



Technocracy And Democracy: Conflicts Between Models and Participation in Environmental Law and Planning

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I. INTRODUCTION

Many of our environmental laws create an unfortunate paradox. They mandate science-based planning, and that mandate often translates into a practical or even legal requirement to use complex simulation models.¹ The same laws also contain provisions for public participation in government agency environmental planning and decision-making. When agencies engage in technical decision-making, however, and particularly when they use complex models, the reasoning underpinning decisions becomes difficult for public participants to understand. As a result, legal mandates for science-based planning and for public participation come into conflict, and processes legally required to be transparent and open can instead become opaque and closed.

This conflict is inherent in many environmental statutes, and is acute in the State Implementation Plan (SIP) process required by the Clean Air Act.² SIPs codify states' plans for meeting federal air quality goals.³ This is a rather important function; although long recognized as an environmental concern,⁴ air pollution remains a ubiquitous and

1. The term "model" does not lend itself to simple definition, but in general terms it is a tool used to simulate some aspect of the real world. EDITH STOKEY & RICHARD ZECKHAUSER, *A PRIMER FOR POLICY ANALYSIS* 8 (1978) ("A model is a simplified representation of some aspect of the real world, sometimes of an object, sometimes of a situation or a process. It may be an actual physical representation—a globe, for instance—or a diagram, a concept, or even a set of equations. It is a purposeful reduction of a mass of information to a manageable size and shape . . .").

2. 42 U.S.C. §§ 7401–7671q (2000).

3. 42 U.S.C. §§ 7407, 7410 (2000); see *West Virginia v. EPA*, 36 F.3d 861, 867–68 (D.C. Cir. 2004). In California, local air districts write plans that are aggregated into a SIP by the California Air Resources Board.

4. For an interesting historical account of one of the first American air pollution disputes, see DONALD MACMILLAN, *SMOKE WARS: ANACONDA COPPER, MONTANA AIR POLLUTION, AND THE COURTS, 1890–1924* (2000). For a description of later twentieth century air pollution history, see CHARLES O. JONES, *CLEAN AIR: THE POLICIES AND POLITICS OF POLLUTION CONTROL* (1975). A more recent account of the 1990 Clean Air Act Amendments is provided by GARY C. BRYNER, *BLUE SKIES, GREEN POLITICS: THE CLEAN AIR ACT OF 1990 AND ITS IMPLEMENTATION* (2d ed. 1995). See also *Clean Air Act Amendments of 1990*, Report of the Committee on Energy and Commerce, U.S. H.R. Rep. 101-490, pt. 1 (1990). For a lay description of air pollution, as well as historical accounts of air pollution events that caused human and animal deaths, see STEPHEN E. BLEWETT & MARY EMBREE, *WHAT'S IN THE AIR: NATURAL AND MAN-MADE AIR POLLUTION* (1998).

sometimes deadly problem.⁵ After thirty years of federal regulation, most urban areas in the United States still have not attained all federal ambient air quality goals.⁶ The persistence of the problem affects millions of people.⁷ As a result, the general public has very good reasons to want to participate in air quality planning.⁸

Although people hoping to participate in air pollution planning processes might wish for those processes to be accessible, understanding and addressing air pollution requires the use of computer-based air quality simulation models. Models can process reams of data and represent mathematically complex chemical, physical and social relationships, allowing modelers to make predictions and test assumptions in ways that otherwise would not be possible. Not surprisingly, models have become essential and ubiquitous planning tools, our dependence upon them making their abandonment all but unthinkable.

Nevertheless, models are incomplete representations of reality and suffer from many sources of uncertainty.⁹ Every model, strictly speaking, is an approximation, for no model can be an exact representation of the

5. See AMERICAN LUNG ASS'N, 2002 STATE OF THE AIR REPORT, at <http://www.cleanairstandards.org/article/articleview/182/1/27/> (last visited Apr. 7, 2004) ("More than 142 million Americans—75 percent of the nation's population living in counties with ozone monitors—are breathing unhealthy amounts of ozone air pollution."). EPA also has reported that approximately 81.5 million and 34.7 million people lived in counties where allowable 8-hour and 1-hour average ozone concentrations, respectively, were exceeded, and that the problems occur in rural, suburban, and urban areas alike. EPA, LATEST FINDINGS ON NATIONAL AIR QUALITY: 2002 STATUS AND TRENDS at <http://www.epa.gov/airtrends/reports.html> (last visited Apr. 7, 2004).

6. See EPA, 1-Hour Ozone Area Non-Attainment Map, at <http://www.epa.gov/airprogrom/oar/oaqps/greenbk/onmapc.html> (last visited Feb. 13, 2003) (showing ozone non-attainment areas).

7. *Id.* The statistics provided by EPA may be misleading, however. By reporting population totals for areas (e.g., counties) not in attainment of ambient air quality standards, EPA suggests that the entire population in those areas is breathing air of similar quality. In fact, air quality standard violations may occur infrequently and in only portions of the county.

8. The term "public" can be used to encompass a broad range of potential participants, ranging from regulated industry to at-risk individuals to public interest groups. In this article, our discussion focuses primarily upon lay citizens and the public interest or community groups that attempt to represent average citizens. The participation problems we discuss also create hurdles to industry participation, but industry and regulated entities typically devote considerable financial resources to involvement in spite of those hurdles, and the problems we discuss therefore tend to be more pronounced for the lay public and, to a lesser extent, public interest or community groups. See generally MANCUR OLSON, *THE LOGIC OF COLLECTIVE ACTION* 165–66 (1971) (discussing the tendency of diffuse groups to have greater difficulty mobilizing to participate, and the anti-democratic implications of that tendency).

9. Among modelers, this is common knowledge. Indeed, a primary focus of modelers' work is identifying and minimizing the limitations of models. Planners, lawyers, and other non-modelers are often unaware of the limitations of models, however, or, even if they do have a general awareness of those limitations, have no way of discerning how the specific limitations of models may affect public policy choices. It is to those non-modelers that this article's extensive discussion of the limitations of models is primarily directed.

real world.¹⁰ Air quality planning models, like any physically based simulation, also are unverifiable, limiting modelers' ability to assess their reliability.¹¹ Approximations, subjective choices, and errors in both design and application are common in any modeling effort, but the complexity of current state-of-the-science models hinders assessment of their certainty.¹² These factors limit the reliability of modeling results, and render model-based planning—particularly the process of making policy decisions based on uncertain results—well worthy of public scrutiny.

Unfortunately, engaging in such scrutiny is often prohibitively difficult. A process based upon complex technical analyses makes participation difficult for even model-savvy parties, let alone lay persons. The economic inability of low-income communities to pay for modeling expertise only exacerbates this problem. The opacity of modeling processes can also limit the effectiveness of judicial review, depriving would-be citizen participants of an important method of challenging decision-making processes gone awry.¹³ As a result, model-based planning often defies public participation.

The practical consequences of such thwarted participation can be troubling. An absence of participation can foster feelings of exclusion and alienation, leading to distrust of regulators and of expertise-based decision-making. Points that regulators discount or fail to anticipate may never be explored, and this lack of exploration may lead to plans based partly on misunderstanding of public concerns. Assumptions and conclusions of the expert decision-makers may never be subjected to

10. M. GRANGER MORGAN & MAX HENRION, *UNCERTAINTY: A GUIDE TO DEALING WITH UNCERTAINTY IN QUANTITATIVE RISK AND POLICY ANALYSIS* 68 (1990) ("Any model is unavoidably a simplification of reality. Any real-world system contains phenomena or behaviors that cannot be produced by even the most detailed model. Even if a model is a good approximation to a particular real-world system and usually gives accurate results, it can never be completely exact. Careful thought leads us to the following disturbing conclusion: *Every model is definitely false.*").

11. See Naomi Oreskes et al., *Verification, Validation, and Confirmation of Numerical Models in the Earth Sciences*, 263 *SCIENCE* 641-46 (1994).

12. See THE NORTH AMERICAN RESEARCH STRATEGY FOR TROPOSPHERIC OZONE SYNTHESIS TEAM, AN ASSESSMENT OF TROPOSPHERIC OZONE POLLUTION: A NORTH AMERICAN PERSPECTIVE 4-11 (2000) [hereinafter NARSTO] ("Unfortunately, the uncertainty in model predictions depends on a variety of factors, including the type of prediction, the application, the uncertainties in the model input and parameters, and the model itself. Moreover, as discussed, the methods currently available for assessing model uncertainty are themselves uncertain."). See generally James Fine et al., *Evaluating Uncertainties in Regional Photochemical Air Quality Modeling*, 28 *ANN. REV. ENV'T & RESOURCES* 59 (2003).

13. This increased opacity has not stopped numerous petitioners—mostly representing regulated industries—from challenging agencies' uses of models. See generally Thomas O. McGarity & Wendy E. Wagner, *Legal Aspects of the Regulatory Use of Environmental Modeling*, 33 *ENVTL. L. REP.* 10751 (2003) (providing a comprehensive review of modeling cases). Nevertheless, judicial experience arising out of these cases does not remove some of the inherent problems faced by any court attempting to review a model-based decision.

critical examination in an open public forum. Likewise, public pressure that might lead to more environmentally protective policies may be muted, leading regulators to adopt plans less likely to satisfy the substantive mandates of applicable law. Finally, and perhaps most importantly, impediments to public participation undermine the mandates of environmental laws that specifically provide for such participation opportunities.¹⁴

In this Article, we explore the tension between public participation and modeling by focusing on the SIP development process. We begin by discussing the roots of the problem, exploring the origins of legal requirements for both public participation and modeling. We then discuss how the use of models fits within planning processes, describing both the ways in which planning depends upon models and the ways in which model use impedes the public role. We offer as an example the history of a particular SIP planning process—the development of the San Joaquin Valley ozone plan for California’s 1994 SIP¹⁵—to illustrate tensions between model-based planning and public participation. We close with recommendations for ameliorating this paradox without excluding public concerns or compromising the sophistication and integrity of science-led planning.

Although we focus upon the SIP development process, the problems we describe are by no means unique to air quality planning. Throughout environmental planning, models are ubiquitous. Likewise, public participation is a legally required component of most environmental planning processes. The tensions and contradictions that we describe pervade the world of environmental planning, and the solutions we propose apply well beyond SIP development.

14. See BRUCE A. ACKERMAN & WILLIAM T. HASSLER, *CLEAN COAL/DIRTY AIR: OR HOW THE CLEAN AIR ACT BECAME A MULTIBILLION-DOLLAR BAIL-OUT FOR HIGH-SULFUR COAL PRODUCERS AND WHAT SHOULD BE DONE ABOUT IT* 4–9 (1981) [hereinafter “CLEAN COAL/DIRTY AIR”] (describing the demise of the “New Deal” administrative law model based on decisions by oligopolies of experts).

Thwarting participation may also, in theory, bring benefits. With fewer participants, planning processes may proceed more quickly—particularly if those few participants all share a high level of technical expertise. See OLSON, *supra* note 8, at 53–65 (discussing the efficiency advantages of small groups). But while smaller-group processes may promise faster resolutions, they also can lead to groupthink—particularly if the interests of those in or with access to the planning group are fairly homogenous—and the policies insular groups create can have lower odds of fulfilling substantive legal mandates. As a consequence, those policies can be more likely to require prompt reexamination, and the apparent efficiency of resolutions reached without public involvement can be illusory.

15. See SAN JOAQUIN VALLEY UNIFIED AIR POLLUTION CONTROL DISTRICT, *THE OZONE ATTAINMENT DEMONSTRATION PLAN* (1994) [hereinafter “ATTAINMENT PLAN”] Pages in the Attainment Plan are denoted by a two-number system, with the chapter number followed by a page number. Thus, a citation to pages 1-6 and 1-7 refers to pages 6 and 7 in chapter one. For the 1994 California State Implementation Plan, see <http://www.arb.ca.gov/planning/sip/94sip/sipvol1.htm> (last visited on Apr. 7, 2004).

II. THE ORIGINS OF THE PARADOX: ENVIRONMENTAL LAW, SCIENCE, AND PUBLIC PARTICIPATION

The roots of the modeling-participation paradox run deep within our system of environmental laws. On the one hand, our system draws heavily on a traditional respect for agency expertise, and that respect has inexorably led to the use of models and exclusive decision-making. On the other hand, our environmental laws draw upon a tradition of distrust of government, and rely upon the interested public to influence, critique, and even sue to overturn agency decisions. This section explores how those traditions have evolved and become embedded within environmental law in general and the SIP approval process in particular.

A. THE ENTRENCHMENT OF MODELING IN ENVIRONMENTAL LAW

I. *Science and Environmental Law: The Roots of Modeling Requirements*

Environmental statutes commonly call for agencies to ground their decisions in science.¹⁶ These laws assume that science will provide answers to environmental problems and that agencies, as repositories, generators and interpreters of technical evidence, will be well suited to translate science into policy.¹⁷ Our current dependence upon model-based planning derives in part from this emphasis upon science.¹⁸

Reliance on scientific expertise is deeply rooted in administrative

16. See, e.g., National Environmental Policy Act, 42 U.S.C. § 4332(A) (2000) (requiring comprehensive discussion of the environmental impacts of proposed action, which necessarily means scientific study); Endangered Species Act, 16 U.S.C. § 1533(b)(1)(A) (2000) (requiring that listing decisions be based upon science); Clean Water Act, 33 U.S.C. § 1314(a)(1) (2000) (requiring science-based water quality standards); Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 U.S.C. § 9605, 9621 (2000) (requiring science-based cleanup standards).

17. A. Dan Tarlock, *Who Owns Science?*, 10 PENN ST. ENVTL. L. REV. 135, 138-39 (2002).

18. The word “science” has plural vernacular meanings. Some—in particular scientists—use the term narrowly to refer to the process of seeking truth through a recursive Baconian process of experimentation via observation and hypothesis testing. Others use “science” to refer to the body of knowledge developed and not yet rejected through use of the scientific method; our high school science classes, for example, convey information as well as methodology. Many of us also use the term “science” to refer to “state-of-the-science” gadgetry. See, e.g., POPULAR SCIENCE, at <http://www.popsci.com/popsci/> (last visited Aug. 24, 2004) (a magazine devoted largely to technology). To make matters more complicated, policy scholars have drawn a distinction between research science and “mandated” or “regulatory” science. Those scholars have found that the latter form of science, which occurs pursuant to regulatory pressures, has highly different characteristics from science conducted in “pure research” settings. SHEILA JASANOFF, SCIENCE AT THE BAR 5-7 (1990).

In this article, we use the term “science” to refer to both the process through which scientific information is developed (e.g., model development, gathering observational data, and using that data to execute and evaluate the modeled simulation) and the body of information that arises out of that process (e.g., modeling results, such as predictions). Much of the “science” we refer to is, at least to some extent, regulatory science. Nevertheless, we caution readers that the modeling we describe draws heavily upon both regulatory and traditional science as well as upon information and decisionmaking methods that are not at all scientific, as well as upon modes of decisionmaking that are not, under any of these definitions, scientific.

law. In the nineteenth century, proponents of the administrative state proposed the notion that professionally expert agencies should be isolated from politics and allowed to do their technical work.¹⁹ The resulting bureaucratic model, in which a closed dialogue between scientists and policymakers was to set the course of the bureaucracy, held sway throughout the early twentieth century and became institutionalized, with some limitations placed on discretion, into law with the Administrative Procedures Act.²⁰

In the late 1960s and the 1970s, when Congress drafted most of our canon of environmental laws, environmental problems seemed particularly well suited for an expert-based decision-making approach. Faith in science was still prevalent.²¹ Then as now, understanding environmental problems almost always required scientific understanding. Not surprisingly, environmental scientists had played crucial roles in raising public awareness of environmental problems.²² Moreover, environmental problems seemed amenable to scientific solutions, for our society was only beginning to realize how hard environmental problems would be for even scientists to understand.²³ It was a time when both

19. See, e.g., Woodrow Wilson, *The Study of Administration*, 2 POL. SCI. Q. 197, 210 (1887) (“Although politics sets the tasks for administration, it should not be suffered to manipulate its offices.”); CLEAN COAL/DIRTY AIR, *supra* note 14, at 4–6 (describing the “New Deal” administrative model).

20. 5 U.S.C. §§ 551–706 (2000); see Richard Posner, *The Rise and Fall of Administrative Law*, 72 CHI.-KENT L. REV. 953, 953–54 (1997); STEPHEN G. BREYER ET AL., ADMINISTRATIVE LAW AND REGULATORY POLICY 22–23 (4th ed. 1999).

21. See JASANOFF, *supra* note 18, at 2 (describing the bases for that faith, which continues to the present day). Jasanoff writes:

America’s preoccupation with progress through science and technology appears, at one level, to be solidly grounded in historical achievements. A century of inventions has enlarged our capabilities and improved our quality of life in myriad unpredictable ways. At every turn we encounter new material indicators of progress: air bags and antilock brakes, electronic mail, fax machines and bank cards, heart transplants and laser surgery, genetic screening, *in vitro* fertilization, and a burgeoning pharmacopeia for treating mental and physical illness. In just one generation the space program has expanded the physical frontiers of human experience, while discoveries in the biological sciences have revolutionized our ability to manipulate the basic processes of life so as to fight infertility, aging, hunger, and disease.

Id.

22. Tarlock, *supra* note 17, at 136–37 (describing the influence of scientists/naturalists like Rachel Carson and Aldo Leopold upon the nascent environmental movement). For a more recent example of a scientist influencing environmental policy, see PENELOPE CANAN & NANCY REICHMAN, OZONE CONNECTIONS: EXPERT NETWORKS IN GLOBAL ENVIRONMENTAL GOVERNANCE 48–52 (2002) (describing the role of Mostafa Tolba, the chief architect of the Montreal Protocol, an international treaty to phase-out the use of substances that destroy protective stratospheric ozone).

23. Aldo Leopold had already suggested that the great scientific discovery of the Twentieth Century was the complexity of natural systems, but the stunning degree of that complexity, and the resulting difficulty of making environmental decisions, was only beginning to be understood. See Aldo Leopold, *The Round River*, in A SAND COUNTY ALMANAC, WITH ESSAYS ON CONSERVATION FROM ROUND RIVER 190 (Oxford Univ. Press ed. 1966) (“The outstanding scientific discovery of the Twentieth century is not television, or radio, but the complexity of the land organism. Only those who know the most about it can appreciate how little is known about it.”).

scientists and legislators could easily believe in scientific solutions to environmental problems.²⁴

Perhaps as a result, scientific and technological positivism, with a touch of naiveté, permeates our environmental statutes.²⁵ In drafting these statutes, Congress assumed that science would drive decision-making and that agencies could interpret scientific information to set the right policies.²⁶ Congress also assumed that agencies could do all of this

Across a wide range of fields, our understanding of the environment was still highly simplistic. Air pollution modelers, for example, were using simple linear relationships to associate emissions with resultant air pollution and were not yet considering the ways in which emissions and meteorology could interact in nonlinear, counterintuitive ways. Likewise, ecologists were still wedded to the notion that the environment gravitated toward a stable, harmonious state. See DANIEL B. BOTKIN, *DISCORDANT HARMONIES* (1990) (describing how these assumptions of stability were wrong, and how years of subsequent research have gradually forced scientists to recognize the natural environment as a dynamic, shifting, and unpredictable entity).

24. See Richard J. Lazarus, *The Tragedy of Distrust in the Implementation of Federal Environmental Law*, 54 *LAW & CONTEMP. PROBS.* 311, 322 (1991). Lazarus writes:

A strong national consensus in favor of environmental protection prompted the President to create EPA, Congress to pass sweeping environmental laws, and courts to open their doors to environmental plaintiffs. But both the public and those institutions were remarkably unsophisticated about the demands that they were placing upon themselves.

There was little, if any, sense of the huge short-term costs associated with treating pollution as a cost of doing business. Nor was there much awareness of the degree to which settled expectations and lifestyles could be disrupted if the natural environment were to be treated as more than an economic commodity. The public and governmental institutions likewise did not truly appreciate the incalculable nature of the benefits of environmental protection, including the scientific uncertainty associated with the measurement of those benefits and the long term intergenerational nature of their realization. There was especially little apprehension of how those characteristics would challenge the patience of both those sympathetic to, and those skeptical of, the new federal programs.

