. *Journal of the Minnesota Academy of Science* 53:1, 16–20.

Describes four categories of public concern: (1) equity; (2) irreversible harm; (3) incomplete knowledge; and (4) hubris.

Spangler, M. (1980). Syndromes of Risk and Environmental Protection: The Conflict of Individual and Societal Values. *The Environmental Professional* 2, 274–291.

Postulates numerous syndromes (attitudinal patterns) that may account for an individual's response to technology issues. Briefly discusses three social decision philosophies.

Urban, D., and Hoban, T. (1997) Cognitive Determinants of Risk Perceptions Associated with Biotechnology. *Scientometrics* 40:2, 299–331.

Summarizes results of several psychometric risk perception studies that focus on which hazards characteristics (e.g., familiarity, equity, involuntariness, etc.) tend to increase perceptions of risk. Presents a four-part model of the cognitive determinants of risk. Offers a statistical analysis of survey results, which indicate that biotechnology risk perceptions are largely independent of knowledge and cognitive ability.

Zechendorf, B. (1994) What the Public Thinks about Biotechnology. *Bio/Technology* 12:9, 870–875.

Presents trends in public opinion of biotechnology using a variety of survey sources. Asserts that knowledge and understanding increases acceptance of biotechnology.

Conflict Resolution

Buckle, L. and Thomas-Buckle, S. (1986) Placing Environmental Mediation in Context: Lessons From “Failed” Mediations. *Environmental Impact Assessment Review* 6, 55–70.

Reviews recent attempts to develop evaluative criteria for environmental mediation. Argues that evaluations should be more process-oriented than outcome-oriented. Provides an empirical study of “failed” mediation (that did not produce a signed agreement but did result in a better understanding of interests, available options, and negotiation methods).

Druckman, D., Rozelle, R., and Zechmeister, K. (1977) Conflict of Interest and Value Dissensus: Two Perspectives. In *Negotiations: Social-Psychological Perspectives*. Druckman, D. (ed.) Beverly Hills, CA: Sage Publications, 105–131.

Describes three paradigms for understanding conflict: (1) conflict resulting from different interests; (2) conflict resulting from different value structures; and (3) conflict resulting from an interplay of interests and values. Summarizes two perspectives on the third type of conflict. Describes a simulation exercise to examine whether greater value is assigned to interests or values and how the relationship between the two affects the intensity of the conflict.

Druckman, D., Broome, B., and Korper, S. (1988) Value Differences and Conflict Resolution: Facilitation or Delinking? *Journal of Conflict Resolution* 32:3, 489–510.

Examines three conditions of conflict resolution in simulation exercises: facilitation (value differences presented in workshops run by a neutral facilitator); de-linked (values separated from position statements); and embedded (values and position explicitly linked in position statements). Suggests that the facilitation condition and de-linked condition were more conducive to negotiation than the embedded condition.

Floyd, D. (1993) Managing Rangeland Resources Conflicts. *Rangelands* 15:1, 27–30.

Explores three models of environmental conflict, the (1) misunderstanding model; (2) conflicting interest model; and (3) basic principles model. Develops a means of predicting the degree of conflict in rangeland issues by pinpointing disputants' positions along a continuum representing the issue as disputants conceive it (geocommodity, biocommodity, use amenity, preservation amenity), whereby greater distance between positions indicates greater potential conflict.

Floyd, D., Germain, R., and Horst, K. (1996) A Model for Assessing Negotiations and Mediation in Forest Resource Conflicts. *Journal of Forestry* 94, 29–33.

Examines the conditions under which alternative dispute resolution (ADR) is most successful by analyzing 12 forest management conflicts. Concludes that the distance between disputant positions, time spent on the resolution, and numbers of participants have the greatest effect on the success of ADR.

Frankena, F. (1983) Facts, Values, and Technical Expertise in a Renewable Energy Siting Dispute. *Journal of Economic Psychology* 4, 131–147.

Provides a content analysis of a specific siting dispute, focusing on the occurrence of fact/value arguments in a site hearing and in newspaper reports. Concludes that value issues become more important than technical issues in the conflict when experts disagree.

Gray, B. (1997) Framing and Reframing of Intractable Environmental Disputes. In *Research on Negotiation in Organizations*. Lewicki, R. and Bies, R. (eds.) Greenwich, CT: Jai Press, 163–188.