Id.

25. The National Environmental Policy Act (NEPA), for example, calls for agencies to prepare a “detailed statement” about potential environmental effects before undertaking any action that may significantly affect the environment, without even a hint that its drafters understood how complicated those statements would evolve to be. See 42 U.S.C. § 4332 (2000). The act makes provisions for addressing uncertainty, but its underlying assumption appears to be that in most cases information on the environmental consequences of actions would be either available or attainable through reasonable effort. See JASANOFF, *supra* note 18, at 2. The Endangered Species Act is fundamentally science-driven, with the Fish and Wildlife and National Marine Fisheries Services’ decisions to add a species to the endangered list to be based upon solely “the best scientific and commercial data available.” 16 U.S.C. § 1533(b)(1)(A) (2000); Holly Doremus, *Listing Decisions Under the Endangered Species Act: Why Better Science Isn’t Always Better Policy*, 75 *WASH. U. L.Q.* 1029 (1997). The Clean Water Act incorporates science-based water quality standards, and CERCLA mandates cleanup to levels based on scientific studies of human health. 33 U.S.C. § 1314 (2000); 42 U.S.C. §§ 9605, 9621 (2000).

26. See McGarity & Wagner, *supra* note 13, at 207–14 (describing multiple ways in which Congress asked agencies to utilize science—often to the exclusion of other decision-making criteria—in setting policy). Commentors also ascribe a host of less naive motives to the 1970s Congresses. Richard Lazarus suggests that in a divided country craving consensus about something, environmental protection served as a badly needed rallying point. See Lazarus, *supra* note 24, at 322. For Congress to act upon this consensus may have been laudable, but commentators suggest that in their exuberance to show environmental leadership, Congress and President Nixon steadily escalated the stringency of their proposed laws, eventually creating symbolic acts and leaving EPA to reap the political consequences when implementation proved impossible. *E.g.*, John P. Dwyer, *The Pathology of Symbolic Legislation*, 17 *ECOLOGY L.Q.* 233, 242–50 (1990); Lazarus, *supra* note 24, at 323 (“Congress

quickly; the new statutes set hundreds of short-term deadlines for setting standards or policy and for meeting environmental goals.²⁷

The 1970 Clean Air Act Amendments contained some of the most spectacular examples of scientific optimism. Congress demanded that automobile manufacturers reduce emissions of carbon monoxide, hydrocarbons, and nitrogen oxides by ninety percent in five years.²⁸ It required the newly formed EPA to identify air pollutants and to set health-based air quality standards for those pollutants within a matter of months.²⁹ It gave states three years to develop plans that would achieve standards by 1975.³⁰ In several instances, Congress established goals knowing that the technology to achieve them did not yet exist; “technology forcing” was a core element of the Act.³¹ Critics have called these requirements symbolic gestures,³² and indeed very few of the deadlines were met.³³ Nevertheless, that this ambitious scheme could even be proposed, let alone enacted, indicates a high level of faith in the ability of agencies to make effective science-based decisions.³⁴

made no effort to bridge the gap between the nation’s aspirations for environmental protection and its understanding of the underlying issues and its own capacity for change. The result was a seemingly never-ending onslaught of impossible agency tasks.”). Emphasis on science may have played an especially convenient role in such legislative punting. Wendy Wagner has observed that by grounding law in science, politically contentious value choices can be hidden behind seemingly non-value-based technical decisions, allowing the lawmakers and decisionmakers to escape political heat. Wendy E. Wagner, *Congress, Science, and Environmental Policy*, 1999 U. ILL. L. REV. 181, 227, 235. Nevertheless, even if Congress acted with a certain amount of politically convenient irresponsibility, scientific understanding of the complexity of environmental problems has developed substantially since the 1970s, and at least some of the scientific confidence apparent on the face of those early statutes probably was genuine.

27. Lazarus, *supra* note 24, at 323 (“The statutes imposed hundreds of stringent deadlines on the agency and removed much of the agency’s substantive discretion in accomplishing them. One-third of the deadlines were for six months or less. Sixty percent were for one year or less. According to EPA’s current administrator, William Reilly, Congress and the courts had imposed 800 deadlines on the agency through 1989.”) (internal citations omitted).

28. *Id.* at 324. For original language of the Clean Air Act, see Pub. L. No. 91-604, § 6(a), 1970 U.S.C.A. (84 Stat.) 1971.

29. Pub. L. No. 91-604, § 4(a), 1970 U.S.C.A. (84 Stat.) 1956, *codified at* 42 U.S.C. § 7409 (1994).

30. *Id.*; Lazarus, *supra* note 24, at 324.

31. *Union Elec. Co. v. EPA*, 427 U.S. 246, 256–57 (1976) (noting that the Act’s “requirements are of a ‘technology-forcing character’ and are expressly designed to force regulated sources to develop pollution control devices that might at the time appear to be economically or technologically infeasible.”) (quoting *Train v. Natural Resources Def. Council*, 421 U.S. 60, 91 (1975)).

32. *E.g.*, Dwyer, *supra* note 26; Lazarus, *supra* note 24.

33. *See* Lazarus, *supra* note 24, at 325.

Not surprisingly, fewer than 15 percent of the Clean Air Act’s deadlines were met. None of those met pertained to compliance with environmental quality standards. *Twenty years later, many areas of the nation still have not met the NAAQS. Both EPA and Congress have given the auto companies numerous extensions of the deadline for meeting 90 percent reduction in emissions of hydrocarbons, carbon monoxide, and nitrogen oxides, and, twenty years later, the companies have still not reduced nitrogen oxides by 90 percent.*

Id. (emphasis added).

34. In part, this emphasis upon science also reflected distrust of agencies; by demanding science-

This emphasis on science has not disappeared since the 1970s. Legislators consistently call for scientific foundations for decisions.³⁵ Congress may be inconsistent in its support of scientific research, and allegations of “junk” or incomplete science are often used to disparage the basis of any policy with which advocates do not agree,³⁶ but the general tenor of this rhetoric suggests a belief among legislators and the public that a few interlopers are trespassing in the high temple of scientific inquiry. Science still connotes integrity and is still popularly viewed as a necessary component of, and proper basis, for environmental policy.³⁷

Respect for agencies’ interpretations of science has also become deeply institutionalized within the judiciary. The judiciary does acknowledge an obligation to carefully review the procedural integrity of agency decision-making, and will sometimes overturn agency decisions based on highly technical analysis.³⁸ In the early 1970s, the “hard look doctrine,” which required judges to take a long, careful look at agency

based decisionmaking, Congress also sought to constrain agency discretion and force achievement of particular goals. See *CLEAN COAL/DIRTY AIR*, *supra* note 14, at 7–8, 104 (describing the agency-forcing role of early statutes, and the ways in which that role moved beyond the broad discretion accorded to agencies under a New Deal administrative model).

35. Wagner, *supra* note 26, at 184 (“Establishing a basis for regulating pollutants, pesticides, and toxic substances, for example, can be informed by science but cannot be completely resolved by it because of both preventable and unpreventable limits to experimentation. Despite these limits, Congress continues to develop laws and policies that frame multidisciplinary environmental problems as if they could be resolved largely or exclusively by science.”); *id.* at 223–28 (describing public confidence in and lack of understanding of science); see Doremus, *supra* note 25 (discussing how the Endangered Species Act’s science-only mandate obscures non-scientific value choices). Of course, these calls may be disingenuous; science takes time, and demands for more science prior to regulatory decisions may be merely delaying tactics. For example, a recent effort to revise the Endangered Species Act to require “sound science” was decried by many for being an attempt to undermine the Act disguised as a quest for scientific integrity. See, e.g., Union of Concerned Scientists, *Science Regarding the Endangered Species Act Manipulated*, at http://www.ucsusa.org/global_environment/rsi/page.cfm?pageID=1366 (last visited Nov. 15, 2004).

36. See Wagner, *supra* note 26, at 198–200. In a more recent example, EPA is currently being accused of failing to consider relevant scientific information in setting industrial mercury emissions standards. See, e.g., Shankar Vedantam, *New EPA Mercury Rule Omits Conflicting Data Study Called Stricter Limits Cost-Effective*, WASH. POST, Mar. 22, 2005, at A1.

37. See Wagner, *supra* note 26, at 223–28; Connie Ozawa, *Science in Environmental Conflicts*, 39 *SOCIOLOGICAL PERSPECTIVES* 219, 224 (1996) (“As long as agency decision makers were constrained by the technical experts’ interpretations of the physical conditions and alternative actions, Congress assumed that raw politics would be constrained.”).

38. See, e.g., *Sierra Club v. EPA*, 346 F.3d 955 (9th Cir. 2003) (overturning EPA’s approval of a SIP because the Court disagreed with EPA’s interpretation of the significance of graphs showing wind directions on days on which high pollutant levels occurred); McGarity & Wagner, *supra* note 13 (describing and criticizing cases in which courts performed non-deferential review of model-based decisions). McGarity and Wagner cite *Ohio v. EPA*, 784 F.2d 224 (6th Cir. 1986), *on reh’g*, 798 F.2d 880 (6th Cir. 1986), and *Gulf South Insulation v. Consumer Product Safety Commission*, 701 F.2d 1137 (5th Cir. 1983), as prominent, but probably outlying, examples of judicial overreaching. *Id.* at nn.70 & 93 and accompanying text.

decisions, evolved in part as a response to distrust of agency integrity.³⁹ Even in the heyday of exacting judicial review, however, judges rarely were willing to substitute an agency's expert judgment with their own. Deference to agency judgment is a core element of judicial review of environmental decisions, and judicial opinions are filled with statements about how agencies, not judges, hold technical expertise.⁴⁰

2. *Modeling, the SIP Process, and the Clean Air Act*

In a legal scheme founded upon confidence in technology and science, heavy dependence upon modeling should not be surprising. Standardized, science-based systems are likely to appeal to policymakers fond of expert decision-making, and models allow scientific knowledge to be codified and standardized.⁴¹ Indeed, quantitative modeling results may appear to technically non-savvy observers like the very pinnacle of systematized expert decision-making.⁴²

Models also are quite useful. Policymakers often must predict outcomes of complicated processes, and making those predictions would be all but impossible without models.⁴³ Complex environmental systems often involve more variables, data, and interdependent feedback processes than people reasonably can organize in their minds, and interactions within these systems may create counterintuitive, nonlinear responses that are impossible to understand without models. Models can organize, manipulate, and process vast quantities of data and can simulate complex multivariable processes, and these capacities allow them to predict the future, compare alternative possible futures,⁴⁴ test

39. See *Small Refiner Lead Phase-Down Task Force v. EPA*, 705 F.2d 506, 520–21 (D.C. Cir. 1983) (discussing the meaning of “hard look” review).

40. E.g., *N. Ohio Lung Ass'n v. EPA*, 572 F.2d 1143, 1148 (6th Cir. 1978) (“It is not for us to determine in the first instance whether the Ohio SIP meets all the criteria of the statute. That responsibility rests with the Administrator. . . . The Court is not empowered to substitute its judgment for that of the agency.”) (internal citations omitted); *Ethyl Corp. v. EPA*, 541 F.2d 1, 36 (D.C. Cir. 1976) (“[A]fter our careful study of the record, we must take a step back from the agency decision. We must look at the decision not as the chemist, biologist or statistician that we are qualified neither by training nor experience to be, but as a reviewing court exercising our narrowly defined duty of holding agencies to certain minimal standards of rationality.”).

41. PHILIP M. ROTH ET AL., *THE ROLE OF GRID-BASED, REACTIVE AIR QUALITY MODELING IN POLICY ANALYSIS: PERSPECTIVES AND IMPLICATIONS, AS DRAWN FROM A CASE STUDY* 46 (1989) (“Modeling is a codification of current knowledge.”).

42. See MARTIN GREENBERGER ET AL., *MODELS IN THE POLICY PROCESS: PUBLIC DECISION MAKING IN THE COMPUTER ERA* (1976) (stating that models represent “another phase in the continuing attempt by quantitative researchers to apply systematic analysis and scientific procedures to the understanding of policy problems and the making of public decisions”); *West Virginia v. EPA*, 362 F.3d 861, 867–68 (D.C. Cir. 2004) (noting the high degree of deference courts grant expert decisionmaking in general and modeling in particular).

43. See NARSTO, *supra* note 12, at 4-3 (describing the photochemical air quality models as the “only prognostic tool available to the policy-making community”).

44. See *also* *Sierra Club v. Costle*, 657 F.2d 298, 332 (D.C. Cir. 1981) (“Realistically, computer modeling is a useful and often essential tool for performing the Herculean labors Congress imposed on

the ramifications of assumptions, and contribute to improved understanding of system interactions. These powers are invaluable in planning efforts.

Models also can perform these functions relatively cheaply and with minimal social or environmental cost. Policymakers rarely can perform real-world experiments; large-scale experiments upon the environment are generally prohibitively time-consuming and expensive, and the threat of human injury or irreparable environmental harm makes some experimentation ethically suspect at best.⁴⁵ Models avoid these problems by performing their tasks in controlled settings, without experimentation upon the actual environment. Gathering model input data can require extensive effort—indeed, data gathering is often the most expensive and time-consuming task in a modeling study—but with adequate input data, models can produce predictions remarkably quickly. Furthermore, modeling decision stakes are often orders of magnitude greater than actual modeling costs, with billions of dollars, as well as the health of millions, depending upon local emissions control decisions.⁴⁶ As a result, the financial costs of modeling, while often quite large in actual dollar terms, can pale in comparison to the costs of other planning methods.⁴⁷

The 1970 Clean Air Act Amendments did not explicitly call for the use of models in the SIP process.⁴⁸ However, it required EPA to set

EPA in the Clean Air Act.”).

45. Of course, even with the benefit of modeled predictions the environmental outcomes of regulatory policies often will be unpredictable; to some extent, all policies are experimental. Models, however, can still play a vital role in excluding from the scope of real-world testing regulatory systems that are especially likely to be harmful; even if every policy is to some extent a test, not all policies deserve real-world testing. See Carl J. Walters & C.S. Holling, *Large-scale Management Experiments and Learning by Doing*, 71 *ECOLOGY* 2060, 2060–68 (1990).

46. EPA has estimated that compliance with the Clean Air Act and the 1990 Clean Air Act Amendments has cost hundreds of billions of dollars, and that economic benefits of the Clean Air Act are even higher. EPA, *COSTS AND BENEFITS OF THE CLEAN AIR ACT*, ES-6 (1990), available at <http://www.epa.gov/air/sect812/812exec2.pdf> (last visited May 3, 2004); EPA, *THE COSTS AND BENEFITS OF THE CLEAN AIR ACT 1990 TO 2010*, ES-ii (1999), available at <http://www.epa.gov/air/sect812/1990-2010/cap1130.pdf> (last visited May 3, 2004); see *infra* Part IV.D (discussing the consequences of polluted air in the San Joaquin Valley). Of course, modeling by no means guarantees better decisions, but even increasing the odds of better decisions can translate into substantial economic gain.

47. Computer-based simulation can be at least an order of magnitude cheaper than learning by doing. For example, the San Joaquin Valley Air Quality Study included a model development and application, as well as intensive data gathering field campaigns, for a total cost of less than \$20 million. POLICY COMMITTEE, *SAN JOAQUIN VALLEY AIR QUALITY STUDY*, CALIFORNIA AIR RESOURCES BOARD AND SAN JOAQUIN VALLEY UNIFIED AIR POLLUTION CONTROL DISTRICT, *SAN JOAQUIN VALLEY AIR QUALITY STUDY POLICY—RELEVANT FINDINGS* 3 (1996). In contrast, emissions control costs determined, in part, by the modeling study cost several hundred million dollars or more.

48. Philip Roth et al., *Tropospheric Ozone*, in *KEEPING PACE WITH SCIENCE AND ENGINEERING: CASE STUDIES IN ENVIRONMENTAL REGULATION* 57 (Myron F. Uman ed., 1993) (“The development of models capable of simulating the dynamics of atmospheric processes that lead to ozone formation began about 1970. By 1973, the EPA had committed its research efforts to supporting continued development of the Urban Airshed Model. The model saw very limited application—solely in the Los

national health-based ambient air quality standards and required states to devise and implement the SIPs that will achieve those standards.⁴⁹ To devise those SIPs, state planners needed to predict the outcomes of control strategies, and they could best do this with models. Thus, models rapidly became a part of SIP development and review.

For example, tropospheric ozone—one of the first air pollutants for which EPA set air quality standards, and the pollutant upon which this paper's case study⁵⁰ focuses—forms in the atmosphere when emissions of nitrogen oxides and hydrocarbons (“precursor pollutants”) react chemically in the presence of heat and sunlight.⁵¹ The chemical transformations and transport processes involved are exceedingly complex,⁵² and predicting future concentrations requires at least a conceptual model of the relationship between precursor pollutant emissions and ozone concentrations. Since predicting ozone attainment was an early statutory requirement, the use of models was a practical necessity from the outset.

The 1990 Clean Air Act Amendments turned the practical necessity of modeling into an explicit legal requirement, calling repeatedly for the use of models. For example, they required demonstrations that the SIP would in fact achieve air quality goals (“attainment demonstrations”).

[The SIP must] provide for attainment of the ozone national ambient air quality standard by the applicable attainment date. This attainment demonstration must be based on photochemical grid modeling or any other analytical method determined by the Administrator, in the Administrator's discretion, to be at least as effective.⁵³

EPA cannot approve an ozone SIP if it does not demonstrate attainment, and as a result, SIP development is now legally as well as practically required to be a model-dependant process.⁵⁴

Courts have occasionally recognized the manipulability of models, but they have also been instrumental in their adoption. Even prior to the 1990 amendments of the Act, judges repeatedly upheld agency decisions based on modeling results. In one of the earlier and more extensive

Angeles Basin—during the mid-1970's; more widespread and intensive application began in 1979 and has continued to this day.”)

49. 42 U.S.C. §§ 7409–7410 (2000).

50. See National Ambient Air Quality Standards for Ozone—Final Decision, 15 Fed. Reg. 13,008-1, 13,009 (EPA, 1993) (describing the early history of the ozone standards, which first were set in 1971).

51. See JOHN H. SEINFELD & SPYROS N. PANDIS, *ATMOSPHERIC CHEMISTRY AND PHYSICS* 164–73, 299–302 (1998) (providing a detailed description of ozone photochemistry).

52. Roth et al., *supra* note 48, at 39.

53. 42 U.S.C. § 7511a(c)(2)(A); see *Sierra Club v. EPA*, 356 F.3d 296, 304–06 (D.C. Cir. 2004) (interpreting this requirement).

54. This does not mean, of course, that air quality planners rely solely upon models. Planners instead typically rely on a range of types of technical evidence, and while in some processes models are of crucial importance, in others they play minor roles.

discussions, the D.C. Circuit explicitly acknowledged the limitations of models as flawed predictive tools, and also discussed in detail the potential problems with allowing a model to obscure the human factors in decision-making.⁵⁵ Nevertheless, it unequivocally concluded that modeling was an important component of decision-making under the Clean Air Act.⁵⁶ The court noted that “[r]ealistically, computer modeling is a useful and often essential tool for performing the Herculean labors Congress imposed on EPA in the Clean Air Act.”⁵⁷

Other courts have provided similar endorsements, often without the D.C. Circuit’s caveats.⁵⁸ Judicial deference to modeling has not been limitless; courts have repeatedly asserted that models must bear some rational connection to reality and that EPA must explain both the models’ functions and the assumptions.⁵⁹ Nevertheless, most cases that

55. *Sierra Club v. EPA*, 356 F.3d at 304–06.

Such models, despite their complex design and aura of scientific validity, are at best imperfect and subject to manipulation as EPA forthrightly recognizes. The results ultimately are shaped by the assumptions adopted at the outset, and can change drastically for a given range of input data if key assumptions are adjusted even slightly. The accuracy of the model’s predictions also hinges on whether the underlying assumptions reflect reality, which is no small feat in this volatile world.

Id. (citations omitted).

56. *Id.*

57. *Sierra Club v. Costle*, 657 F.2d 298, 332 (D.C. Cir. 1981).

58. *New York v. U.S. EPA*, 716 F.2d 440, 443–44 (7th Cir. 1983) (rejecting New York’s contention that EPA had used the wrong model); *Conn. Fund for the Env’t v. EPA*, 696 F.2d 169, 177 (2d Cir. 1982) (“[T]he Agency claims it lacks a model that would enable it to predict accurately the effects of such secondary formation, and on this issue we must defer to the Agency’s technical expertise We think it would be unwise to order the Agency to consider effects it cannot accurately measure”); *Connecticut v. EPA*, 696 F.2d 147, 158–59 (2d Cir. 1982) (also rejecting the contention that EPA had used the wrong model); *see also* *1000 Friends of Md. v. Browner*, 265 F.3d 216, 229–30 (4th Cir. 2001) (holding that EPA may rely on older modeling during an SIP revision if it believes that older modeling shows the revision will attain NAAQS compliance); *Air Pollution Control Dist. of Jefferson County v. EPA*, 739 F.2d 1071, 1083–84 (6th Cir. 1984); *Republic Steel Corp. v. Costle*, 621 F.2d 797, 805–06 (6th Cir. 1980) (upholding EPA’s choice to use a model rather than actual monitoring data); *Sierra Club v. EPA*, 356 F.3d at 304–06 (upholding EPA’s authority to tweak its model results); *Appalachian Power Co. v. EPA*, 249 F.3d 1032, 1051–53 (D.C. Cir. 2001); *Appalachian Power Co. v. EPA*, 135 F.3d 791, 802–06 (D.C. Cir. 1998); *New York v. EPA*, 852 F.2d 574, 580 (D.C. Cir. 1988) (upholding EPA’s decision not to grant credence to a model used by Pennsylvania).

59. *See, e.g., Appalachian Power Co.*, 249 F.3d at 1054 (“EPA has ‘undoubted power to use predictive models’ but only so long as it ‘explain[s] the assumptions and methodology used in preparing the model’ and ‘provide[s] a complete analytic defense’ should the model be challenged.”) (quoting *Small Refiners Lead Phase-Down Task Force v. EPA*, 705 F.2d 506, 535 (D.C. Cir. 1983)); *Chem. Mfrs. Ass’n v. EPA*, 28 F.3d 1259, 1265 (D.C. Cir. 1994) (“If we [judges] are to earn our keep, however, judicial deference to the agency’s modeling cannot be utterly boundless; we must reverse the agency’s application of the generic air dispersion model as arbitrary and capricious if there is simply no rational relationship between the model and the known behavior of the hazardous air pollutant to which it is applied.”); *see also* *Lands Council v. Forester of Region One of the U.S. Forest Serv.*, 395 F.3d 1019, 1032 (9th Cir. 2004) (“The Forest Service’s heavy reliance on the WATSED model in this case does not meet the regulatory requirements because there was inadequate disclosure that the model’s consideration of relevant variables is incomplete We hold that this withholding of information violated NEPA, which requires up-front disclosures of relevant shortcomings in the data

address the use of models—even those in which EPA’s decisions did not survive judicial review—use language of extreme deference.⁶⁰

As a result, models have become practically and legally entrenched in air pollution planning.⁶¹ Nonetheless, as Part III of this Article discusses, models have limitations that have significant implications when juxtaposed with statutory mandates to facilitate public participation.

B. ENVIRONMENTAL REGULATION AND PUBLIC PARTICIPATION

I. *Origins of Public Participation Provisions*

The early environmental statutes were founded upon faith in science, but they also were deeply imbued with distrust of government.⁶² In the late 1960s, Congress may have viewed science as the proper basis for environmental decision-making and government agencies as the entities best suited to implement policy, but the notion that those agencies would always act in the public interest was under increasing attack. The work of Rachel Carson and Ralph Nader, in combination with the generalized Vietnam War-era climate of distrust, left the public with little faith that agencies would be fully committed to environmental protection.⁶³ Critics charged that agencies were prone to capture by

or models.”).

For a comprehensive summary of cases reviewing model-based decisions, see McGarity & Wagner, *supra* note 13. McGarity and Wagner conclude that, in some cases, courts have been overly skeptical of model-based decisions, but that in general courts appear, despite a profusion of cases characterized by “tedious, technical nitpicking,” to have shown a healthy understanding of the importance and also the limits of models, and have demanded reasoned explanations but not perfection of agencies.

60. See, e.g., *West Virginia v. EPA*, 362 F.3d 861, 867–68 (D.C. Cir. 2004) (noting the high degree of deference courts grant to model-based decisions); *New York*, 852 F.2d at 580 (“It is well established that when a court is reviewing predictions within an agency’s area of special expertise, at the frontiers of science, the ‘court must generally be at its most deferential.’ . . . *Acceptance or rejection of a particular air pollution model and the results obtained from it are interpretations of scientific evidence.*”) (emphasis added).

61. In addition to legislators and judges, legal scholars have shown a high level of faith in the ability of models to address air pollution problems. Richard Revesz and Jonathon Remy Nash, for example, have proposed that emissions trading regimes could be automated through a website linked to a model that would immediately compute the trades’ consequences for pollution distribution. Though Revesz and Nash acknowledge the limitations of the model they propose using, their article nonetheless evinces an extremely high level of optimism about the ability of models to predict quickly and effectively compliance outcomes. See Jonathon Remy Nash & Richard L. Revesz, *Markets and Geography: Designing Marketable Permit Schemes to Control Local and Regional for Pollutants*, 28 *ECOLOGY L.Q.* 569, 573 (2001).

62. See *CLEAN COAL/DIRTY AIR*, *supra* note 14, at 4–8 (discussing this distrust, and suggesting that the specificity of environmental statutes’ mandates arose partly out of distrust).

63. Lazarus, *supra* note 24, at 322.

Nor were the late 1960s and early 1970s a time susceptible to the type of candid dialogue between citizen groups and business, Congress and the President, or scientists and economists that would have been required to begin to reach consensus on these issues. The civil rights and antiwar movements had polarized the nation. In the aftermath of powerful denunciations of the chemical and auto industries and government by activists Rachel Carson (*Silent Spring* (1962)) and Ralph Nader (*Unsafe at Any Speed* (1965)), the

regulated entities or were likely to undermine their missions through a series of political compromises.⁶⁴ In an attempt to check these tendencies, Congress inserted numerous participation provisions designed to allow public participants to ensure that the regulators were doing their jobs.

These provisions were not entirely unprecedented. The APA codified notice and comment rulemaking, and it provided interested private parties the right to submit comments and seek judicial review of agency decisions.⁶⁵ Agencies did not need to agree with public comments,⁶⁶ but they did generally need to create a paper trail documenting their reasoning, and challengers could have unreasonable or illegal agency actions overturned.⁶⁷

The environmental statutes of the 1970s significantly enlarged the scope of these public rights. In addition to the rulemaking, adjudication, and judicial review provisions of the APA, many statutes required public hearings and created detailed procedural and reporting requirements.⁶⁸ These requirements obliged agencies, and in some situations industry, to provide the public with information about what they were doing and why, and allowed public participants to find out when agencies were failing to take enforcement action.⁶⁹ Statutes also set forth detailed procedures for environmental planning and decision-making, again forcing agencies to take specific steps or risk litigation.⁷⁰

credibility of government and business on health and safety issues was exceedingly low.

Id. Lazarus notes further, "Simply put, EPA was not trusted." *Id.* at 316.

64. *Id.* at 316 (describing Marvin Bernstein's theories of capture and Joseph Sax's worries that agencies would buckle to persistent political pressure and bargain away environmental protection).

65. 5 U.S.C. §§ 553, 706(2)(A) (2000); see Michael I. Jeffery, *Intervenor Funding as the Key to Effective Citizen Participation in Environmental Decision-Making: Putting the People Back in the Picture*, 19 ARIZ. J. INT'L. & COMP. L. 643, 649-50 (2002) (providing a quick summary of the ways in which the APA facilitates public participation). The primary participants in APA rulemaking, and thus the primary beneficiaries of the notice-and-comment and judicial review requirements, are probably the regulated entities rather than the public. See Rena L. Steinzor, *Toward Better Bubbles and Future Lives: A Progressive Response to the Conservative Agenda for Reforming Environmental Law*, 32 ENVTL. L. REP. 11421 (2002) ("By the time a rule crawls, belly down, across the finish line, those responsible for writing it have heard every fact, opinion, and threat that a large army of outside, especially industrial, constituencies can think to make.").

66. 5 U.S.C. § 553(c) (2000).

67. 5 U.S.C. § 706(2)(A) (2000). *But see* CLEAN COAL/DIRTY AIR, *supra* note 14, at 6 (noting that under a New Deal model, an agency is "to be insulated from judicial review") (emphasis removed).

68. NEPA, for example, is almost entirely devoted to providing information to the public. See 42 U.S.C. §§ 4321-4370e (2000). For other examples of reporting requirements, see 33 U.S.C. § 1315 (mandating state water quality reports); *id.* § 1318 (requiring permittees to submit reports); and 42 U.S.C. § 7619 (1994) (requiring air quality monitoring and reporting).

69. See NRDC v. EPA, 489 F.2d 390, 397 (5th Cir. 1974) ("The Amendments embraced the concept of 'citizen enforcement' of antipollution laws. . . . The public information requirements play a crucial role in assuring effective citizen enforcement. They are designed to ensure that 'citizen enforcers' will have access to any and all information they will need in prosecuting enforcement suits or in deciding whether to bring them.").

70. Frances Irwin & Carl Bruch, *Public Access to Information, Public Participation, and Justice*, in

Perhaps most importantly, several statutes contained citizen suit provisions.⁷¹ The Clean Air Act, for example, provides that

any person may commence a civil action on his own behalf—

(1) against any person . . . who is alleged to have violated (if there is evidence that the alleged violation has been repeated) or to be in violation of (A) an emission standard or limitation under this chapter or (B) an order issued by the Administrator or a State with respect to such a standard or limitation,

(2) against the Administrator where there is alleged a failure of the Administrator to perform any act or duty under this chapter which is not discretionary with the administrator, or

(3) against any person who proposes to construct or constructs any new or modified major emitting facility without [the required] permit⁷²

Citizen suit provisions created a powerful check against agency indiscretion, providing public participants with a powerful legal tool to back up earlier efforts at involvement and participation.⁷³ An agency faced with the possibility of citizen suits ignores credible public comment at its own peril. Moreover, if the agency fails to fulfill its regulatory duties, it may find its role usurped.

Although distrust may have been a primary motivation for the creation of these provisions, it is not the sole reason for public involvement in environmental planning. Many public participation mechanisms function collaboratively. Notice and comment rulemaking, for example, allows agencies to incorporate public suggestions in a process that is not necessarily adversarial.⁷⁴ Often participants wish no more than to inform, persuade, or even praise; their primary purpose may be to help, rather than compel, the agency to do its job.⁷⁵ Indeed, an

STUMBLING TOWARDS SUSTAINABILITY 511, 527 (John C. Dernbach ed., 2002); e.g. National Environmental Policy Act, 42 U.S.C. §§ 4321-4370f (2000); National Forest Management Act, 16 U.S.C. § 1604 (2000); Endangered Species Act § 7, 16 U.S.C. § 1536 (2000).

71. E.g., Clean Water Act, 33 U.S.C. § 1365 (1994); Endangered Species Act, 16 U.S.C. § 1540(g) (1994); see CLEAN COAL/DIRTY AIR, *supra* note 14, at 8–9 (discussing the function of these provisions).

72. 42 U.S.C. § 7604(a) (1994).

73. See *Virginia v. Browner*, 80 F.3d 869, 880 (4th Cir. 1996) (“The comment of an ordinary citizen carries more weight if officials know that the citizen has the power to seek judicial review of any administrative decision harming him.”).

74. See Jeffery, *supra* note 65, at 649–50 (describing how informal rulemaking provides opportunities to influence rules at the developmental stage).

75. See *id.* at 648 (“Meaningfully implemented, citizen participation encourages government accountability, ensures continuation of a participatory democracy and can even, in an environmental context, stimulate inventive and socially acceptable answers to environmental problems”); Irwin & Bruch, *supra* note 70, at 571 (“Many environmental statutes rely on public participation to improve the decisionmaking process and to build public support for the final decision.”); Anne Simon, *Valuing Public Participation*, 25 *ECOLOGY L.Q.* 757, 760. Simon writes:

One fairly obvious, but also quite significant, benefit [from encouraging more “permeable” decision-making processes] is the promotion of genuine participation, which is a value in itself. The second is that such permeability can allow for substantively new ideas and new

early collaborative dialogue between the agency and public participants is often far more informative and effective than later participation through adversarial litigation.⁷⁶

Accordingly, agencies have developed additional formalized procedures for seeking collaborative input. Subject to the limitations imposed by the Federal Advisory Committee Act (FACA),⁷⁷ agencies often use advisory committees—groups composed of regulated and interested parties—in the preliminary stages of developing proposed rules.⁷⁸ Agencies may also formalize similar procedures through negotiated rulemaking.⁷⁹ Whether or not these procedures are a positive development—some critics praise them for pre-empting conflict,⁸⁰ but others argue that they promote cronyism or capture⁸¹—they have become common, and provide another important mechanism for interested groups to influence agencies' technical decisions.

2. *Public Participation and the SIP Process*

Like many environmental planning efforts, the SIP process allows, at least on paper, public participants numerous access points to influence plan development. In practice, agencies often make extensive use of advisory committees in SIP planning, allowing an additional avenue for interested parties to influence the planning process.⁸²

Section 110 of the CAA directs that “[e]ach state shall, after reasonable notice and public hearings, adopt and submit to the

connections to enter regulatory processes and to affect the agency's scientific and policy deliberations. Third, real permeability may mobilize more or different or better government resources than would have been brought to bear on a particular problem if the regulatory process were left simply to trundle along on its own.

Id.

76. See Simon, *supra* note 75, at 762–63 (arguing that surprises and objections are inherent in regulatory planning, and that incorporating them at the outset is preferable to holding them at bay as long as possible). See also EPA, *Improved Science-Based Environmental Stakeholder Processes: A Commentary by the EPA Science Advisory Board* 8 (2001), available at www.epa.gov/sab/pdf/eccmo1006.pdf.

77. 5 U.S.C. app. § 1 (1994).

78. Steven P. Croley, *Theories of Regulation: Incorporating the Administrative Process*, 98 COLUM. L. REV. 1, 111 (1998).

79. 5 U.S.C. § 561-590 (1994); Croley, *supra* note 78, at 111.

80. *E.g.*, Philip J. Harter, *Negotiating Regulations: A Cure for Malaise*, 71 GEO. L.J. 1, 30 (1982); see William Funk, *Bargaining Toward the New Millennium: Regulatory Negotiation and the Subversion of the Public Interest*, 46 DUKE L.J. 1351, 1351–54 (1997) (summarizing the early literature's overwhelmingly favorable discussions of negotiated rulemaking).

81. *E.g.*, Funk, *supra* note 80, at 1383–87; see also Cary Coglianese, *Assessing Consensus: The Promise and Performance of Negotiated Rulemaking*, 46 DUKE L.J. 1255 (1997) (arguing that negotiated rulemaking doesn't actually deliver many of the benefits its proponents promised). Indeed, the FACA and the Sunshine in Government Act are both designed to limit the ways informal procedures allow important decisions to be made without public participation or notice. Croley, *supra* note 78, at 117–18 n.347.

82. See, *e.g.*, *infra* Part IV.C.1 (describing committee involvement in air quality planning in the San Joaquin Valley).

Administrator . . . a plan which provides for implementation, maintenance, and enforcement of such primary standard in each air quality control region (or portion thereof) within such State.”⁸³ The act also states that “[e]ach implementation plan submitted by a State under this chapter shall be adopted by the State after reasonable notice and public hearing,”⁸⁴ and requires that the plan “provide for consultation and participation by local political subdivisions affected by the plan.”⁸⁵ States may revise their SIPs, but again only after notice and public hearing.⁸⁶

Once the state has completed its proposed SIP, EPA must review it. EPA can accept the plan or, if the plan fails to meet statutory requirements, either order the state to resubmit a new plan or reject the plan outright and develop its own.⁸⁷ SIP approval or disapproval is considered rulemaking, and thus is governed by the APA’s public notice and comment requirements.⁸⁸ Section 553 of the APA provides:

[A]fter notice required by this section, the agency shall give interested persons an opportunity to participate in the rule making through submission of written data, views, or arguments with or without opportunity for oral presentation. After consideration of the relevant matter presented, the agency shall incorporate in the rules adopted a concise general statement of their basis and purpose.⁸⁹

Failure to comply with this requirement is grounds for invalidation of EPA’s approval of the SIP.⁹⁰

Section 110 also includes reporting requirements; emitting sources are to submit “periodic reports on the nature and amounts of emissions and emissions-related data from such sources,” and those reports “shall be available at reasonable times for public inspection.”⁹¹ These requirements provide for further public participation by facilitating public monitoring of SIP implementation and potentially providing information to support citizen suits. Public participants may file such suits under the Clean Air Act’s citizen suit provision, and indeed public interest groups have filed numerous lawsuits seeking to enjoin the EPA

83. 42 U.S.C. § 7410(a)(1) (1994).

84. *Id.* § 7410(a)(2).

85. *Id.* § 7410(a)(2)(M).

86. *Id.* § 7410(l).

87. *Id.* § 7410(k). EPA may also approve only a portion of a SIP, allowing EPA to proceed with implementing planned emissions controls while the planning agency endeavors to remedy other components of the plan, such as the technical basis of the attainment demonstration. *See, e.g.,* Approval and Promulgation of Ozone Attainment Plan and Finding of Failure To Attain; State of California, San Francisco Bay Area, 66 Fed. Reg. 48,340 (Sept. 20, 2001) (to be codified at 40 C.F.R. pt. 52) (providing such a partial approval).

88. *See* *Buckeye Power, Inc. v. EPA*, 481 F.2d 162, 170 n.4 (6th Cir. 1973).

89. 5 U.S.C. § 553(c) (1994).

90. *See* *Buckeye Power*, 481 F.2d at 170–71.

91. 42 U.S.C. § 7410(a)(2)(F) (1994).

from approving or disapproving state SIPs.⁹²

Judicial review of agencies' compliance with prescribed procedures under the CAA, as with other environmental statutes, can be exacting. An outright failure to complete a required procedure is often grounds for invalidating the agency's action.⁹³ Failure to provide accurate or clear information to the public, for example, can hamstring public participation, and may be grounds for invalidation of an agency's decision.⁹⁴

The CAA thus calls for multiple stages of public participation in the SIP planning process. In addition to informal interactions, public participants may comment on the plans as the states develop them. It may comment again in accordance with the APA when the federal government considers whether to approve the SIP.⁹⁵ Finally, it may monitor the implementation and enforcement of the regulations created by the plans. With redundant opportunities for involvement, and with the judiciary alert to any failure to follow prescribed procedure, transparency is a legal mandate.

III. MODELS AND THE DECISIONMAKING PROCESS

In theory, the Clean Air Act and other environmental statutes that emphasize both science-based decision-making and public participation should create a workable regulatory system of checks and balances. Decisions should be made primarily by the agencies on technical bases.⁹⁶ Through reporting requirements, notice and comment periods, and citizen suit provisions, however, potential public participants ought to have opportunities to become informed and involved. Should an agency ignore cogent public critiques and select a course of action inconsistent with substantive mandates, public participants can sue to enjoin plan implementation.

Models can disrupt the balance between expert decision-making and public involvement. The limitations of models create uncertainty and

92. For a summary of such litigation arising out of air pollution in the San Joaquin Valley, see *Central Valley Air Quality Coalition, Legal Actions*, at http://www.calcleanair.org/legal_actions.htm (last visited Apr. 8, 2004).