Provides a history of environmental disputes in the U.S., characterizing them as conflicts along different dimensions, including interests, rights and power, and values. Argues that a focus on different dimensions leads to differential framing of disputes and perceptions of environmental degradation. Summarizes some successes in overcoming intractability via alternative dispute resolution and constructive confrontation.

Hare, A. P. (1985) *Social Interaction as Drama: Applications from Conflict Resolution*. Beverly Hill: Sage Publications.

Presents basic social-psychological theories and hypotheses as they relate to a dramaturgical perspective on social interactions. Develops a framework for understanding social interactions as dramatic events. Applies that framework to four conflict resolution case studies.

Lach, D. (1996) Introduction: Environmental Conflict. *Sociological Perspectives* 39:2, 211–217.

Briefly discusses the application of conflict theory to environmental conflicts. Presents and summarizes the seven articles found in this special issue of *Sociological Perspectives*.

Lavallee, L. and Suedfeld, P. (1997) Conflict in Clayoquot Sound: Using Thematic Content Analysis to Understand Psychological Aspects of Environmental Controversy. *Canadian Journal of Behavioral Science* 29:3, 195–210.

Examines publicity campaigns of seven interest groups (including environmentalist, industry, and government groups, and a mixed advisory board) in a forest land-use controversy, focusing on (1) integrative complexity (presence of complex reasoning); (2) motive imagery (display of power, achievement, and affiliation needs); and (3) value pluralism (presence of important but conflicting values).

Lentz, S. (1986) The Labor Model for Mediation and its Application to the Resolution of Environmental Disputes. *The Journal of Applied Behavioral Science* 22:2, 127–139.

Describes the role of the traditional and revisionist mediator in environmental dispute mediation in terms of the traditional labor model of mediation.

MacNaughton, A. (1996) Collaborative Problem-Solving in Environmental Dispute Resolution. *NR&E*, Summer, 3–6, 70.

Discusses the basic tenets of dispute resolution as well as the questions that must be examined in determining which approach to take in specific environmental conflicts or disputes.

Maguire, L. and Boiney, L. (1994) Resolving Environmental Disputes: A Framework Incorporating Decision Analysis and Dispute Resolution Techniques. *Journal of Environmental Management* 42, 31–48.

Offers a model by which values and judgments are elicited from disputants and formalized in decisions. Discusses how the reasons for divergent decisions can then be traced to their sources and negotiated more effectively.

Painter, A. (1988) The Future of Environmental Dispute Resolution. *Natural Resources Journal* 28, 145–170.

Cites numerous successes of environmental dispute resolution and provides specific cases. Offers an abstract, metaphysical view of the underlying causes of conflict, including the role of world-views, interests, and values.

Susskind, L. and Ozawa, C. (1985) Mediating Public Disputes: Obstacles and Possibilities. *Journal of Social Issues* 41:2, 145–159.

Describes procedural concerns within mediation. Presents three case studies to illustrate some methods for dealing with those concerns.

Thompson, L. and Gonzales, R. (1997) Environmental Disputes. In *Environment, Ethics, and Behavior: the Psychology of Environmental Valuation and Degradation*. Bazerman, M., Messick, D., Tenbrunsel, A., and Wade-Benzoni, K. (eds.) San Francisco: The New Lexington Press, 75–104.

Reviews basic concepts of behavioral negotiation theory. Presents a framework for understanding the nature of a conflict, distinguishing among conflicts of interests, values, and a combination of interests and values. Identifies psychological and behavioral barriers to conflict resolution in the face of ideological differences, along with strategies used in efforts to win. Suggests ways to overcome obstacles to environmental dispute resolution.

Environmental Dialog/Discourse

Hajer, M. (1995) *The Politics of Environmental Discourse: Ecological Modernization and the Policy Process*. Oxford: Claredon Press.

Discusses the discourse analysis of authors like Foucault and social psychologists like Harre with regard to environmental policy making. Argues that discourse reflects the realities of environmental conflict and policy; conflicts are not over appropriate actions but over the meaning of social and physical phenomena. Develops a theoretical framework and applies it to a case study of acid rain.

Mazmanian, D. and Morell, D. (1994) The “NIMBY” Syndrome: Facility Siting and the Failure of Democratic Discourse. In *Environmental Policy in the 1990s: Toward a New Agenda*. Vig, N. and Kraft, M. (eds). Washington, DC: CQ Press, 233–249.

Proposes four key issues that help determine public acceptance of facility siting decisions: (1) who determines the need for the facility; (2) what economic benefits, risks, and location choices are associated with the facility; (3) what standard of fairness is chosen; and (4) who has the authority to make the decision and the process through which the decision takes place. Offers case studies and suggestions for overcoming public objections.

Tong, S. and Lu, Y. (1999) Major Issues in the Environmental Health Decision-Making Process. *Journal of Environmental Health*. 62:1, 33–35.

Explains the need to bridge the gap between the scientific and administrative stages of the environmental health decision-making process. Offers a description of tools and strategies that can be used to include scientists, regulators, and broader stakeholder networks in the decision-making process.

Russell, M. (1990) *The Making of Cruel Choices. Valuing Health Risks, Costs, and Benefits for Environmental Decision Making: Report of a Conference*. Washington, D.C.: National Academy Press. 15–22.

Examines how governing bodies make decisions affecting their citizens and how those decisions are made legitimate. Argues for a formal analysis that openly presents complex trade-off options.

Williams, B. and Matheny, A. (1995) *Democracy, Dialogue, and Environmental Disputes: the Contested Languages of Social Regulation*. New Haven: Yale University Press.

Identifies, and argues for the inadequacy of, traditional, distinct languages and conceptual frameworks for addressing environmental issues. Suggests the necessity of creating institutional mechanisms capable of engaging alternative languages and conceptualizations

of environmental problems in a dialog as the means to arrive at truth and politically viable policies.

Risk Perception

Bjornstad, D. J., Jones, D. W., Russell, M., Redus, K. S., and Dummer, C. L. (1998) *Outcome-Oriented Risk Planning for DOE's Cleanup*, Joint Institute for Energy and Environment, Knoxville, TN.

This report examines a risk-based approach to U.S. Department of Energy site cleanup that represents an alternative to a Superfund template in which sites requiring cleanup are identified, matched to available technologies, established end-states are assessed for compliance with EPA regulations and stakeholder preferences, and activities are scheduled over long periods of time. Using the data bases assembled for the Oak Ridge National Laboratory cleanup, this paper employs a non-linear programming approach to examine how DOE might use risk measure as a cleanup metric and how alternative levels of performance might be achieved if DOE followed different cleanup strategies.

Burger, E. (1988) How Citizens Think About Risks to Health. *Risk Analysis* 8:3, 309–313.

Analyzes some of the factors that influence public perceptions of risk, e.g., scientific ignorance, media influence, attitude toward science and technology in general, distrust of corporate establishment.

Covello, V., Menkes, J., and Nehnevajsa, J. (1982) Risk Analysis, Philosophy, and the Social and Behavioral Sciences: Reflections on the Scope of Risk Analysis Research. *Risk Analysis* 2:2, 53–58.

Reviews the roles of philosophy as well as social and behavioral sciences in risk analysis research. Proposes a series of research questions that derive from those roles.

Douglas, M. and Wildavsky, A. (1982) How Can We Know the Risks We Face? Why Risk Selection is a Social Process. *Risk Analysis* 2:2, 49–51.

Discusses the gap between “expert” and lay public opinions of risk. Proposes that risk perception necessarily is a social phenomenon that is organized through social bias.

Fischhoff, B., Watson, S., and Hope, C. (1984) Defining Risk. *Policy Sciences* 17, 123–139.

Discusses the attributes (mortality, morbidity, psychological concern) of a hazard that give rise to different judgments of riskiness. Describes a method for quantifying and assigning weights for each attribute to arrive at a single estimate of a given risk.

Fischhoff, B. (1997) Ranking Risks. In *Environment, Ethics, and Behavior: The Psychology of Environmental Valuation and Degradation*. Bazerman, M., Messick, D., Tenbrunsel, A., and Wade-Benzoni, K. (eds.), San Francisco: The New Lexington Press. 342–371.

Proposes a method for ranking risks that relies upon eliciting public values/rankings along four important dimensions of risk (including ecological impact). Summarizes contributions of others to psychological research on risk ranking.

Hansson, S. (1989) Dimensions of Risk. *Risk Analysis* 9:1, 107–112.

Examines the complexity of risk assessment. Postulates eight characteristics/aspects of risk relevant to risk management: (1) health end-points; (2) voluntariness; (3) individual versus population threat; (4) consequence probability trade-off; (5) timing; (6) uncertainty; (7) novelty; and (8) knowledge.