93. See *Concerned Citizens of Bridesburg v. EPA*, 836 F.2d 777, 788-89 (3d Cir. 1987); *Buckeye Power*, 481 F.2d at 170-71.

94. See *Sierra Club v. Costle*, 657 F.2d 298, 353-54 (D.C. Cir. 1981). *But see* *Conn. Fund for the Env't v. EPA*, 696 F.2d 179, 185-86 (2d Cir. 1982) (holding that a lack of clarity in Connecticut's plan, although troubling to the court, was not grounds for overturning the state's adoption of the plan).

95. *Conn. Fund for the Env't*, 696 F.2d at 185. The SIP development process is not as inclusive as some environmental planning processes; for example, SIP approval does not require preparation of an environmental impact statement.

96. See *Ozawa*, *supra* note 37, at 223-25 (commenting that Congress wanted decision makers "constrained by the technical experts' interpretations of the physical conditions and alternative actions" in order to reduce "raw politics," and describing how an idealized process should work).

necessitate subjective judgment, both in model design and in the interpretation of results. Model-based planning decisions are thus well worthy of public review, but, unfortunately, models' complexity and opacity create obstacles to such critique. Thus, model-based decision-making can fail to comport with a traditional rational-expert ideal while also restricting effective public participation. This section explores this problem, focusing first on the limitations of models and then on how those limitations impede public involvement in planning.

A. LIMITATIONS OF MODELS

1. *Uncertainty*

Many of the problems with model-based planning arise out of the uncertainty associated with any modeling study. The following discussion describes several sources of such uncertainty.

a. *Inherent Limits of Simulation*

Air quality models, like all models, are fundamentally simulations, and as simulations, they are inherently limited in their representation of the real world.⁹⁷ Modelers devote tremendous energy to identifying and reducing such uncertainty, but no model can incorporate all real data or simulate all of the processes that might influence an outcome. Because every model is necessarily an approximation of reality, models' predictions unavoidably contain some error.⁹⁸

b. *Prediction*

Using models to predict the future compounds this inherent error.⁹⁹ Planners typically develop air quality plans over a span of years, and expect their plans to achieve results years after planning and implementation occur.¹⁰⁰ Predicting future outcomes, however, is impossible to do with certainty.¹⁰¹ Modelers must base their predictions on future economic, meteorological and political conditions, on complex chemical and physical interactions, all subject to a host of other

97. See *Small Refiner Lead Phase-Down Task Force v. EPA*, 605 F.2d 506, 535 (D.C. Cir. 1983) ("Any model is an abstraction from and simplification of the real world."); ALBERT EINSTEIN, *GEOMETRY AND EXPERIENCE* 190 (1953) ("As far as the laws of mathematics refer to reality, they are not certain; and as far as they are certain, they do not refer to reality.").

98. NARSTO, *supra* note 12, at 4-3 ("Because air quality models are imperfect representations of the real atmosphere, their output must have some level of error.").

99. See generally E.F. SCHUMACHER, *SMALL IS BEAUTIFUL: ECONOMICS AS IF PEOPLE MATTERED* 212 (1973) ("[I]t is the planners, more than perhaps anyone else, who would like nothing better than to have a machine to foretell the future.").

100. See, e.g., 42 U.S.C. §§ 7407, 7410 (requiring development of plans that demonstrate future compliance). This predictive function is not unique to air quality planning, of course; throughout environmental planning, planners use modelers to predict future conditions.

101. See Oreskes et al., *supra* note 11, at 643 (stating that "even if a model result is consistent with present and past observational data, there is no guarantee that the model will perform at an equal level when used to predict the future").

potentially unanticipated factors.¹⁰² The further into the future the model must project, the more uncertain results are likely to be.¹⁰³ In recent years, air pollution modelers have made efforts to address this uncertainty by simulating several sets of future year conditions to produce a composite of prediction scenarios and by assigning probabilities to future realizations.¹⁰⁴ Though an important step forward, such probabilistic description of alternative futures is not yet common practice.

c. *Complexity in Model Formulation*

Air quality models seek to simulate complicated processes, and this complexity also leads to uncertainty.¹⁰⁵ The chemistry that creates high levels of ozone, for example, involves non-linear interactions that produce surprising and counterintuitive results.¹⁰⁶ Likewise, relationships between economic output, technological change, and pollutant emissions can defy simple explanation.¹⁰⁷ This complexity creates a greater number of potential errors within the model simulation.¹⁰⁸

102. See Fine et al., *supra* note 12, at 68.

Important assumptions used to estimate future emissions pertain to the rates used for population and economic growth and for land use conversion, forecasted changes in driving patterns, and the anticipated effectiveness and rates of implementation of emissions control technologies. Inevitably, these assumptions will lead to some error. None of these assumptions can account for unanticipated gradual changes, such as the rise in popularity of sport utility vehicles and light-duty trucks during the 1990s, or abrupt changes, such as a sudden increase in crude oil prices that leads power producers to switch from oil to natural gas fuel.

Id.

103. See generally WILLIAM ASCHER & HAROLD D. LASSWELL, *FORECASTING: AN APPRAISAL FOR POLICY-MAKERS AND PLANNERS* (1978) (examining the accuracy of forecasts developed using models).

104. See, e.g., Christian Hogrefe & S. Trivikrama Rao, *Demonstrating Attainment Of the Air Quality Standards: Integration Of Observations and Model Predictions into the Probabilistic Framework*, 51 J. AIR & WASTE MGMT. ASS'N 1060 (2001).

105. See Fine et al., *supra* note 12, at 63.

A PAQSM is a mathematical representation of physical and chemical processes occurring in the atmosphere and at the atmosphere/land interface; the model includes emissions, diffusive and advective transport, chemical transformation, and deposition. . . . In addition to emissions and atmospheric processing, it represents the physical system comprised of topography (e.g., mountains), surface characteristics (e.g., land use and land cover), and meteorology (e.g., winds, temperatures, and clouds). The PAQSM domain may range from an urban airshed to a regional to a continental-scale area.

Id.

106. NATIONAL RESEARCH COUNCIL, *RETHINKING THE OZONE PROBLEM IN URBAN AND REGIONAL AIR POLLUTION II* (1991) ("NOx reductions can have either a beneficial or detrimental effect on ozone concentrations, depending on the locations and emissions rates of VOC and NOx sources in a region. The effect of NOx reductions depends on the local VOC/NOx and a variety of other factors."). For a description of the complexities involved in creating ozone, see SEINFELD & PANDIS, *supra* note 51, at 299-302.

107. See Fine et al., *supra* note 12, at 68.

108. KENNETH DEMERJIAN ET AL., *A NEW APPROACH FOR DEMONSTRATING ATTAINMENT OF THE AMBIENT OZONE STANDARD: MODELING, ANALYSIS, AND MONITORING CONSIDERATIONS II-8* (1995).

As greater attention is given to simulating the dynamics of individual processes, model complexity increases. Attending increased model complexity are (a) increased difficulty in

Models have improved since the early days of air quality planning. As simulation models have evolved, they have become increasingly complex; this complexity has reduced the extent to which models oversimplify the real world.¹⁰⁹ Current models use more monitoring data, greater computing power, improved and expanded algorithms, and more efficient, accurate mathematical solution methods than did their predecessors.¹¹⁰ Nevertheless, models' skill in simulating ozone concentrations has not increased commensurately,¹¹¹ and significant limitations remain for both the mathematical representations and applications of air quality models.¹¹² Additionally, due to the time and effort involved in developing or updating an air quality model, usually no single "state-of-the-science" model contains a formulation depicting the most modern scientific understanding.¹¹³ As a result, the difficulty of modeling complex processes remains a source of uncertainty.

d. *Input Data Limitations*

Modeling simulations are also limited by the availability and completeness of input data.¹¹⁴ Modelers cannot construct their simulations based upon complete descriptions of the real world, and instead often must use sparse and uncertain data.¹¹⁵ Flaws and incompleteness in these data sets further add to the separation between

simulating each individual process correctly, (b) the potential for greater cumulative uncertainty (while imprecision may increase, bias may be reduced) and (c) increased computational demands. Thus, the potential for uncertainty increases after a certain point, rendering overall acceptance of the model more difficult.

Id.

109. For discussions of the growth in complexity and adoption of air quality models by the regulated community, see ROTH ET AL., *supra* note 41, and Roth et al., *supra* note 48.

110. For a discussion of recent PAQSM improvements, see NARSTO, *supra* note 12, ch. 4.

111. *See id.* at 4-9 ("In terms of simple measures, the skill of operational air-quality models to simulate surface O₃ concentrations does not seem to have improved substantially, despite increases in model sophistication and complexity.")

112. *See id.* at 4-5 ("AQMS [air quality modeling systems], despite two decades of improvement, still contain significant limitations in their formulation and application.")

113. *See* Armistead Russell, *Regional Photochemical Air Quality Modeling: Model Formulations, History, and State of the Science*, 22 ANN. REV. ENERGY & ENV'T 573-74 (1997).

There are, at present, a number of regional, photochemical air quality models. Although they are all based on solving the same basic equations, they have different evolutionary paths, attributes, and applications If one were to suggest an order of complexity and scientific comprehensiveness, the Eulerian, multi-scale/nested models with multiple layers, plume-in-grid treatment, and cloud dynamics would be considered as approaching the state of the science, though none of the models contains all of the most modern representations of the science.

Id.

114. *See generally id.* at 560 ("Inputs to regional air quality models can be broadly grouped into the following categories: meteorology, emissions, topography, atmospheric concentrations, and grid structure.")

115. *See, e.g.,* NARSTO, *supra* note 12, at 4-6 (noting that fine-scale processes are often accounted for only approximately in ozone models).

model inputs and real-world conditions.¹¹⁶

The same complexity that theoretically might allow for more accurate simulations can compound these input data problems.¹¹⁷ Intensive field studies may be necessary to provide observational databases sufficiently robust to execute models and evaluate their performance. Air districts, however, cannot afford to generate such data on a routine basis. Typically, they can only monitor one or a few ozone episodes¹¹⁸ comprehensively enough to provide modeling input data, and they therefore must base their selection of an ozone event to model partly upon data availability.¹¹⁹ SIP planners should, in theory, base their simulations on worst-case ozone events, but the few actual episodes for which data are available may not capture natural variability. As a result, those data may be neither spatially nor temporally representative of the conditions in need of analysis.¹²⁰

Data limitations can also limit the ability of modelers to determine how well their models are working. For example, air quality models provide output in the form of predicted pollutant concentrations for large areas over extended periods of time.¹²¹ Monitors, however, measure concentrations at points in space; no monitor has yet been deployed that can measure air quality at the volumes represented by the grid system of

116. See Fine et al., *supra* note 12, at 68 (“Observational data collected to initialize the modeling system, provide boundary conditions, and evaluate model performance have uncertainties due to limited characterization of their spatial and temporal variability. Observational data also have uncertainties caused by monitoring equipment, user error, or monitoring network design.”). Monitors also may be sited to measure peak, rather than representative, concentrations. NARSTO, *supra* note 12, at 4-8 (stating that “some VOC and NOx monitors have been sited to obtain maximum source-oriented concentrations and hence are clearly not representative of grid-cell averages”).

117. See Fine et al., *supra* note 12, at 65 (noting that the more complex, three-dimensional “Eulerian” models require more complete input data to initialize the modeling system and to evaluate model performance).

118. An “ozone episode” or “ozone event” is a period of particularly high ozone concentrations.

119. The planning process reviewed in our case study involved full PAQSM simulation of one episode that occurred August 2–6, 1990. The episode did not represent the most severe observed ozone conditions; four times over the previous three years, the air district had measured concentrations of 170 ppb or higher. ATTAINMENT PLAN, *supra* note 15, at 1-2; see also CALIFORNIA AIR RESOURCES BOARD, PERFORMANCE EVALUATION OF SAQM IN CENTRAL CALIFORNIA AND ATTAINMENT DEMONSTRATION FOR THE AUGUST 3–6, 1990 OZONE EPISODE (1996).

120. See Fine et al., *supra* note 12, at 73.

With few exceptions . . . neither the modeling systems nor the air quality planning efforts using modeling tools have incorporated representations of variability. At the modeling system level, emissions and meteorology are not characterized probabilistically. At the planning level, the few simulated ozone episodes may not represent the myriad conditions capable of causing violations of ozone air quality standards.

Id.

121. See *id.* at 69 (“Measurements taken at one or several points within a grid cell typically represent volumes on the order of tens of cubic meters. Modeled concentrations are grid-cell averages for volumes ranging up to several hundred cubic kilometers.”); BCCA Appeal Group v. NRDC, 355 F.3d 817, 832 (5th Cir. 2003) (noting this incommensurability problem, and deferring to EPA’s choice to measure compliance at grid rather than measuring point scale).

a modeling domain. Therefore, to evaluate model performance, modelers must compare volume-averaged predictions with point measurements that may not be representative of the modeled volume.¹²² Such differences between the forms of model predictions and observations gathered in the real world confound the evaluation of model performance.

e. *Opacity*

Although the complexity of models may improve their representation of the real world, it also increases their opacity, hindering modelers' efforts to detect and correct errors. Complexity makes it difficult to "see" what happens within the model by making it more difficult to detect compensating errors or biases within the simulation.¹²³ Complexity also can prevent formal "Gaussian" error propagation analysis.¹²⁴ Analytical error propagation is tractable when the mathematical relationships are relatively simple and the variables are not interdependent, but air pollution models often involve covarying input variables, which often are related through complex mathematical functions, and complex and incommensurate uncertainties.¹²⁵ As a result, mathematical error analysis is often impossible.¹²⁶ Some methods do exist for exploring uncertainties in photochemical air quality simulation model (PAQSM) outputs, but no one has yet figured out how to make practical use of them for decision-making.¹²⁷ Consequently, the complexity of the models can leave modelers without effective methods for formally or informally evaluating the effect of input errors on model predictions, and quantitative and comprehensive information about the reliability of modeling results is quite limited and incomplete, if available at all.

2. *Subjectivity*

Models are limited by more than just inherent uncertainties in their formulation and input data.¹²⁸ Modeling is fundamentally a very human

122. See NARSTO, *supra* note 12, at 4-8 (discussing the incommensurability problem).

123. Compensating errors are errors that offset each other, thereby making a model appear more accurate than it really is.

124. See MORGAN & HENRION, *supra* note 10, at 183 ("For all except the simplest cases, such as linear combinations of normal variables, exact analytic methods for propagation of uncertainty are intractable or require elaborate numerical integration . . .").

125. An example of incommensurability involves the use of observed parameters to evaluate the accuracy of model-calculated parameters. For example, grid-based models produce grid-cell average ambient pollutant concentrations, whereas observed pollutant concentrations represent one or several monitoring points. Thus, these two values describe the same parameter—ambient pollutant concentrations—but represent different spatial scales. See NARSTO, *supra* note 12, at 4-8 (discussing incommensurability and methods for managing it).

126. See MORGAN & HENRION, *supra* note 10, at 175-76 (defining Gaussian error analysis); *id.* at 172-219 (providing a general discussion of the analysis of error in model outputs due to input errors, including both exact analytical and approximation techniques).

127. See Fine et al., *supra* note 12, at 98 (stating that such an approach should be developed).

128. GREENBERGER ET AL., *supra* note 42, at 84 ("Like any tool, its effectiveness is governed by the

process, and the assumptions, beliefs, and objectives of the modelers affect the accuracy of model predictions and the effectiveness of model-based planning.¹²⁹ To some extent, subjectivity is a direct result of uncertainty; modelers have to fill in information gaps with their own judgments. In other ways, however, the subjectivity provides an entirely new source of model limitations, for, despite their best efforts to exercise good judgment, modelers' subjective decisions can compound uncertainty problems and lead to results that are neither objective nor accurate. The following discussion highlights several important sources of subjectivity in modeling.

a. *Model Selection*

The choice of a modeling system often involves subjective judgment. Different models produce different results, and some are better than others at simulating certain processes or quantifying types of risk.¹³⁰ Since all air quality models are inherently uncertain and difficult to validate or verify, however, determining whether a model is acceptable for use can be challenging.¹³¹ The choice of a model will depend at least in part upon the modelers' beliefs about which kinds of error are most likely to be problematic and about what levels of risk and error are, or should be, socially acceptable.¹³²

Regulators often seek, through formal guidance, to reduce the subjectivity associated with model selection. EPA and the California Air

skill and expertise of its user. Conversely, its use and development can help build skill and expertise.”).

129. See generally *Dura Auto. Sys. of Ind., Inc. v. CTS Corp.*, 285 F.3d 609, 615–16 (7th Cir. 2002) (noting that modeling inherently involves the exercise of professional discretion, and refusing to allow expert testimony from a scientist who used modeling results without having knowledge of the way that professional discretion was exercised).

130. See M. LUNDEN ET AL., DEPT. OF ENERGY, AN ASSESSMENT OF THE AIR QUALITY MODELING EFFORTS IN SOUTHWEST WYOMING, VII-2 to VII-3 (1999) (discussing the trade-offs of using point source dispersion versus gridded modeling formulations); Russell, *supra* note 113, at 542–50 (discussing different formulations in use and their relative benefits). Modelers also may have to choose when a model is ready for use; development of a model is generally an iterative process, and modelers often must decide when deadlines prevent further improvement of the model. See ROTH ET AL., *supra* note 41, at 1 (“At any juncture a decision to apply a model is a decision to take advantage of the model’s capabilities at its current stage of development.”); JAMES FINE, THE ENDS OF UNCERTAINTY: AIR QUALITY SCIENCE AND PLANNING IN CENTRAL CALIFORNIA 298 (2003), available at http://www.osti.gov/energycitations/product.biblio.jsp?osti_id=822267 (unpublished Ph.D. dissertation, Ernest Orlando Lawrence Berkeley National Laboratory) [hereinafter “THE ENDS OF UNCERTAINTY”] (quoting Scott Nester, Planner at the SJVUAPCD (“[W]e’re under a sanctioned timeline to produce a plan that includes modeling. In essence, we don’t have the luxury of time, we don’t have unlimited resources. We’re going to go with what we’ve got when it comes down to it.”)).

131. McGarity and Wagner conclude that courts have showed relatively little deference to agency selections of particular models. See McGarity & Wagner, *supra* note 13, at 10759.

132. See Fine et al., *supra* note 12, at 70 (“If more than one algorithm is available and appropriate, choosing one inevitably means accepting some uncertainties over others.”); Oreskes et al., *supra* note 11, at 642 (noting that sometimes more than one model can produce an apparent fit with observational data, forcing modelers to choose a model using criteria other than empirical verification of performance).

Resources Board (CARB), for example, issue guidance on what models to use, how to use them, and what constitutes acceptable performance.¹³³ The criteria, however, also are the product of policy choices; they represent compromises between the level of performance regulators believe is needed and the level they believe, based on past experience, is possible.¹³⁴ Thus, even when standardized guidelines help decide which models are used, the process of model acceptance through performance evaluation depends upon accepted political and social norms.¹³⁵ Furthermore, these evaluations of possible and actual performance may be skewed by the fact that models are often “tuned” in an attempt to improve the fit between modeled outputs and observational data.¹³⁶ This practice can undermine the validity of the subsequent performance assessments.¹³⁷

b. *Assumptions*

Perhaps the most obvious source of subjectivity is the need for models to incorporate assumptions. Modelers lack complete data and are not omniscient. They must make assumptions about present, future, and even past environmental conditions, about interactions between physical, social and economic systems, and even about human behavior.¹³⁸ The

133. See, e.g., EPA, GUIDANCE ON THE USE OF MODELED RESULTS TO DEMONSTRATE ATTAINMENT OF THE OZONE NAAQS (1996); EPA, GUIDELINE FOR REGULATORY APPLICATION OF THE URBAN AIRSHED MODEL (1991); EPA, GUIDELINE ON AIR QUALITY MODELS (REVISED) AND SUPPLEMENT A (1987); EPA AND CALIFORNIA AIR RES. BD., PROTOCOL FOR DETERMINING THE BEST PERFORMING MODEL (1992).