Jasanoff, S. (1999) Songlines of Risk. *Environmental Values* 8:2, 135–152.

Provides an overview of three traditions of risk analysis: (1) risk defined and managed by a team of technical experts; (2) risk understood as a combination of scientific facts and cultural understanding; and (3) risk used to gain power in society (by establishing some as “expert” and others as “inarticulate”). Argues that risk assessment is a cultural structure consisting of causation, agency, and uncertainty. Suggests that risk analysis must be conducted as a political and social process, unique to each community or location.

MacLean, D. (1982) Risk and Consent: Philosophical Issues for Centralized Decisions. *Risk Analysis* 2:2, 59–67.

Asserts that consent is impossible to achieve in decisions affecting large numbers of people. Describes and critiques three *indirect* consent models: (1) implicit consent, whereby people reveal their preferences for risk and safety through market experiences (e.g., buying a smoke detector) and these preferences are applied, by analogy, to non-market settings; (2) hypothetical consent, in which people first consent to the decision-making process and its rationality and then consent to the decision; and (3) nonconsent, where different preferences have different weights, and value trade-offs occur.

Metlay, D. (1982) The Institutional Aspects of Radioactive Waste Management. *Radiation Research*. 91, 34–44.

Provides an overview of some nontechnical aspects of waste management, including the following: (a) consideration of effects on future generations; (b) logistics involved in developing a waste disposal facility; (c) management of socioeconomic impacts; (d) the organizational design of a waste management program; and (e) relationships between federal and state governments concerning decision-making authority. Argues that nontechnical issues have arisen due to an historically weak technical base.

O’Riordan, T. (1982) Risk Perception Studies and Policy Priorities. *Risk Analysis* 2:2, 95–100.

Suggests that distrust concerning risk assessments and the people who conduct them may be understood better when researched in a setting characterized by information exchange and dynamic views than in a setting characterized by static, individual views.

Slovic, P., Fischhoff, B., and Lichtenstein, S. (1979) Rating the Risks. *Environment* 21:3, 14–20, 36–39.

Discusses heuristics people use in evaluating risks. Provides different groups’ rankings of various risks from technologies or activities. Compares those rankings with estimates of the frequency of death from these same technologies and activities. Suggests that members of the public consider factors other than fatality rates when ranking risks.

Slovic, P., Fischhoff, B., and Lichtenstein, S. (1982) Why Study Risk Perception? *Risk Analysis* 2:2, 83–93.

Discusses the history of risk perception studies, including key research questions, a description of the psychometric paradigm, and a list of generalizable results from the psychometric paradigm. Responds to criticism of such research and offers three cases where risk perception research provided usable knowledge to policy makers.

Environmental Values

Axelrod, L. (1994) Balancing Personal Needs with Environmental Preservation: Identifying the Values that Guide Decisions in Ecological Dilemmas. *Journal of Social Issues* 50:3, 85–104.

Examines the correlation between value orientations (social, economic, or universal) among individuals and environmental preservation concerns. Considers some implications for resolving environmental conflict.

Burgess, J., Limb, M., and Harrison, C. (1988) Exploring Environmental Values through the Medium of Small Groups: 1. Theory and Practice. *Environment and Planning A* 20, 309–326.

Reviews research concerning once-only small groups and in-depth small groups as it applies to geographical research. Summarizes the theory of Group Analysis (a psychoanalytic approach that maintains that individuality is defined through social interactions) and asserts its importance in the study of environmental values. Develops a methodology to record and interpret qualitative data from in-depth small group interactions and applies it to the Greenwich open-space project. Discusses implications for environmental management research.

Chang, N., Yeh, S.C., and Wu, G. C. (1999) Stability Analysis of Grey Compromise Programming and Its Application to Watershed Land-Use Planning. *International Journal of Systems Science* 30:6, 571–589.

Presents a new mathematical programming theory, grey compromise programming, to include uncertainties about the relationship between land capacity and resultant water quality in watershed optimal land-use planning. Applies the theory to a case study of Taiwan's Tweng-Wen reservoir watershed. Concludes that several alternatives exist, including increasing residential and/or forest use while decreasing grassland use.