134. See NARSTO, *supra* note 12, at 4-7 (noting that the basis for selecting performance standards “appears to be historical” (i.e., they reflect the range of model performance that air quality models have typically achieved for [ozone])).

135. More useful evaluative criteria for determining the acceptability of a given modeling application for decision-making would consider what is intended to be learned by the modeling effort. See Fine et al., *supra* note 12, at 77 (discussing how such need-based criteria could work).

136. Modelers “tune” a model by adjusting it to produce outcomes more consistent with expected results. While the practice can produce more realistic outcomes, it also can mask both deficiencies in the model and flaws in modeling assumptions.

137. See Fine et al., *supra* note 12, at 90 (“In general, model tuning should be avoided. Scientific principals should determine how best to represent atmospheric processes and to develop model inputs.”); Oreskes, *supra* note 11, at 643 (stating that “models almost invariably need additional tuning during the so-called verification phase”).

138. See McGarity & Wagner, *supra* note 13, at 10763 (“Since models are placeholders for reality, they necessarily involve assumptions about the real world.”). The processes of gathering data and transforming data into a form suitable for model use are also likely to involve subjective judgments, and because modelers often do not gather their own data, the modeler may not even know that these judgments have taken place. See Interview with Lynn Terry, Deputy Executive Officer, CARB (Sept. 12, 2001). Ms. Terry oversees plan development and a staff of air quality modelers. She spoke of her reservations about modeling input data on anticipated population and economic growth and land use changes, which are provided by councils of government based upon their own models:

I have concerns about [COGs'] models being black boxes. Whereas for air quality models we have plenty of people who know the ins and outs and can run them independently, we just haven't had the resources to look at what they're doing and what they're giving us. Over time I'd like to do more of that and I've pushed on them to be more public in their process.

level of air pollutant emissions, for example, is connected to overall economic activity, so modeled simulations must incorporate assumptions about economic growth. Driving patterns also affect pollutant emissions, and air quality simulations therefore must incorporate predictions about what, where, and when people will be driving.¹³⁹ These and many other assumptions may be informed by past experience, but ultimately modelers must make some subjective judgments, even if only to assume that past experience will be repeated.¹⁴⁰ As a result, any modeling prediction is partly the product of the intuition and judgment of the modeler.

c. *Results Communication*

Finally, modelers may introduce subjectivity into the planning process through their means of communicating their results.¹⁴¹ Modeling predictions, and the caveats that should go with those predictions, are not likely to be inherently comprehensible by either planners or the public. Moreover, if non-modelers are to understand the uncertainties associated with a modeled prediction, they may need to know something about the modeling process, an understanding gained only through the modeler's description. Determining what to include in that description, however, introduces an element of subjectivity. If predictions are provided without associated discussion of assumptions and uncertainties, modelers will implicitly convey an air of certainty, and will leave non-modelers without information necessary to evaluate the reliability of modeling results.¹⁴² If, however, the modelers choose to describe in some detail the limitations of their predicted results, that description still may emphasize selectively the uncertainties believed to be most important or, at least, most amendable to quantification. Some information and experiential knowledge will be lost in the translation, and the communication of results will introduce one more element of subjectivity (and, indeed, uncertainty) into the modeling process.

139. The EPA provides guidance and tools for estimating past, present and future motor vehicle emissions. The primary tool of choice is yet another model, MOBILE (currently up to version 6), which can be found at <http://www.epa.gov/otaq/m6.htm> (last visited on Apr. 8, 2004). For EPA guidance on developing motor vehicle emissions estimates, see EPA, *Procedure for Emission Inventory Preparation—Volume IV: Mobile Sources* (1992), at <http://www.epa.gov/otaq/inventory.htm> (last visited Mar. 7, 2005). For an excellent review of the MOBILE model, see NATIONAL RESEARCH COUNCIL, TRANSPORTATION RESEARCH BOARD, MODELING MOBILE SOURCE EMISSIONS (2000), available at <http://books.nap.edu/catalog/9857.html> (last visited Mar. 7, 2005).

140. See generally Fine et al., *supra* note 12, at 68.

141. See GREENBERGER ET AL., *supra* note 42, at 81 (“The modeler often dominates the model. Therefore, the modeler is in the powerful role of mediator between model and decision maker. A modeler’s expertise and authority, which both may be enhanced or acquired by the model itself, is often as or more persuasive than the model.”).

142. See generally Robert Kuehn, *The Environmental Justice Implications of Quantitative Risk Assessment*, 1996 U. ILL. L. REV. 103, 158–61 (noting a similar problem, and its anti-democratic implications, with quantitative risk assessment).

Even if modelers do try to communicate uncertainty, their words may fall on unreceptive ears. The decision-makers who use the modeling results, rather than the modelers, often lack interest in uncertainty assessment and communication. Highlighting uncertainties associated with the technical basis for decisions can make the job of defending decisions more difficult, and decision-makers—and the attorneys who will ultimately represent them—may be reluctant to hear information that might undermine the certainty of their decisions.¹⁴³

d. *Underprediction: the Outcome of Uncertainty and Subjectivity*

If modeling was only uncertain, but still objective, we might expect a range of outcomes, with some models overestimating air pollution gains and others producing underestimations. Instead, air quality models have consistently overestimated air quality gains, and most ozone SIPs, despite predictions of compliance, have not yielded attainment.¹⁴⁴ The obvious skewing is not random, suggesting that there is bias inherent in the modeling results or the translation of those results to decisions. Such skewing may result from modelers' reluctance to force difficult policy choices, from modelers' chronic underestimation of anticipated emissions, from failures in rule enforcement, or other causes. But whatever the cause, the unfortunate reality is that air quality models persistently predict cleaner air than is actually achieved.

B. IMPLICATIONS OF MODEL LIMITATIONS ON PLANNING PROCESSES

As a result of these limitations, model-based planning, even when conducted by talented and dedicated modelers and planners, cannot comport with a classical vision of unbiased, politically disinterested expert-based planning, and instead is well worthy of public involvement, oversight and critique. Unfortunately, some of the same characteristics that make model-based planning uncertain and subjective also limit public involvement.

1. *Complexity and the Black Box Problem*

The complexity of models is a primary obstacle to participation.

¹⁴³ Commenting on an early draft of this paper, Steve Ziman wrote, "Modelers are willing to accept what is politically ok, and the decision-makers will use any answer so long as it is the answer they want." He stated that the problem of uncertainty communication derives from "decision-makers who don't want to acknowledge the limitations and factor them into the use of [modeling] results." Steve Ziman, comments on draft of this Article (on file with the authors).

¹⁴⁴ See *supra* notes 5–7 and accompanying text (discussing continuing problems with nonattainment); DEMERJIAN ET AL., *supra* note 108, at II-10 ("It is crucial to recognize that the history of air quality projections using PAQSMs is one of consistently overestimating the reductions in peak ozone concentrations that are to be realized in a specified period of time."); THE ENDS OF UNCERTAINTY, *supra* note 130, at 301 (quoting Evan Shipp, meteorologist at the SJVUAPCD: "I have some experience outside of the [San Joaquin] Valley. I have an idea of the way the SIP planning goes, because I've been through three or four SIPs. We didn't make attainment in any one of those SIPs.").

Whereas an expert, through dedicated study, can come to appreciate the nuances of modeling and modeling results, a lay-person cannot be reasonably expected to comprehend the inner workings of models sufficiently to engage in meaningful critique. Unless she receives a cogent explanation, in lay terms, of the model's use, she will be left with the choice of simply accepting or rejecting the modeling results.¹⁴⁵ The model itself will remain a black box, with its inner workings concealed and the process by which it produces results beyond the scope of debate.¹⁴⁶

Effective communication of modeling issues might ameliorate these problems, but such communication rarely occurs.¹⁴⁷ Explaining the uses of models is challenging, and even if planners genuinely attempt to explain models to the public, providing such an explanation can be difficult. The complexities of models are hard to discuss in simple terms. The chances of modelers being sufficiently technically savvy, diligent, patient, and creative to effectively explain models are slim, especially when they are working under time constraints or when their supervisors do not request this additional information.

2. *Concealed Uncertainties*

In addition to making the planning process less approachable, the use of models conceals uncertainties. Apparently precise model predictions may not be qualified by any discussion of a possible error range; even if modelers are able to create a range-of-error prediction—and often they are not—this information does nothing to enhance public understanding if it is not disclosed.¹⁴⁸ Moreover, a simple output prediction may be unaccompanied by specific discussion of the myriad sources of uncertainty that affect model inputs and model processes, and a non-savvy observer may have no way of finding the sources of

145. See SHEILA JASANOFF, *THE FIFTH BRANCH: SCIENCE ADVISORS AS POLICYMAKERS* 11 (1990) (noting that some people will distrust processes they do not understand).

146. See Kuehn, *supra* note 142, at 158–62.

147. Often, planners will have limited incentive to engage in such communication, for the process may proceed more smoothly if potential adversaries do not understand models. See *id.* at 132, 160 (observing that technical decisionmaking processes can exclude the public and “focus government power in the hands of the few who can understand or participate in the process”). This problem is especially acute where planning processes have followed a decide-announce-defend model, in which the agency decides its proposed course of action behind closed doors rather than in collaboration with public participants and then seeks only to defend its choice. See *id.* at 160–61 (describing decide-announce-defend processes); Judith Hendry, *Decide, Announce, Defend: Turning the NEPA Process into an Advocacy Tool Rather than a Decision-Making Tool*, in *COMMUNICATION AND PUBLIC PARTICIPATION IN ENVIRONMENTAL DECISIONMAKING* 100 (Stephen P. Depoe et al. eds., 2004) (“This ‘decide, announce, defend’ strategy undermines the intent of NEPA by viewing public participation as an end rather than as a means to decision making and the NEPA process as merely an instrument to validate a priori decisions.”). However, while exclusionary motivations may exacerbate the problems we describe, problems occur even when planners attempt to facilitate or solicit public involvement.

148. See *infra* Section IV (discussing insufficient disclosure of uncertainties).

uncertainty.¹⁴⁹ Finally, even if the sources of error are apparent, an observer may have difficulty connecting modeling uncertainty to decision risks; they may not know, for example, whether a particular uncertainty is likely to lead to over- or under-regulation.

3. *Concealed Judgments and Policy Choices*

In addition to concealing uncertainty, the complexity of models prevents public participants from knowing the subjective decisions and policy choices made by planners and modelers during the modeling process. Public participants may be unaware, for example, of the criteria used to select a “representative” event for simulation,¹⁵⁰ even though they might question whether that event was sufficiently representative. Public participants also may not know the details of assumptions about future economic growth or about the effectiveness of untested emissions controls.¹⁵¹ Modelers routinely use their judgment to make corrections during a modeling simulation, but public participants not savvy about modeling methods will be unaware of the influence of the modeler.¹⁵² Judgment and policy choices must enter the modeling process at several stages, but a simple prediction of attainment may be unaccompanied by meaningful discussion of the assumptions upon which it is based.

4. *Relocation of Negotiation and Decision-making*

Due to lack of public awareness, debates about the implications of uncertainties, judgments, and policy choices associated with modeling tend to be relocated to forums with technically savvy participants.¹⁵³ In scoping meetings with the lay public, such discussions are unlikely to occur or to be effective, for participants rarely have the scientific knowledge necessary to engage the agency in a productive dialogue. Within the technically sophisticated advisory groups that often assist air quality planners, however, such discussions are possible, and indeed are far more likely to occur.¹⁵⁴ Unfortunately, those technical advisory groups

149. See Kuehn, *supra* note 142, at 158–62 (discussing the implications of concealed uncertainties).

150. Modelers typically predict future plan performance by simulating how the proposed plan would fare if a past meteorological event repeats itself. The past event is referred to as the “representative” event.

151. See, e.g., *infra* Part IV. Among modelers the authors spoke to, there is a common belief that applicable law does not allow for model uncertainty information to be provided. We disagree with that conventional wisdom; in fact, EPA’s current modeling guidance specifically states that modelers should attempt to obtain uncertainty information and provide it to decisionmakers. Requirements for Preparation, Adoption, and Submittal of Implementation Plans, 58 Fed. Reg. 38,816, 38,840–41 (July 20, 1993) (to be codified at 30 C.F.R. pts. 51, 52, 260, and 266). The confusion may result from the fact that that same guidance expressly declines to provide the decisionmaker with any directive about how to use the uncertainty information. *Id.* As a result, decisionmakers may be reluctant to receive from modelers information that they don’t know how to utilize.

152. See, e.g., *infra* Part IV.

153. See, e.g., *id.*

154. See Kuehn, *supra* note 142, at 130–31.

are not a representative cross-section of the public; industry, which has the time and money to develop the requisite level of expertise, and other regulators are disproportionately likely to be present.¹⁵⁵ As proxies, regulators may try to represent the full spectrum of public interests, but when members of the general public or public interest groups¹⁵⁶ are not present, concerns unanticipated by the regulators may never be raised.¹⁵⁷ Additionally, regulators, who are typically trained to play a balanced role, may be reluctant to advocate unrepresented stakeholder interests. Where dialogue about uncertainties, judgments, and policy choices does occur, it is likely to be within a closed group, and some public concerns may receive insufficient attention.

5. *A Confluence of Participation Problems: the Signal-to-Noise Problem*

In practice, participation problems often coincide and may combine to foreclose public dialogue about important planning decisions. The signal-to-noise issue provides one example of this problem. One way to establish just how reliable a model needs to be is to compare a model's signal—that is, the needed or predicted level of change in pollutant concentrations—with its noise, which, in modeling parlance, refers to the error range of the prediction.¹⁵⁸ For example, a model may predict that emissions controls will produce a central estimate peak 1-hour concentration of 119 ppb (parts per billion), but the prediction might have an error range, using a 95 percent confidence interval, of +/- 20 ppb. Now suppose that EPA's regulatory standard requires that the peak 1-hour ozone concentration not exceed 120 ppb. In one sense, the model has predicted compliance; the 119 ppb concentration is below the standard. In another sense, however, compliance may be illusory, for values above the standard fall within the prediction's expected range of error. The prediction, in effect, is that the concentration is quite likely to be between 99 ppb and 139 ppb, with a greater likelihood of an outcome near the center of that range and with a significant, troubling likelihood

155. *See id.* at 132; *see, e.g., infra* Part IV (describing the imbalanced composition of advisory committees).

156. Public interest groups may, of course, have agendas that are not consistent with, or only partially representative of, the diverse interests of the general public. *See generally* OLSON, *supra* note 8 (discussing the limitations of groups as proxy representatives of public interests); THEODORE J. LOWI, *THE END OF LIBERALISM* 86–95 (1969) (raising similar doubts about the ability of interest groups to represent the general public). But even if public interest or community groups are imperfect public representatives, their presence can make the decisionmaking more representative than if composed only of regulators and private industry representatives.

157. *See* Simon, *supra* note 75 (noting that often the public surprises regulators with its concerns, and that these surprises are often important contributions to the decision-making process).

158. Unfortunately, the comparison of signal with noise is not formally required as part of model performance evaluation. Instead, regulatory guidance for PAQSM performance evaluation relies upon comparison of predicted and observed ozone.

that the outcome will violate the standard.¹⁵⁹

Nothing in the Clean Air Act instructs planners on how to deal with this scenario.¹⁶⁰ The act requires planners to demonstrate compliance but does not specify the requisite level of confidence to be ascribed to the demonstration. Likewise, EPA's current regulatory guidance suggests that using a best estimate is appropriate, but expressly declines to endorse this approach.¹⁶¹ In lieu of clear legal guidance, the response to uncertainties becomes a policy choice. It is, quite obviously, a choice in which the public has an enormous stake, since ultimately it concerns the level of risk people are willing to accept.¹⁶² Nevertheless, if uncertainty is shrouded by the modeling, technically savvy participants will be the only ones discussing the decision. For the public, the dialogue and the policy choice will be concealed.

C. AFFECTED GROUPS

To some extent, models make participation more difficult for everyone. They present obstacles of time, finances and expertise even to environmental and industry groups with technical staff. However, the burden does not fall upon all parties equally,¹⁶³ and the effects on three rather different groups merit particular concern.

I. Planners

The first affected group is planners. Planners are responsible for translating modeling into policy. Although they often work closely with modelers, they don't always understand the details of modeling, and in planner-modeler communications information is often lost. This lack of understanding obviously can have detrimental consequences for planning efforts; planners may fail to compensate for uncertainty, or fail to consider substituting their own, potentially better-informed, policy judgments for those of the modelers.

Information regarding assumptions and uncertainty that is not conveyed to or understood by the planners is even less likely to reach the public. Typically it is the planners, not the modelers, who prepare the

159. See Kuehn, *supra* note 142, at 158–59 (emphasizing that the public should receive information about error ranges); see also Granger Morgan, *The Neglected Art of Bounding Analysis*, ENVTL. SCI. & TECH. 162A–164A (Apr. 11, 2001).

160. The Clean Air Act requires a demonstration of attainment, but what that means in terms of certainty is far from self-evident.

161. Requirements for Preparation, Adoption, and Submittal of Implementation Plans, 58 Fed. Reg. 38,816, 38,840–41 (EPA, July 20, 1993) (to be codified at 40 C.F.R. pts. 51, 52, 260 & 266).

162. See Kuehn, *supra* note 142, at 158–62.

163. See generally Croley, *supra* note 78, at 119–35. Croley hypothesizes that cost and complexity will deter participation by those who lack money, and that regulated industries' heightened interests in rulemaking processes will lead to greater participation. Croley then analyzes existing data on participation in administrative processes and concludes that the overwhelming majority of participation does come from regulated industry. *Id.*; see also Kuehn, *supra* note 142, at 130–32.

documentation available for public review, and who review and respond to public criticism. If planners are unaware of uncertainties and concealed policy choices, the public dialogue will be limited by ignorance on all sides.

2. *Judicial Review*

The second key affected group is judges. A judge who would object to the way a model was used must find flaws so serious that the model use was either procedurally defective or substantively arbitrary and capricious, and is unlikely to make such a finding unless she is confident in her understanding of the agency's use of the model.¹⁶⁴ Such understanding is difficult for a time-pressed, non-scientifically expert judge to develop, and, unsurprisingly, judicial objections to uses of models are rare.¹⁶⁵

To some extent, the rarity of such objections is appropriate; our administrative law system is predicated on the notion that judges should not usurp the role of technical experts.¹⁶⁶ Moreover, to the extent that public participants are advocating more stringent regulation, those participants may welcome limited judicial review, for in practice most litigation against model-based decisions has been instigated by industry.¹⁶⁷ Nevertheless, hamstrung judicial review also has troubling ramifications. Judges are important guarantors of a reasonable administrative process, and while they are expected to show deference to agency judgment, that deference should not arise out of ignorance or confusion.¹⁶⁸ Likewise, if judges only partially understand model-based decisions, they may be overly receptive to criticisms of those decisions, and agencies may find their actions overturned even where deference would be appropriate.¹⁶⁹ Where the opacity of modeling undermines

164. *Small Refiner Lead Phase-Down Task Force v. EPA*, 705 F.2d 506, 535 (D.C. Cir. 1983) (explaining the circumstances under which a judge will overturn the use of a model).

165. *Chem. Mfrs. Ass'n v. EPA*, 28 F.3d 1259, 1265 (D.C. Cir. 1994), stands as a rare example of judicial willingness to invalidate the use of a model for substantive insufficiency; *Appalachian Power Co. v. EPA*, 249 F.3d 1031, 1055 (D.C. Cir. 2001), and *Lands Council v. Forester of Region One of the U.S. Forest Serv.*, 395 F.3d 1019, 1031-32 (9th Cir. 2004), provide similarly rare examples of a remand because of insufficient explanation of a model. See generally McGarity & Wagner, *supra* note 13 (documenting cases in which model-based decisions have been overturned, and observing that courts in general have accorded model-based decisions deferential review).

166. See, e.g., *New York v. EPA*, 852 F.2d 574, 580 (D.C. Cir. 1988) ("It is well established that when a court is reviewing predictions within an agency's area of special expertise, at the frontiers of science, the 'court must generally be at its most deferential.' . . . *Acceptance or rejection of a particular air pollution model and the results obtained from it are interpretations of scientific evidence.*") (emphasis added).

167. See McGarity & Wagner, *supra* note 13 (summarizing cases).

168. See *Chem. Mfrs. Ass'n*, 28 F.3d at 1265 ("If we are to earn our keep, however, judicial deference to the agency's modeling cannot be utterly boundless.")

169. As McGarity and Wagner point out, clearer discussion of modeling limitations can also facilitate reversals by judicial panels motivated by hostility to the agency's policy goals. McGarity & Wagner, *supra* note 13, at 10771. Nevertheless, they argue that clearer discussions will generally

judges' ability to understand decision-making processes, that opacity will limit judicial capacity to separate the rational from the irrational.

3. *Economically Disadvantaged Communities*

The poor are especially impacted.¹⁷⁰ The ability to critique a model requires a level of education, time and expertise unlikely to be found in the average layperson.¹⁷¹ Such a layperson might be able to educate himself and thus understand and criticize the model, or, far more plausibly, might retain an expert or attempt to participate through the proxy services of an advocacy or lobbying organization. But either method of participation requires time or money; for the person who lacks both, a model-based decision-making process will remain inaccessible.¹⁷² In air quality planning, this lack of accessibility is deeply problematic.

The existence of a nexus between air pollution planning and environmental injustice is a matter of substantial research and debate. While many studies document connections between air pollution and disparately harsh effects upon poor and/or minority groups, the ties between race, affluence, and exposure are not clear for the pollutants that planners have been persistently unable to address—ozone and particulate matter. Several studies suggest that poor and minority populations are particularly likely to live in areas not meeting ambient air quality standards, but these studies often use county-level attainment data, and thus treat as uniform areas where pollutant concentrations may in fact vary widely on a local scale.¹⁷³ Some local studies indicate that,

provide agencies with greater insulation from, rather than increased vulnerability to, judicial reversals.

170. See generally Kuehn, *supra* note 142. Kuehn discusses similar problems with quantitative risk assessment, another commonly used form of modeling, and argues that increased use of quantitative risk assessment will exacerbate environmental injustice.

The result of reliance on risk assessment, therefore, is a process that is both less democratic—because understanding and critiquing risk assessments are beyond the technical and financial resources of almost all citizens—and more oligarchic, because it tends to focus government power in the hands of the few who can understand or participate in the process. Much of the support for regulatory reform, such as risk assessment and cost-benefit analysis, may be viewed as an attempt to shift the basis of regulation away from democratic modes of public decision making and toward more technocratic, expert-based modes.

Id. at 132 (citations omitted).

171. See *id.* at 130–31 (discussing the difficulties faced by a layperson seeking to understand or critique a quantitative risk assessment).

172. See *id.* at 131 (noting that agency staff tend to doubt the accuracy of citizen information, and prefer dealing with technically knowledgeable participants). Low-income communities are likely to contain few people with the expertise necessary to understand why a proposed SIP might be worth criticizing. Since very few people have the technical training or time to critique a model on their own, those seeking to criticize a model must hire experts. But experts are expensive, and low-income communities have few avenues for purchasing such representation.

173. See, e.g., AM. LUNG ASS'N OF CAL., IN THE SPOTLIGHT, at <http://www.californialung.org/spotlight/envjustice.html> (last visited Sept. 9, 2004). The website states:

Children living in low-income communities of color are also exposed to higher levels of ozone air pollution. Ozone forms when emissions from motor vehicles, power plants and other industries react with sunlight. Nearly 62 percent of African American children, 70

even though ozone-precursor emissions are concentrated in urban areas, the highest ozone concentrations tend to occur downwind in more suburban and affluent areas.¹⁷⁴ On the other hand, one of the most problematic effects of ozone is exacerbation of asthma symptoms, and asthma rates are typically higher in the poor urban areas with large minority populations. Thus, even if exposure levels are not tied to race or affluence, the effects of exposure may be skewed.

Regardless of whether poor and minority populations bear a disproportionate share of the impacts of unsuccessful air quality planning, the inescapable reality is that millions of poor people and people of color do live in areas with heavy air pollution.¹⁷⁵ These populations thus have strong stakes in air pollution planning, and when plans fail disadvantaged groups—particularly the children and the elderly—suffer.¹⁷⁶ For these reasons, minority and low-income individuals ought to have the opportunity participate meaningfully in SIP planning processes, and potential barriers to their participation are highly problematic.

Agencies have several incentives to compensate for this potential for exclusion. Many agency staff take very seriously the obligation to involve and protect at-risk communities.¹⁷⁷ In addition, agencies are under executive¹⁷⁸ and, potentially, judicial directives to consider the

percent of Latino children, and 70 percent of Asian American children live in areas that exceed the ozone standard, compared to less than 51 percent of white children.

Id.; see also Feng Liu, *Who Will Be Protected by EPA's New Ozone and Particulate Matter Standards?*, ENVTL. SCI. & TECH. 32A-39A (Jan. 1, 1998) (employing a county-level analysis and concluding that disparate impacts do exist); CAL/EPA'S OFFICE OF ENVTL. HEALTH HAZARD ASSESSMENT & AM. LUNG ASS'N OF CAL., AIR POLLUTION AND CHILDREN'S HEALTH, at http://www.californialung.org/downloads/diesel010501/ALA-OEHHA_children.pdf (last visited Mar. 6, 2003) [hereinafter *Air Pollution and Children's Health*].

174. See, e.g., Feng Liu, *Urban Ozone Plumes and Population Distribution by Income and Race: a Case Study of New York and Philadelphia*, 46 J. AIR & WASTE MGMT. ASS'N 207-15 (1996); AM. LUNG ASS'N, TRENDS IN AIR QUALITY 4 (2002) (noting that "the highest ozone concentrations are typically found at suburban sites because of the downwind transport of emissions from urban sites"), available at <http://www.lungusa.org/data/aqp/AQ1.pdf>.

175. See, e.g., AM. LUNG ASS'N OF CAL., *supra* note 173.

176. See generally Kuehn, *supra* note 142, at 124 (noting that low-income, minority populations generally include more children and that such populations also tend to be subjected to a wide range of other health stresses, which in turn can increase vulnerability to environmental pollution); AIR POLLUTION AND CHILDREN'S HEALTH, *supra* note 173.

177. See ERIC MARSH, STAKEHOLDER INVOLVEMENT & PUBLIC PARTICIPATION AT THE U.S. EPA: LESSONS LEARNED, BARRIERS, & INNOVATIVE APPROACHES (Jan. 2001), available at www.epa.gov/publicinvolvement/pdf/sipp.pdf (describing efforts EPA has made to increase inclusiveness).

178. Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations, 59 Fed. Reg. 7,629 (Feb. 11, 1994). States endorsed similar policies rhetorically; the California Air Resources Board, for example, trumpets its intent to incorporate environmental justice concerns into its policymaking, and promises more extensive outreach to ensure inclusive decision-making processes. See ARB's Community Health, at <http://www.arb.ca.gov/ch/programs/programs.htm> (last visited May 14, 2004).

environmental justice effects of their decisions.¹⁷⁹ These legal mandates, however, are only likely to provide constraints upon agency actions in situations involving either manifestly racial intent or egregiously disparate impacts; most ozone planning processes are unlikely to involve injustice stark enough to invite judicial remedy,¹⁸⁰ and indeed may involve situations where impacts are shared relatively equally by all segments of the general population. As a result, and as the following section illustrates, models can have their most exclusionary effects upon those who can least afford to be excluded, and who have few remedies for that exclusion.

IV. MODELS AND PLANNING IN THE SAN JOAQUIN VALLEY

A. INTRODUCTION

In the early 1990s, state and local regulators, in accordance with the Federal Clean Air Act, began developing the San Joaquin Valley's (SJV) portion of California's SIP. They faced a daunting challenge. The topography and geography of the Valley create a natural sump for air pollution, the Valley had a well-documented human-caused air quality problem, and population was expected to double in just two decades.¹⁸¹ The modelers and planners had the resources for success, however. An eighteen million dollar, multiple agency, multi-stakeholder research effort had generated SARMAP, a state-of-the-science model.¹⁸² A robust observational database supplied the model's input data.¹⁸³ The planning teams and advisory committees included highly qualified experts who had several decades experience dealing with air quality science and planning elsewhere in California.

179. Although judicial enforcement of disparate impact environmental justice claims remain a theoretical possibility, few such claims have achieved success. *See* *S. Camden Citizens in Action v. N.J. Dep't of Env'tl. Prot.*, 145 F. Supp. 2d 446 (D.N.J. 2001); Brendan Cody, Note, *South Camden Citizens in Action: Siting Decisions, Disparate Impact Discrimination, and Section 1983*, 29 Ecology L.Q. 231 (2002) (noting that the series of South Camden decisions leaves potential plaintiffs with substantive rights but no mechanism for enforcement, forcing them to rely on EPA's willingness to implement regulations it has shown little inclination towards enforcing).

180. *See* Cody, *supra* note 179.

181. The California Department of Finance projects 7.3 million residents in the SJV by 2040. MARY HEIM ET AL., COUNTY POPULATION PROJECTIONS WITH AGE, SEX AND RACE/ETHNIC DETAIL (1998), available at http://www.dof.ca.gov/HTML/DEMOGRAP/Proj_age.htm (last visited Apr. 8, 2004).

182. ATTAINMENT PLAN, *supra* note 15, at 1-6 to 1-7.

183. The observational database was generated using routine monitoring stations augmented by intensive measurements gathered during field campaigns conducted in July and August, 1990. CAL. AIR RES. BD. & SAN JOAQUIN VALLEY UNIFIED AIR POLLUTION CONTROL DIST., SAN JOAQUIN VALLEY AIR QUALITY STUDY POLICY—RELEVANT FINDINGS 4 (1996) ("During the field study, researchers took continuous measurements of air pollutants and/or weather indicators at almost 400 surface and upper air monitoring sites. When the analysis of these data indicated that a high ozone episode might be building, the routine monitoring was augmented by aircraft flights and weather balloon releases from 25 sites . . .").

Nevertheless, the planning effort failed. Though the models and planners predicted attainment of the ozone standard by 1999,¹⁸⁴ and though their plans did succeed in generating significant emissions reductions, air quality improvements have been slow,¹⁸⁵ and air quality in the Valley still has not met federal or state standards. Recently, EPA designated part of the SJV as a “severe” nonattainment region, with a deadline for meeting the standard pushed back to 2010.¹⁸⁶ At the request of air quality regulators in the Valley, EPA then further downgraded the Valley’s status to “extreme.”¹⁸⁷ Moreover, this failure occurred in a disappointingly undemocratic fashion. Despite the Clean Air Act’s mandate for public participation, the planning process involved only regulators and advisory groups composed primarily of industry representatives and technocrats from other government agencies. Public interest groups, community groups, and individual members of the public were mostly uninvolved.

In this section, we explore the story of the 1990s planning process and the ways in which models affected that process. We do not suggest that successful planning could have occurred without models. Nevertheless, we conclude that the model used to inform planning was limited in several respects and ultimately failed to deliver reliable predictions. Further, the ways in which planners used the modeling results had the unfortunate impact of rendering the process both opaque and inaccessible for public participation.

The story of the San Joaquin Valley thus illustrates many¹⁸⁸ of the

184. ATTAINMENT PLAN, *supra* note 15, at ii, I-2 (1994).

185. EPA concluded in 2001 that there was “no significant” trend in peak ambient ozone concentrations in any of the major cities of the SJV. OFFICE OF AIR QUALITY PLANNING AND STANDARDS, U.S. ENVIRONMENTAL PROTECTION AGENCY, NATIONAL AIR QUALITY AND EMISSIONS TRENDS REPORT, SPECIAL STUDIES EDITION, 2003 APPENDIX A, TABLE A-16 (2003); OFFICE OF AIR QUALITY PLANNING AND STANDARDS, UNITED STATES ENVIRONMENTAL PROTECTION AGENCY, NATIONAL AIR QUALITY AND EMISSIONS TRENDS REPORT 141, 150, 170 (2003) (Bakersfield, Fresno, and Stockton figures, respectively). The SJVUAPCD has a slightly different interpretation of progress. SJVUAPCD, DRAFT 2002 AMENDMENT TO THE SAN JOAQUIN VALLEY OZONE PLAN 2-10 (2001) (“[T]here has been no improvement in decreasing annual maximum [for one-hour ozone]. However, there has been considerable improvement in other statistics, particularly in the number of days and the number of hours over the standard.”). In the 2001 Triennial Progress Report, the SJVUAPCD presented expected peak day concentration metrics that suggested considerable progress. SJVUAPCD, CALIFORNIA CLEAN AIR ACT TRIENNIAL PROGRESS REPORT AND PLAN REVISION 1997-99 4 (Mar. 15, 2001) (“The [Expected Peak Day Concentration] for 17 of the 23 sites in the SJV [Air Basin] decreased (some by only one part per billion), five out of 23 increased, and one site had data for only 1999.”).

186. Clean Air Act Reclassification, San Joaquin Valley Nonattainment Area; Designation of East Kern County Nonattainment Area and Extension of Attainment Date; California; Ozone, 66 Fed. Reg. 56,476 (Nov. 8, 2001).

187. Mark Grossi, *Valley Seeks “Extreme” Air Polluter Designation*, FRESNO BEE, Dec. 19, 2003, at A1, available at <http://www.fresnobee.com/local/politics/story/7916689p-8793407c.html>.

188. The San Joaquin Valley’s story does not illustrate all of the problems discussed in Section III; we offer this story to provide concrete examples of some potential problems rather than a thorough

problems that can occur when planners must rely upon sophisticated modeling.

B. THE SETTING AND THE STAKEHOLDERS

1. *Geography and Pollution*

West-bound drivers who navigate the passes of the Sierra Nevada descend through pine and oak-covered foothills, winding to the floor of California's Great Central Valley.¹⁸⁹ Once covered with a lush mix of wildlife-rich wetlands and Serengeti-like plains,¹⁹⁰ the Central Valley's broad, flat floor now supports growing cities, hundreds of small towns, major highways, and millions of acres of agriculture. It is a huge area; the entire Central Valley is approximately 450 miles long and 40 to 60 miles wide, and the San Joaquin Valley—the focus of this case study—alone includes eight counties covering approximately 27,000 square miles, an area bigger than New Jersey.¹⁹¹

2. *People, Economy, and History*

The San Joaquin Valley has 3.3 million people living in several major cities and in surrounding rural communities.¹⁹² This population has grown dramatically during the past few decades; more than half of the current residents arrived after 1970.¹⁹³ Demographers expect growth to continue, with the total population more than doubling by 2040.¹⁹⁴

A high and growing percentage of that population is non-Caucasian.¹⁹⁵ Projections from the California Department of Finance indicate that by 2040 nearly 70 percent of the population will be minority (Hispanic, Black, Asian, Pacific Islander, or American Indian).¹⁹⁶ Many of the Valley's residents also are relative newcomers to America; the

sampling of all the issues that may arise.

189. California Almanac, at http://www.netstate.com/states/geography/ca_geography.htm (last visited May 14, 2004).

190. See MARK ARAX & RICK WARTZMAN, *THE KING OF CALIFORNIA* 46–86 (2003) (describing the earlier history of the San Joaquin Valley and the draining of Tulare Lake); Mark Grossi, *Rescuing the San Joaquin*, FRESNO BEE, June 20, 1999, at A1, available at <http://www.fresnobee.com/man/projects/savesjr/mainbar.html>.

191. See Counting California, at <http://countingcalifornia.cdlib.org> (last visited May 14, 2004).

192. U.S. Bureau of the Census, Population of Counties by Decennial Census, at <http://www.census.gov/population/cencounts/ca190090.txt>. For a description of one rural community with many residents not counted in the U.S. Census, see JENNIFER SHERMAN ET AL., *FINDING INVISIBLE FARM WORKERS: THE PARLIER SURVEY 10* (1997).

193. U.S. Census Bureau, *supra* note 192.

194. See note 181, *supra*.

195. The SJVUAPCD has a higher percentage of people who consider themselves Hispanic or Latino than the San Francisco Bay Area or California overall. Note, however, that the U.S. Bureau of Census considers Hispanics to be of any race. This assumption makes it difficult to estimate the percentage of minorities in the SJV, because Hispanics may be considered white in the 2000 Census. See U.S. Census Bureau, Hispanic Origin, at http://quickfacts.census.gov/qfd/meta/long_68188.htm.

196. HEIM ET AL., *supra* note 181.

Central Valley always has been a magnet for immigration, and for over a century its fields have lured agricultural laborers from all over the world. The Central Valley economy remains heavily dependant upon an influx of laborers from Mexico and elsewhere.¹⁹⁷

Relative to their fellow Californians, people in the SJV are poorer, less employed, and less educated.¹⁹⁸ The median household income in the SJV was \$32,353 in 1997, which was 18 percent lower than the California median of \$39,595 and 37 percent below the San Francisco Bay Area median of \$51,687.¹⁹⁹ More than twice as many people in the SJV live in poverty as in the Bay Area.²⁰⁰

This poverty derives largely from low wages and high unemployment, occurring in spite of the Valley's spectacular agricultural productivity. The SJV is the nation's most productive agricultural region, producing \$14.5 billion in agricultural products in 1999.²⁰¹ Kern County is the single most productive petroleum-producing county in the nation, though its productive deposits are almost gone.²⁰² But these industries,

197. See DONALD WORSTER, *RIVERS OF EMPIRE* 218–27 (1985).

198. Based on data from the 2000 Census, there were 42 and 49 high school graduates per 100 people in California as a whole and in the San Francisco Bay Area, respectively, but only 32 per 100 in the SJV. Similarly, California and the Bay Area respectively have 13 and 18 college graduates per 100 people, whereas in the SJV only 7 in 100 people have a college degree (calculated using county-specific data from U.S. Census Bureau, 2000 Census, County Quick Facts, at <http://quickfacts.census.gov/>). In addition, several indicators suggest that SJV residents have less education and less access to health care than other Californians. They have fewer physicians and hospital beds per capita, less adequate prenatal care, and a higher rate of births to adolescent mothers. KENNETH W. UMBACH, *A STATISTICAL TOUR OF CALIFORNIA'S GREAT CENTRAL VALLEY*, Figs. 24, 25, 27, 29 (1997), available at <http://www.library.ca.gov/CRB/97/09/>.

199. 2000 Census, County Quick Facts, *supra* note 198. One economic study of the SJV found that real per capita income has declined from \$21,700 in 1990 to \$20,900 in 2000 (in 2000 dollars). TAPAN MUNROE ET AL., *ECONOMIC FORECAST FOR CALIFORNIA'S GREAT CENTRAL VALLEY* 47 (2001), available at <http://www.greatvalley.org/publications/list.aspx>.

200. 2000 Census, County Quick Facts, *supra* note 198. Poverty is defined by the U.S. Census in terms of family income thresholds and as a function of household size and composition. For example, a family consisting of a mother, father, two children and great-aunt had a poverty income threshold of \$21,665 in 2001. For a detailed definition, see the U.S. Census website, at <http://www.census.gov/hhes/poverty/povdef.html> (last visited on Apr. 16, 2003).

201. NICOLAI KUMINOFF ET AL., *THE MEASURE OF CALIFORNIA AGRICULTURE* 65 (2000), available at <http://aic.ucdavis.edu/pubs/moca.html>.

202. No studies of petroleum employment exist for the SJV. James Parsons, a cultural geographer, called petroleum the “kicker” in the regional economy, but other evidence suggests the petroleum industry has done relatively little to create local jobs or wealth. *Compare* James Parsons, lecture, *A Geographer Looks at the San Joaquin Valley*, 1987 Carl Sauer Memorial Lecturer (Apr. 30, 1986), available at http://geography.berkeley.edu/ProjectsResources/Publications/Parsons_SauerLect.html (contains slight revisions), *with* note 206, *infra*.