Eagly, A., and Kulesa, P. (1997) Attitudes, Attitude Structure, and Resistance to Change: Implications for Persuasion on Environmental Issues. In *Environment, Ethics, and Behavior: The Psychology of Environmental Valuation and Degradation*. Bazerman, M., Messick, D., Tenbrunsel, A., and Wade-Benzoni, K. (eds.), San Francisco: The New Lexington Press, 122–153.

Provides an overview of attitude and attitude-change theory. Describes several attitude modification and persuasion techniques. Argues that effective persuasion must address the underlying values to which environmental attitudes are linked.

Kempton, W., Boster, J., and Hartley, J. (1995) *Environmental Values in American Culture*. Cambridge: The MIT Press.

Presents survey results concerning environmental values. Identifies and confirms distinct models of reasoning as well as identifies environmental values paradigms.

Simmons, D., Binney, S., and Dodd, B. (1992) Valuing “A Clean Environment:” Factor Location, Norms, and Relation to Risks. *Journal of Social Behavior and Personality* 7:4, 649–658.

Summarizes the use of, and modifications made to, the Rokeach Value Survey (one of the most widely used surveys to understand how environmental values interact with other values). Adds “A Clean Environment” to the list of terminal values. Concludes that it is an important part of the complex of values and is embedded in risk perception.

Shelton, M. and Rogers, R. (1981) Fear-Arousing and Empathy-Arousing Appeals to Help: The Pathos of Persuasion. *Journal of Applied Social Psychology* 11:4, 366–378.

Provides empirical evidence that empathy-arousing appeals promote attitude change regarding environmental protection. Discusses implications for media campaigns that promote ecological actions.

Stern, P., Dietz, T. and Kalof, L. (1993) Value Orientations, Gender, and Environmental Concern. *Environment and Behavior* 25:3, 322–348.

Develops a model to test how three world views (egoistic, social-altruistic, biospheric) as well as gender affect environmental concern and related actions.

Stern, P., and Dietz, T. (1994) The Value Basis of Environmental Concern. *Journal of Social Issues* 50:3, 65–84.

Reviews literature concerning the relationships among values, beliefs, and attitudes. Tests empirically a theory that links world view (biospheric, social-altruistic, egoistic) and risk perceptions with environmental values and related actions. Concludes that environmentalism is clearly linked to world view and that a biospheric world view is indistinguishable from a social-altruistic world view in a general population sample.

Stern, P., Dietz, T., Kalof, L., Guagnano, G. (1995) Values, Beliefs, and Proenvironmental Action: Attitude Formation Toward Emergent Attitude Objects. *Journal of Applied Social Psychology* 25:18, 1611–1636.

Theorizes how individuals form attitudes about emerging environmental issues. Proposes a “norm activation model,” which postulates that individuals construct attitudes based on the implications of a phenomenon for the things they value most. The model is linked to analyses of underlying value orientations, namely: (1) biospheric-altruistic; (2) biospheric; and (3) egoistic. Suggests how information (and its framing and legitimation) intervenes in attitude formation.

Van Liere, K. and Dunlap, R. (1980) The Social Bases of Environmental Concern: A Review of Hypotheses, Explanations and Empirical Evidence. *Public Opinion Quarterly*, 181–197.

Examines the statistical evidence for a correlation between environmental concern and five factors: age, sex, political party, social class, and residence. Reviews explanations for the potential influence of these factors. Suggests that cognitive factors should be examined in addition to demographic characteristics.

Yount, J. and Horton, P. (1992) Factors Influencing Environmental Attitude: The Relationship Between Environmental Attitude Defensibility and Cognitive Reasoning Level. *Journal of Research in Science Teaching* 29:10, 1059–1078.

Examines empirically the effects of an environmental studies course on college students. Concludes that, while increased information did not change attitudes, it led to increased defensibility of pre-existing attitudes among students with higher cognitive reasoning levels. Offers suggestions for teaching environmental information more effectively.

Attitude/Value Theory

Grube, J., Mayton, D., and Ball-Rokeach, S. (1994) Inducing Change in Values, Attitudes, and Behaviors: Belief System Theory and the Method of Value Self-Confrontation. *Journal of Social Issues* 50:4, 153–173.

Summarizes tenets of the belief system theory and methods of value self-confrontation. Presents and discusses several value self-confrontation studies.

Keeney, R. (1992) *Value-Focused Thinking: A Path to Creative Decisionmaking*. Cambridge, MA: Harvard University Press.