Kern County is the most productive county in California, generating two-thirds of all California petroleum. In 1999, oil wells in Kern County produced over 500,000 barrels of oil per day. The county ranks behind only Texas (1.4 million barrels per day), Louisiana (1.3 million barrels per day) and Alaska (1 million barrels per day) as the nation's most productive region. Although oil production in Kern County has declined steadily since peak production of 424 billion barrels in 1985, it accounted for 200 billion barrels, or 68% of the state's total production, in 2001. Cal. Dept. of Conservation,

although vital to the region's economy, have not created regional wealth. Unemployment in the SJV averaged 13.9 percent from 1990 to 2000, almost double the California average of 7 percent.²⁰³ Even for those who are employed, the Valley's industries do not provide the same abundance of high-wage employment as California's coastal areas.²⁰⁴ Low-wage agricultural jobs dominate employment in the SJV.²⁰⁵ Though quite visible, petroleum production provides relatively little employment in the region, even in Kern County.²⁰⁶

Although failing to bring widespread affluence, the San Joaquin Valley's economy has traditionally provided great wealth to a select few, a wealthy elite that has aggressively defended its good fortune.²⁰⁷ Historically, businesses were closely connected to the power structure, allowing the usually non-white poor²⁰⁸ to be exploited and denied—

California Crude Oil Production Drop Continues (Jan. 28, 2003), at http://www.consrv.ca.gov/index/news/2003%20News%20Releases/NR2002-02_OilandGasReport.htm; Ed Wilson et al., California Oil and Gas Production Report (2003), available at http://www.consrv.ca.gov/DOG/pubs_stats/pub_index.htm.

203. See MUNROE ET AL., *supra* note 199, at 12.

204. See *id.* at 15 (“Population-driven and cost-driven development activities that draw people and businesses to the [San Joaquin Valley] for the low cost of doing business and the low cost of living have created substantial economic growth through construction and retail jobs. Yet population-driven and cost-driven development have not created many of the high paying jobs that increase real per capita income (a key indicator of rising affluence in a region).”).

205. In 2000, the University of California Agricultural Issues Center provided a comprehensive assessment of the economics of agriculture in the SJV. The report estimates that agriculture represented 32 percent of total income (\$20 billion) and 37 percent of the jobs (466,519) in the SJV. KUMINOFF, *supra* note 201, at 107. Another estimate for 2000 employment confirmed the importance of farm employment and noted that employment in other sectors may also be due to agriculture. MUNROE ET AL., *supra* note 199, at 7 (“Farming dominates the Central Valley economy with annual production of over \$16 billion per year. Direct farm employment in the region constitutes 12 percent of total jobs; and addition 28 percent are in farm-related industries.”).

206. Using census data and industrial classifications from a study sponsored by the Western States Petroleum Association, we estimate that 5,400 jobs in Kern County were directly petroleum-related in 1999. See T. ANTHONY QUINN, THE SAN FRANCISCO BAY PETROLEUM INDUSTRY: ECONOMIC IMPACT, COMMUNITY VALUE (Apr. 2001), available at <http://www.wspa.org/issues/ei.htm>. This does not include 2,000 jobs at service stations. This total comprises only four percent of total employment in the county, and a comparison of these numbers with, for example, the 6,000 employees of the Internal Revenue Processing Center in Fresno suggests that the petroleum industry does not play a major job-creating role.

207. See, e.g., ARAX & WARTZMAN, *supra* note 190 (chronicling the rise of the Boswell family empire, and describing how some other enterprising men also managed to make spectacular fortunes in the valley).

208. With the brief exception of the real-life Tom Joads of the Great Depression, the Valley's agricultural laboring class was almost never white. Growers tried importing one group after another, with the rest of the nation rarely paying close attention except when the laborers were Dust-Bowl refugee Okies. WORSTER, *supra* note 197, at 218–27. The growers finally settled upon Mexican laborer to be what Worster describes as “the persistent presence, the dominated class, the despised race, the men and women who made the water empire a success.” *Id.* at 221. Similar demographic patterns persist to this day; poverty rates remain higher for non-whites. E-mail from Deborah Reed, Public Policy Institute of California, to authors (May 17, 2004) (containing a spreadsheet summarizing census data showing poverty rates for different racial groups in San Joaquin Valley Counties).

sometimes violently—safety and better pay.²⁰⁹ *The Grapes of Wrath* and Cesar Chavez's boycotts represent just two of the many social and cultural events that have helped turn San Joaquin Valley poverty and repression into American legend, and scholars have long described the Valley as a dystopian counterpoint to Jeffersonian democratic ideals.²¹⁰

The dynamics of the past have become somewhat ameliorated.²¹¹ Nevertheless, the San Joaquin Valley remains a place where pro-business leanings are a distinctive mark of the political culture,²¹² where traditionally disadvantaged groups continue to comprise a disproportionate percentage of the poor,²¹³ where illegal labor exploitation persists, and where efforts at environmental regulation have often been thwarted in collisions with economic power.²¹⁴ The Valley's current air quality planners are not the heirs of Steinbeck's villains; we have no reason to suggest that the actors in the processes we describe acted out of anything other than good faith.²¹⁵ Nevertheless, any

209. See, e.g., ARAX & WARTZMAN, *supra* note 190, at 137–76 (chronicling some of the labor battles in the San Joaquin Valley's fields). The violence was not exclusively directed at the laborers; Arax and Wartzman also describe incidents of vandalism and intimidation instigated by labor organizers.

210. JOHN STEINBECK, *THE GRAPES OF WRATH* (1939); WORSTER, *supra* note 197, at 296–97 (discussing Chavez's strikes); see also CAREY MCWILLIAMS, *Factories in the Field: The Story of Migratory Farm Labor in California* (Santa Barbara ed., 1971). In his particularly dark account, Worster writes that

contrary to traditional rural ideals, a pronounced system of class relations, and of raw exploitation of one class by another, existed out there . . . the flowering of the West was, and had to be if the dreams of absolute environmental conquest were to become reality, the work of a dominated underclass of hired men and women.

WORSTER, *supra* note 197, at 217. Arax and Wartzman describe a somewhat more benign, but still damning, history of paternalistic but still exploitative management-laborer relations somewhat reminiscent of conditions in the Jim Crow South. ARAX & WARTZMAN, *supra* note 190, at 137–76, 256–85.

211. For example, assimilation of Latinos into California politics has vastly improved. See LUIS ARTEAGA, *THE LATINO VOTE 2000*, at http://www.lif.org/civic/vote_2000.2.html (Oct. 2000) (examining patterns in Latino political participation, and discussing reasons why that participation remains somewhat low).

212. See Gary Polakovic, *California's Smog Story is Tale of 2 States*, L.A. TIMES, Nov. 4, 2001, at B1 (discussing both increasing focus on Latino-specific issues and the continuing pro-business climate of the San Joaquin Valley and several other areas of inland California).

213. E-mail from Deborah Reed, *supra* note 208 (summarizing census data on race and poverty); see DEBORAH REED, PUBLIC POLICY INSTITUTE OF CALIFORNIA, *FALLING BELOW THE POVERTY LINE* (Mar. 2002), at <http://www.ppic.org/main/commentary.asp?i=249> (noting racial disparities in poverty levels); Rollie Smith, *Colonias in the San Joaquin Valley and the Q House*, available at www.greatvalley.org/htn10m/docs/colonias.ppt (discussing disproportionately high poverty in small Hispanic communities).

214. Andy Furillo, *Toiling Under Abuse: the Farmworkers' Struggle Goes on*, SACRAMENTO BEE, May 20, 2001, available at <http://www.crlaf.org/2001bee.htm>.

215. See Mark Grossi et al., *Last Gasp*, FRESNO BEE, Dec. 15, 2002, at 1 (“Valley air district staff members have been pleading the dirty-air case for years . . .”), available at http://www.fresnobee.com/special/valley_air/part1/story1/. *Last Gasp* is the cover story of a special section providing an impressively comprehensive and insightful account of the San Joaquin Valley's air quality problems. In both public hearings and in interviews to support this case study research, planning staff have been consistently cooperative, earnest and forthcoming about the many challenges that they face.

understanding of current patterns of political participation, and of the political climate within which planners make their decisions, must be informed by the area's historic political culture.

3. *The Pollution Problem*

A combination of topography, meteorology and human-caused emissions creates among the nation's worst ambient air quality conditions in the San Joaquin Valley.²¹⁶ Prevailing winds from the San Francisco Bay Area, home to 10 million people, blow east, carrying their emissions into the Central Valley.²¹⁷ Once past the Coastal Mountain Range, the winds gather more pollution from the Valley's growing cities and towns. Local automobile traffic adds more emissions, as does the steady stream of cars and trucks on highways I-5, I-80, and State Route 99.²¹⁸ Industry—particularly agriculture²¹⁹ and petroleum—also contributes. Nature supplies windblown dust and “biogenic” pollutant emissions. Once in the Valley, all of this pollution can stagnate for several days at a time,²²⁰ with the mountains that surround the valley limiting its means of escape.²²¹

Climate makes matters worse. The entire Central Valley, for much of the year, is swelteringly hot. In Fresno, the average maximum daily temperature in July is 98.6°F,²²² and the SJV averages 40 days per year hotter than 100°F.²²³ The sun also is unrelenting; on summer days

216. *Id.*; San Joaquin Valley Unified Air Pollution Control District, The Air Quality Mission, available at http://www.valleyair.org/General_info/aboutdist.htm (last visited Jan. 21, 2004).

217. In the Attainment Plan, the SJVUAPCD placed great stress on these out-of-region sources, repeatedly discussing studies that predicted that regulatory violations would occur in the northern SJV even if within-valley sources were nonexistent. ATTAINMENT PLAN, *supra* note 15, at v-vii, 2-17 to 2-18, 3-11 to 3-12, 5-1 to 5-3. Others are skeptical about how much the valley's air pollution problem can be blamed upon upwind sources. See Mark Grossi et al., *Don't Blame San Francisco*, FRESNO BEE, Dec. 15, 2003, at 5 (“Experts on both sides of the Coastal Range agree the Bay Area's smog is not the key to the Valley's dirty-air problems. It never has been.”).

218. See ATTAINMENT PLAN, *supra* note 15, at ii. Mobile sources contribute 47 and 40 percent, respectively, of NOx and reactive organic gas (ROG) emissions estimated for 1990. Passenger autos and light duty trucks (which include SUVs) contribute 20 and 27 percent of total NOx and ROG emissions, respectively. See SJVUAPCD, DRAFT 2002 AMENDMENT TO THE SAN JOAQUIN VALLEY OZONE PLAN (2002).

219. See Mark Grossi, *Agriculture a Leading Polluter*, FRESNO BEE, Dec. 15, 2002, at 15; Mark Grossi, *Cows Rival Cars as Smog Producers*, FRESNO BEE, Dec. 15, 2002, at 17.

220. This case study discusses a period of elevated ozone concentrations observed in the San Joaquin Valley. Such several-day events are referred to as “ozone episodes.”

221. See GREAT VALLEY CENTER, THE STATE OF THE GREAT CENTRAL VALLEY OF CALIFORNIA 6, available at http://www.greatvalley.org/publications/pub_detail.aspx?pId=78 (Apr. 4, 2001) (“The geography that defines the Valley and which contributes to many of its positive attributes also creates a collection point for air pollutants that originate from both from within the Valley and from the San Francisco Bay Area.”); *Last Gasp*, *supra* note 215.

222. See Cal. Dept. of Finance, *Table A-5: Average Maximum, Minimum, and Annual Temperatures* (2001), available at <http://countingcalifornia.cdlib.org/matrix/c28.html>.

223. SJVUAPCD, AMENDED 2002 AND 2005 RATE OF PROGRESS PLAN FOR SAN JOAQUIN, at 2-2 (2001), at <http://www.valleyair.org/Workshops/postings/1-23-03/2002%20and%202005%20Rate%20of>

thunderheads often build over the Sierra Nevada, but skies in the Valley usually remain cloudless. Heat and sunlight accelerate the chemical processes that lead to high ozone concentrations,²²⁴ and the San Joaquin Valley is thus a natural ozone-generating region.²²⁵

The Valley has experienced high ozone levels for years, and dangerously high ozone levels had become regular phenomena even before scientific studies began in earnest in the mid-1980s.²²⁶ In 1980, for example, a relatively sparse monitoring network measured 64 and 124 days, respectively, violating the federal and state ozone standards.²²⁷ To put these conditions in perspective, the federal ozone standard allows for an average of *one* violation per year of the 1-hour concentration threshold of 0.12 ppm.²²⁸

The resulting pollution is unsightly. On summer days, smog engulfs the Valley in an ugly brownish haze and migrates eastward into the Sierra Nevada mountain range, obscuring the otherwise spectacular vistas of Yosemite, Kings Canyon and Sequoia national parks and damaging the health of forests on the Sierra Nevada's slopes.²²⁹

%20Progress.pdf.

224. See EPA, Plain English Guide to the Clean Air Act, at <http://www.epa.gov/air/urbanair/ozone/what.html> (last visited Mar. 5, 2004) (providing the following heuristic equation for ozone formation: NOx + VOCs + Heat + Sunlight = Ozone. In reality, the relationships are more complicated and nonlinear, but these are indeed the vital ingredients.).

225. Ozone is not the San Joaquin Valley's only air quality problem. Especially in winter, the valley also has frequent violations of federal and state standards for particulate matter. See *Last Gasp*, *supra* note 215; see also Air Resources Board, Top 4 Measurements and Days Above the Standard, available at <http://www.arb.ca.gov/adam/cgi-bin/db2www/adamtop4b.d2w/start> (providing air quality data summaries by air basin or county) (last visited June 26, 2005).

226. Whitten et al., Application of the Urban Airshed Model to Kern County: Final Report 1 (1985) ("During the three years from 1982 through 1984, concentrations at the Edison monitoring station exceeded the NAAQS for ozone (0.12 ppm) on 19, 17, and 23 days, respectively."); see SJVUAPCD, Amendment to the SJV Ozone Plan and Severe versus Extreme Nonattainment Area, public workshop, Jan. 8, 9 and 16, 2002, slide numbers 11, 12 and 13, available at <http://www.valleyair.org/Workshops/postings/01-16-02/2002%20Amendment%20Presentation.pdf>; DONALD BLUMENTHAL ET AL., SOUTH SAN JOAQUIN VALLEY OZONE STUDY: DRAFT FINAL REPORT iii (1985) (report prepared by the Western Oil and Gas Association).

227. See California Air Resources Board (providing California state standards), at <http://www.arb.ca.gov/adam/cgi-bin/db2www/adamtop4b.d2w/start> (last visited Mar. 5, 2004).

228. EPA, National Ambient Air Quality Standards, at <http://www.epa.gov/air/criteria.html> (last visited Mar. 5, 2004).

229. See SIERRA NEVADA ECOSYSTEM PROJECT, FINAL REPORT TO CONGRESS, ch. 9, at 136 (1996), available at http://ceres.ca.gov/snep/pubs/web/v1/cho9/v1_cho9_01.html.

Southern airsheds on the west side [of the Sierra Nevada] are heavily impacted in spring, summer and fall by ozone and small particles derived from Central Valley sources and have some of the poorest air quality in the nation. . . . Extensive ozone damage occurs to sensitive tree species in the southwest and central-western slopes. . . . Visibility is severely degraded for much of the western slope during spring, summer and fall by fine particle sulfates, nitrates, and smoke transported from the Central Valley.

Id.; Mark Grossi et al., *Smog Lurks Even Up High*, FRESNO BEE, Dec. 15, 2002, at 6; Polakovic, *supra* note 212 (Sequoia National Park "now has the most polluted skies of any national park in the country.").

The pollution is also costly and dangerous. Ozone is a photochemical oxidant, and it reduces crop productivity and damages ecosystems.²³⁰ Ozone also aggravates, and may contribute to the onset of, asthma; and asthma rates in the San Joaquin Valley are astronomical.²³¹ Non-asthmatics also suffer; high ozone levels can place anyone at risk, causing temporary irritation, shortness of breath, and, if exposures are repeated over the long term, scarring of lung tissues and exacerbation of chronic health problems.²³²

4. *The Regulators*

Federal, state, and local authorities all have responsibility for managing air quality in the SJV. The jurisdictional boundaries between these separate authorities are complex and not entirely intuitive, and although the regulators endeavor to work together, planning processes remain complicated by some balkanization of authority.²³³ The interplay of federal and state law further complicates the process. While federal law primarily drives SIP planning, provisions of the California Clean Air Act also affect the choices of air quality regulators.

EPA sets the air quality standards that regions must meet, determining the ultimate goals of the SIP process.²³⁴ EPA also directly regulates some pollutant sources, and the nature of its regulations can have profound effects upon the ability of local entities to meet the federal air quality standards.²³⁵ In the Central Valley, for example, EPA's regulations on small engines and interstate trucks have crucial effects upon regional air quality.²³⁶ EPA also has the ultimate authority to approve or reject state air quality plans, and thus controls the final decision-making step in the air quality planning process.²³⁷

The California Air Resources Board (CARB) is California's statewide air quality management agency.²³⁸ It is responsible for

230. See ATTAINMENT PLAN, *supra* note 15, at 1-1 ("It is estimated that the Valley's agricultural crop losses exceed \$150 million due to exposure to ozone.")

231. Rob McConnell et al., *Asthma in Exercising Children Exposed to Ozone: A Cohort Study*, 359 THE LANCET 386 (2002), available at <http://www.niehs.nih.gov/centers/2002News/news4.htm> (finding increased asthma risk among children who exercised in areas with high ozone concentrations. The study was jointly conducted by researchers from the University of Southern California, The National Institute of Environmental Health Sciences, and the California Air Resources Board); Barbara Anderson, *Asthma Steals Joys of Childhood*, FRESNO BEE, Dec. 15, 2002, at 7.

232. See ATTAINMENT PLAN, *supra* note 15, at 1-1, iii; Barbara Anderson, *Dirty Air Puts Everyone at Risk*, FRESNO BEE, Dec. 15, 2002, at 11.

233. See San Joaquin Valley Unified Air Pollution Control District, *The Jurisdictional Puzzle*, available at http://www.valleyair.org/General_info/aboutdist.htm (last visited Jan. 21, 2004).

234. 42 U.S.C. § 7409 (2000); ATTAINMENT PLAN, *supra* note 15, at 1-4.

235. See 42 U.S.C. § 7511(b) (2000); ATTAINMENT PLAN, *supra* note 15, at ii-iv.

236. ATTAINMENT PLAN, *supra* note 15, at ii-iv.

237. 42 U.S.C. § 7410(k); ATTAINMENT PLAN, *supra* note 15, at 1-4.

238. See generally California Air Resources Board, at <http://www.arb.ca.gov/homepage.htm> (last visited Jan. 14, 2004).

integrating local plans developed by individual air districts into the state's SIP, and then for submitting the state's SIP to EPA.²³⁹ Like EPA, it also directly regulates some statewide emissions sources, such as pesticides,²⁴⁰ and uses its expertise to assist local air districts in their planning efforts.

The San Joaquin Valley Unified Air Pollution Control District (SJVUAPCD) is the primary local entity responsible for air quality protection. Regional air districts like the SJVUAPCD are responsible for developing the portions of the state SIP that address regional stationary and mobile source controls.²⁴¹ In addition, in coordination with local transportation planning agencies, the local air districts are responsible for developing transportation management controls.²⁴² Ultimately, the controls developed by the local agencies must be integrated by CARB into the state SIP and then approved by EPA.²⁴³

Because of the region's geography, the SJVUAPCD isn't the only local air district with de facto regulatory authority over San Joaquin Valley air quality. The Bay Area Air Quality Management District and air quality management districts in the northern part of the Central Valley set their own policies, and prevailing winds ensure that those policies affect air quality in the SJV.²⁴⁴

In practice, some of these functions are somewhat integrated. Both CARB and EPA personnel generally play advisory roles throughout the local air districts' planning processes.²⁴⁵ Because EPA has the power to reject the state SIP, its advice carries significant weight, and local agencies tend to involve CARB and EPA throughout the planning process rather than risk disagreement at the process's end.²⁴⁶ EPA and

239. 42 U.S.C. §§ 7407(a), 7410(a) (2000); ATTAINMENT PLAN, *supra* note 15, at 1-4.