Argues for the importance of identifying values relevant to decision making. Provides guidelines for discerning those values and including them in decision making. Illustrates decision-theoretic techniques with case studies.

Kristiansen, C. and Zanna, M. (1988) Justifying Attitudes by Appealing to Values: A Functional Perspective. *British Journal of Social Psychology* 27, 247–256.

Offers empirical evidence to support the claim that people with differing attitudes not only have different values (value importance/priority) but, more importantly, appeal to different values to justify those attitudes (value relevance).

Tetlock, P. (1986) A Value Pluralism Model of Ideological Reasoning. *Journal of Personality and Social Psychology* 50:4, 819–827.

Summarizes the basic tenets of the value pluralism model. Provides empirical evidence that supports the model. Finds that people will engage in more complex thinking (consider value trade-offs) about policy issues when a conflict between important or equally important values exists.

Robinson, I. E., Robinson, E. A., and Slevin K. (1987) Social Norms or Group Pressure? *Free Inquiry in Creative Sociology*. 15:1, 91–92.

Challenges traditional results of autokinetic effect experiments (convergence of individual estimates of light movement in a group situation) by changing the structure of the experiment (namely, varying response times and offering “no movement” as a response). Concludes that there are two types of participants: those who see and report the movement from the beginning and those who need to learn to see or report the movement. Asserts that convergence towards a means may be more the result of conformity to group pressures than the tendency to create order in ambiguous settings.

Zimbardo, P. and Leippe, M. (1991) *The Psychology of Attitude Change and Social Influence*. Philadelphia: Temple University Press.

Covers a broad range of theoretical topics in social influence including persuasion, compliance, conformity, obedience, dissonance. Discusses implications for the legal system, environmentalism, and health professions.

Ethical/Social Issues

Anonymous (1997) Moral Lesson for Policymakers. *Chemistry & Industry* July 7, 495.

Discusses survey results indicating that greater understanding of, or more knowledge about, biotechnology does not necessarily lead to more support for it.

Beachy, R. (1999) Facing Fear of Biotechnology. *Science*. 285:5426, 335.

Argues that scientists should participate in the popular press (by submitting editorials or engaging in radio and television interviews) to enter into stakeholder dialogs currently dominated by shoddy experimental data and inflammatory language.

Carr, S. and Levidow, L (1997) How Biotechnology Regulation Separates Ethics from Risk. *Outlook on Agriculture* 26:3, 145–150.

Explains that critics and proponents of biotechnology have used ethical arguments (different understandings of “natural”) to oppose or support agricultural biotechnology. Postulates that, in response, regulators (e.g., the European Commission) have separated ethics from risk, thereby limiting the scope of each and preventing legitimate public discourse.

Boné, E. (1986) The Ethical and Social Dimensions of Biotechnologies. In *Industrial Technology in Europe: Issues for Public Policy*. Davies, D. (ed.) Dover, NH: Frances Pinter, 99–108.

Raises several ethical issues associated with biotechnology including theological considerations, relationships between researchers and institutions, questions of ownership, and distribution of possible benefits.

Gaskell, G, Bauer, M. W, Durant, J. and Allum, N. C. (1999) Worlds Apart? The Reception of Genetically Modified Foods in Europe and the U.S. *Science* 285:5426, 384–387.

Explains the different patterns of logic used by Europeans and Americans in understanding biotechnology based on survey responses. Examines the effects of media coverage, trust in regulatory mechanisms, and knowledge of biotechnology on attitudes. Concludes that more media coverage (as opposed to more negative media coverage), less trust in regulatory mechanisms, and a perception of genetically modified food as menacing (as opposed to more “textbook” knowledge of biotechnology) accounts for the less supportive attitudes of Europeans to food and agricultural biotechnology.

Lynn, F., Poteat, P., and Palmer, B. (1988) The Interplay of Science, Technology, and Values in Environmental Applications of Biotechnology. *Policy Studies Journal* 17:1, 109–116.

Provides an overview of the ethical problems brought about by the advent of biotechnology and devotes particular attention to the issue of public trust.

Murray, T. (1985) Ethical Issues in Genetic Engineering. *Social Research* 52:3, 471–489.

Discusses the importance, as well as the limitations, of two approaches to raising ethical issues associated with biotechnology (consequentialist—focusing only on consequences—and deontological—focusing on consequences as one aspect of a suite of concerns).

Reichhardt, T. (1999) Trade Concerns Dominate GM Debate in US. *Nature*. 399:6734, 287.

Suggests that Americans are more concerned with trade and agricultural development than with the environmental risks of genetically modified organisms. Asserts that, despite the newly published dangers of the pollen of genetically modified corn to monarch butterflies, Americans will not likely seek greater regulatory control.

Serageldin, I. (1999) *Biotechnology and Food Security in the 21st Century. Science. 285:5426, 387–389.*

Reviews statistics of the world's future food needs and current agricultural capabilities. Argues that the development of agricultural biotechnology may provide some important opportunities as well as some significant ethical questions concerning intellectual property rights vs. moral obligation to the poor. Describes some efforts to ensure the fulfillment of both and suggests ways of furthering public-private partnerships.

Organizational/Environmental Interest Group Theory and Practice

Collins-Jarvis, L. (1997) *Participation and Consensus in Collective Action Organizations: The Influence of Interpersonal Versus Mass-mediated Channels. Journal of Applied Communication Research 25:1, 1–16.*

Provides evidence suggesting that, while direct participation (through volunteerism) in an organization leads to greater goal consensus than indirect participation (through mass media structures), mass media has a greater *influence* on goal consensus than interpersonal interactions. Offers suggestions for improving participation and communication strategies.

Davis, S. (1996) *Environmental Politics and the Changing Context of Interest Group Organization. The Social Science Journal 33:4, 343–357.*

Examines the incentives and motivations for interest group formation and collective action. Challenges the idea that selective individual benefits are a necessary condition for collective action, postulating that shared perceptions of common interests or threats are sufficient.

Egri, C. and Pinfield, L. (1996) *Organizations and the Biosphere: Ecologies and Environments. In Handbook of Organization Studies. Clegg, S., Hardy, C., and Nord, W. (eds.) Thousand Oaks: Sage Publications, 459–483.*

Describes and critiques three environmental perspectives: (1) Dominant Social Paradigm; (2) Radical Environmentalism Perspective; and (3) Reform Environmentalism Perspective. Examines the relationship between organization theory and environmentalism, arguing that the tenets of systems theory (e.g., the recognition of interrelationships between ecological and societal systems) may provide the bridge between the two.

Kowalewski, D. (1995) How Movements Move: The Dynamics of an Ecoprotest Campaign. *The Social Science Journal* 32:1, 49–67.

Develops and empirically tests two models of political movement change: (1) vanguard mobilization (top-down influence) and (2) grassroots initiative (bottom-up influence) to better understand the dynamics of environmental movements over time

Remediation/Bioremediation Technology

Kato, K. and Davis, K. (1996) Current Use of Bioremediation for TCE Cleanup: Results of a Survey. *Remediation*, 1–14.

Presents survey results from environmental professionals on the use of bioremediation for the cleanup of trichloroethylene by research centers and remediation firms, including cost-effectiveness and opinions about the use of nonindigenous microorganisms for bioremediation. Concludes that performance reliability, delivery, and cost concerns rather than safety issues deter environmental professionals from using nonindigenous microorganisms for bioremediation.

Norris, G., Al-Dhahir, Z., Birnstingl, J., Plant, S. J., Cui, S., and Mayell, P. (1999) A Case Study of the Management and Remediation of Soil Contaminated with Polychlorinated Biphenyls. *Engineering Geology* 53, 177–185.

Discusses the investigation of alternative remediation technologies for remediating polychlorinated biphenyl (PCB) and chlorinated solvent contamination within a communications manufacturing facility site. Explains the rejection of several options: high temperature incineration (too costly); soil washing (not commercially viable due to small volume); bioremediation (not viable with existing technology); and solvent washing (too costly and not time sensitive). Summarizes the process and acceptable characteristics of the chosen option, low temperature thermal desorption (LTTD).

Timian, S. J. and Connolly, M. (1996) The Regulation and Development of Bioremediation. *Risk* 7, www.fplc.edu/risk/vol7/summer/Timian.htm.

Describes the use of bioremediation with regard to the Resource Conservation and Recovery Act (RCRA), the Comprehensive Environmental Response, Compensation, and Recovery Act (CERCLA), and the Toxic Substances Control Act (TSCA). Argues for more risk-based regulations of genetically modified microorganisms.