240. ATTAINMENT PLAN, *supra* note 15, at ii, iv.

241. *Id.* at 1-4. As a practical matter, the SIP development efforts by local agencies must account for many regulations that are beyond those local agencies' power to implement or control.

242. *Id.*

243. *Id.*

244. *See id.* at ii, v-vii ("[I]t is clear that the San Francisco Bay Area and the Sacramento Valley Air Basins are responsible for a significant portion of the ozone in the San Joaquin Valley . . . For the air quality to improve in the Valley, the BAAQMD needs to acknowledge its responsibility as a transporter of pollutants."). *But see Don't Blame San Francisco*, *supra* note 217 (questioning the extent to which San Francisco Bay Area emissions can be blamed for the San Joaquin Valley's pollution problems).

245. ATTAINMENT PLAN, *supra* note 15, at 1-6.

The District's ozone model . . . was developed in partnership with the EPA, state and local government and industry. Many parties that contributed funds have participated in directing a study of an appropriate ozone event in the development of a photochemical grid model appropriate for the San Joaquin Valley. . . . The model was developed in accordance with the EPA and the ARB modeling guidelines, and with the active participation of both agencies.

Id.

246. Interview with Carol Bonnenkamp, Environmental Engineer, EPA, in Oakland, Cal. (July 19,

CARB also supply technical expertise; in the 1990s, for example, CARB personnel carried out the SJVUAPCD's modeling effort.²⁴⁷ The local authorities also have the ability to lobby CARB and EPA if state or federal source regulations could be changed to better promote compliance.²⁴⁸ Nevertheless, the SIP planning process remains primarily dependant on work done by the local agencies, although those local agencies must make decisions based partly upon the projected success or failure of the regulatory policies of other entities.²⁴⁹

Discussion of the air quality regulators in the SJV would be incomplete without some mention of the regulated industry, for some industries have traditionally been heavily involved in Valley air quality regulation. Regulated industry associations funded early air quality research in the SJV.²⁵⁰ The associations continue to fund research, and many personnel from regulated industries have been advisors in planning processes.²⁵¹ Both the Valley's traditionally pro-business regulatory climate and realistic fears of industry-funded legal challenges have given regulators reason to proactively involve industry in the regulatory process.²⁵² Thus, many industry representatives wear multiple hats in the planning process, serving as advisors, commentators, and, potentially, as

2001). Ms. Bonnenkamp described her early and continued involvement in the SJV SIP process:

[Y]ou're working with [the Air District] to try to negotiate how quickly you can respond [to deadlines in the Act]. We're trying to figure out what [the Air District] is trying to prove with the modeling. It sounds like it would be straightforward, but it's not. You have meetings with the State, local agency and any consultants just to flesh out what we see as the issues, where we're going to go, and how it's going to shape up.

247. ATTAINMENT PLAN, *supra* note 15, at 5-8 to 5-14. CARB and SJVUAPCD list modeling "caveats" and "concerns" separately, and throughout the plan CARB is described as conducting the simulations. *See, e.g., id.* at 5-1 ("According to the ARB analysis . . .").

248. *See* ATTAINMENT PLAN, *supra* note 15 (repeatedly emphasizing the need for state and federal controls). *But see* Mark Grossi et al., *A History of Delays*, FRESNO BEE, Dec. 15, 2002 at 3 (noting that local regulators have also lobbied federal and state authorities to delay regulation), *available at* 2002 WL 2016854.

249. *See Last Gasp, supra* note 215 ("Officials at the San Joaquin Valley Air Pollution Control District hasten to say they have no control over 60% of the problem—vehicles, which are regulated by federal and state officials.").

250. *See* BLUMENTHAL ET AL., *supra* note 226.

251. *See infra* note 264 (showing the membership of the SJVUAPCD's technical and policy advisory committees).

252. *See A History of Delays, supra* note 248 ("Environmentalists say the Valley air district also has buckled in the face of political flak, especially from industries."). The involvement of the Western States Petroleum Association (WSPA) exemplifies how the threat of litigation provides impetus for seeking early participation of industry. WSPA partially funded SARMAP development, and WSPA representatives served on the advisory committees, requested specific modeling runs, and submitted comments upon the Attainment Plan (all within public view; we do not mean to imply that WSPA's involvement was clandestine or improper). When EPA rejected one element of that plan that the WSPA had specifically sought and obtained from SJVUAPCD, it sued; that lawsuit is ongoing. *See infra* note 283 (describing EPA's revocation of the exemption for petroleum facilities on the west side of the valley and WSPA's subsequent lawsuit).

litigants.²⁵³

C. DEVELOPMENT OF THE 1994 AIR QUALITY PLAN

1. *Early Research and Planning Efforts in the SJV*

Air pollution problems in the Central Valley did not begin in the 1990s; early travelers noted the region's pervasive dust problems,²⁵⁴ and even in the late 1970s and early 1980s air quality measurements revealed that the region's air quality was frequently violating state²⁵⁵ and federal standards.²⁵⁶ Industry-funded air quality research commenced in the early 1980s,²⁵⁷ eventually leading to the San Joaquin Valley Air Quality Study (SJVAQS), an inter-agency, multi-stakeholder, well-funded study intended to produce a state-of-the-science air quality model and supporting observational database.²⁵⁸ Unfortunately, a lack of sufficient regulatory interest, as well as the need to gather more data to understand the problem, delayed early and effective regulation.²⁵⁹

253. Steve Ziman, a representative of Chevron-Texaco and a participant on the SJVUAPCD's Technical Advisory Committee, explained:

The Technical Committee, for which I am one of the industry representatives, has been responsible for management of the design, development, and implementation of the studies. Field programs, data analysis, and so forth. All of these things which then become the basis for carrying out SIP development. Our role ends nominally at the point at which decisions are made as to how a control strategy will be adopted for the SIP. At that point, my role changes to that of representing the industry in the formal and informal proceedings that lead to final adoption. We will comment on the strategies, the individual measures within the strategies, etc.

Interview with Steve Ziman, Senior Staff Scientist, Air Issues, and Technology, Chevron-Texaco, in Richmond, Cal. (July 12, 2001).

254. *Last Gasp*, *supra* note 215, at 2 ("Pioneer William Brewer gazed across the Valley in the 19th century and saw haze and dust—lots and lots of dust. 'Dust fills the air. . . . It covers everything,' Brewer wrote in his journal. 'I cannot conceive of a worse place to live.'").

255. The California Clean Air Act of 1988 established state air quality goals for ambient concentrations of the criteria pollutants. Clean Air Plans (CAPs) are required when observations reveal violations. Cal. Health & Safety Code § 40911. Models need not be used to support these plans, nor are planning or attainment deadlines established in the CCAA. Instead, attainment must be reached by "the earliest practicable date," and precursor emissions must be reduced by five percent annually. If five percent reduction is deemed infeasible, then all "feasible measures" are to be implemented in an "expeditious" manner. Cal. Health & Safety Code §§ 40913, 40914.

256. *See supra* notes 226–27 and accompanying text.

257. *See* BLUMENTHAL ET AL., *supra* note 226.

258. CALIFORNIA AIR RESOURCES BOARD AND SAN JOAQUIN VALLEY UNIFIED AIR POLLUTION CONTROL DISTRICT, SAN JOAQUIN VALLEY AIR QUALITY STUDY POLICY—RELEVANT FINDINGS (1996) [hereinafter SJVAQS POLICY—RELEVANT FINDINGS]. The SJVAQS's model, called SARMAP, was used as the basis for the 1994 Ozone Plan. ATTAINMENT PLAN, *supra* note 15, at v.

259. *See A History of Delays*, *supra* note 248 ("The Valley's last 30 years are littered with accounts of the federal government issuing proposals, edicts and threats to clean up the air, only to accept delays and compromise after meeting resistance. Industries, local elected officials and even state regulators have had a hand in the process."); *Decades of Dirty Air in the San Joaquin Valley*, FRESNO BEE, Dec. 15, 2002, at 4 (providing a timeline of regulatory actions, and discussing repeated delays, extensions, and missed deadlines); Polakovic, *supra* note 212 (describing how a pro-business climate, combined with decreasing legislative interest in air-quality protection, has led to ineffective air quality regulation in several areas of California). In 1982, California did approve an ozone control plan for the

2. *The 1994 Plan*

In 1990, Congress enacted major amendments to the Clean Air Act. By setting forth planning and air quality improvement deadlines for areas not meeting the ozone standard, these amendments mandated the planning processes of the 1990s. For “serious” nonattainment areas such as the SJV, an attainment plan was due by November 15, 1994, and the plan was to “demonstrate,” through modeling, that the ozone standard would be achieved by 1999.²⁶⁰ Failure to meet the planning deadline meant costly sanctions, including the loss of federal funds for highway construction and stricter permitting rules for any industry with potential pollutant emissions.²⁶¹

Efforts to meet the 1994 planning deadline had, as a practical matter, begun with the 1980s air pollution studies and initial attainment plans, but the coordinated planning effort officially kicked off in 1991, when several county air districts merged to form the SJVUAPCD.²⁶² Working closely with CARB, the SJVUAPCD assembled the policy advisory and technical advisory committees that would oversee the research effort and subsequent planning process.²⁶³ Primary responsibility for planning rested

San Joaquin Valley, but even while approving it, EPA predicted, correctly, that it would not achieve federal ozone standard. *Decades of Dirty Air in the San Joaquin Valley*, *supra*.

260. 42 U.S.C. § 7511(a)(1) (setting attainment deadlines), (c)(2) (setting planning deadlines for serious nonattainment areas), (c)(2)(A) (requiring the use of models); *see* ATTAINMENT PLAN, *supra* note 15, at 1-1. Despite the fact that most of the major planning efforts in the valley were driven primarily by federal law, the first post-Clean Air Act Amendments air quality management plan in the SJV was required by a state statute. SAN JOAQUIN VALLEY UNIFIED AIR POLLUTION CONTROL DISTRICT, 1991 AIR QUALITY ATTAINMENT PLAN 1-1 (1992). In 1991, the newly-created SJVUAPCD adopted an air quality management plan pursuant to requirements of the CCAA. *Id.* at 1-4. The plan called for “all feasible” measures to reduce air pollutant emissions, *id.* at 1-1, and was essentially a stop-gap document, functional only until a new plan could be constructed using improved scientific understanding and planning tools provided by the SJVAQS. *Id.* at 1-4.

261. One penalty for failure to promulgate an approved plan is a “conformity lapse.” The San Joaquin Council of Governments (SJCOG) described some of the consequences of such a lapse:

If the SJVUAPCD cannot develop an approved plan to meet the air quality standards, or if SJCOG can not show that we conform to the approved air district plan, federal transportation funds will be withheld. Even locally funded transportation projects on federal highways will be halted. Over \$56 million in projects are at risk in San Joaquin County alone.

SJCOG website, at <http://www.sjcog.org/sections/RACM/index.php>; *see A History of Delays*, *supra* note 248 (“In the Valley, about \$2.2 billion in projects would be jeopardized by a missed smog deadline.”); ATTAINMENT PLAN, *supra* note 15, at 1-3 to 1-4 (describing possible federal sanctions).

262. *See Decades of Dirty Air in the San Joaquin Valley*, *supra* note 259 (stating that the SJVUAPCD was formed following pressure upon the county air districts by federal and state regulators).

263. By design, the scientific research and development plan tasks were to be formally disconnected. SJVAQS POLICY—RELEVANT FINDINGS, *supra* note 258, at 7. The disconnect was planned for two important reasons: first, timelines did not match, because model improvements were to continue well beyond plan submission deadlines; and second, planners were concerned about perceived or real conflicts of interest, because industrial research sponsors also expected to incur hundreds of millions of dollars in plan compliance costs. *Id.* (“Participants also agreed not to defer air quality planning and control activities until the completion of the study, thereby averting questions

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with the SJVUAPCD itself, with substantial technical and policy assistance from CARB and some input from EPA.

a. *The Advisory Committees*

Neither advisory committee was representative of the public as a whole.²⁶⁴ Both were composed exclusively of government employees and

about the motivations of local and industrial groups participating in the study.”); *see also* THE ENDS OF UNCERTAINTY, *supra* note 130, at 268 (quoting Interview with John DaMassa, Chief, Modeling & Meteorology Branch, CARB Planning & Technical Support Division (May 22, 2001)) (“[T]he Technical Committee was involved with review and decisions regarding all of the technical aspects of the study. The Policy Committee . . . reviewed expenditures, progress, any decisions that needed to be made, the schedule, all of the policy level details. They controlled the budget.”).

264. SJVAQS POLICY—RELEVANT FINDINGS, *supra* note 258, apps. B and D, at 27, 29. The following table lists the members of the Policy and Technical Committees overseeing the SJVAQS:

SJVAQS Policy Committee

Name	Organization
Doug Vagim (Chair, 1995–)	CARB
Jaqueline Schafer (Chair, 1993–1994)	CARB
Jananne Sharpless (Chair, 1985–1993)	CARB
Gordon Duffy (Chair, 1983–1985)	CARB
Pauline Larwood (past member)	Kern County Supervisor
May Kay Shell	Kern County Supervisor
Judy Andreen (past member)	Fresno County Supervisor
Dave Howekamp	EPA Region IX
Phil Brady	U.S. Department of Defense
Brenda Mohn	U.S. Department of Defense
Les Clark	Independent Oil Producers Agency
Bill Brommelsiek	Chevron U.S.A.
Catherine Reheis	WSPA
Dave Crow	SJVUAPCD
Bill Harper	Shell Oil (CalResources)
John Torrens	Pacific Gas & Electric
Manuel Cunha	Nisei Farmers League
Peter Mueller	Electric Power Research Institute
Jon Kennedy	U.S. Forest Service
Jan Bush	BAAQMD
Tom Nichols	National Park Service
Jack Lagarias	CARB Board Member

representatives of private industry; their membership did not include any representatives of public interest advocacy organizations.²⁶⁵ The technical advisory team was even less representative; it was composed exclusively of regulators and industry representatives.

b. *The Modeling and Plan Development Process*

With its research and planning teams in place, the SJVUAPCD began the process of developing its attainment plan. Sub-groups set

Valerie Nera	State Chamber of Commerce
Kennan Beard	Beard Land Development
Merlin Fagan	California Farm Bureau
Donald Gordon	Agricultural Council of California
Gordon Kennedy	Private Citizen
James Boyd	CARB

Technical Advisory Committee

Name	Organization
Andrew Ranzieri (Chair)	CARB
Dick Thuillier	Pacific Gas & Electric Company
Paul Solomon	Pacific Gas & Electric Company
Steven Ziman	Chevron U.S.A.
Alan Hansen	Electric Power Research Institute
Carol Bohnenkamp	EPA Region IX
Robin DeMandel	BAAQMD
James Sweet	SJVUAPCD
Linda Chester (former member)	Kern County APCD
John Vimont (former member)	EPA
Philip Roth (Principal Investigator)	Envair
John Watson (Principal Investigator)	Desert Research Institute

APCD = Air Pollution Control District

BAAQMD = Bay Area Air Quality Management District

CARB = California Air Resources Board

CCEEB = California Council for Environmental and Economic Balance

EPA = Environmental Protection Agency

SJVUAPCD = San Joaquin Valley Unified Air Pollution Control District

WSPA = Western States Petroleum Association

265. *Id.* The few elected officials on the Policy Committee were charged, of course, with representing the public. Given the San Joaquin Valley's traditionally pro-business climate, however, and the history of anti-regulatory lobbying by local elected officials, see *A History of Delays, supra* note 248, we do not assume that a local elected official will necessarily be a strong clean air advocate.

about developing a modeling approach—which meant deciding on a modeling system to be used and on an ozone event to simulate—estimating emissions, identifying emissions reductions options, and simulating those reductions using the model.

Typically, modelers attempt to demonstrate future compliance by assessing how future air quality would fare if a past meteorological event repeated itself after implementation of proposed emissions controls.²⁶⁶ Modelers also use that same event to test the model itself; by improving the model's simulations of that past event, they attempt to assure themselves of its ability to predict future outcomes. The past event is generally an extended period of unfavorable weather for air quality—that is, weather that represents a worst-case scenario for generating ozone pollution.²⁶⁷ The planners settled upon a particularly severe week-long pollution event in August 1990,²⁶⁸ and then began preparing the input data to perform a modeling simulation of that event.²⁶⁹ The Technical Committee worked with planners to develop a modeling protocol that described the event and the modeling components to be used.²⁷⁰

Once the simulation dates were specified, planners at the SJVUAPCD and CARB's Planning and Technical Support Division

266. ATTAINMENT PLAN, *supra* note 15, at 2-10 (“The purpose of the ozone model is to predict the effect of changes in emissions on ozone level. But before a model can be used for that purpose, it must be shown to be valid for the area. This has been accomplished by simulating an observed episode of high ozone levels.”).

267. *See id.* at 1-5 to 1-6. In fact, the event simulated had a peak observed ozone concentration of 0.160 ppm, but the design value (the fourth-worst ozone level observed over the previous three-year period) for the region was 0.17 ppm. *See id.* at 1-2. Thus, the event simulated was not as severe as the “worst” ozone conditions observed. Furthermore, the SAQM modeling simulation computed peak ozone values of 0.142 ppm, which is 0.018 ppm (11%) below the observed peak during the simulated event, and 16% below the design value. *See* John DaMassa et al., *Performance Evaluation of SAQM in Central California and Attainment Demonstration for the August 3–6, 1990 Ozone Episode*, 71, 72–74 (1996). Therefore, the task of “demonstrating” attainment with the modeling was made easier by modeling ozone conditions that were not as severe as the worst conditions observed.

268. Warm and stagnant wind conditions allowed pollutant concentrations to build until peak ozone concentrations of nearly 0.160 ppm were observed. *See also* DaMassa et al., *supra* note 267, at 17–22 (describing the meteorology and air quality during the ozone event). Domain-wide, ozone peaks were observed in and near Fresno and Bakersfield on the last two days of the event. *Id.* For a discussion of the chemical transformations and physical processes associated with the high ozone events observed in August, 1990, see Betty K. Pun & Christian Seigneur, *A Conceptual Model for Ozone Formation in the San Joaquin Valley*, Dec. 15, 1998, at 3-1 to 3-12 (chemical transformations), 4-1 to 4-8 (physical processes); ATTAINMENT PLAN, *supra* note 15, at 2-10 to 2-11; *see also* Donald E. Lehrman et al., *Meteorological Analysis of the San Joaquin Valley Air Quality Study, Atmospheric Utilities, Signatures, Predictions and Experiments* (1996).

269. ATTAINMENT PLAN, *supra* note 15, app. C (Modeling Protocol); *id.* ch. 2, at 2-10 to 2-11 (describing of the simulation of the August 4–6, 1990 ozone episode).

270. ATTAINMENT PLAN, *supra* note 15, app. C at C-4 (presenting the modeling protocol and describing plans for two basecase simulations: July 27–29 and August 3–6 in 1990; only the August episode was reported in the Plan).

went about compiling baseline data for the modeling.²⁷¹ They attempted to identify, locate, and quantify all emissions sources that had existed in 1990. They also attempted to do the same for all sources anticipated to exist, in the absence of further controls, in 1999.²⁷² Once the sources were located and quantified, the group “mapped” them, translating emissions data, as well as information about ambient meteorological conditions, into geo-coded formats the model could accept as input.²⁷³

The group’s work involved constant dialogue and consultation with industry, local and state governments, and in some instances consultants.²⁷⁴ The inventory group also published and made publicly available its draft emissions inventory, and that draft inventory received careful scrutiny from regulated industries and the SJVAQS Technical Committee.²⁷⁵

Somewhat concurrently, CARB and SJVUAPCD planners identified potential future emissions controls. Essentially, this group’s task was to identify and develop potential new “rules” and to estimate resultant emissions reductions.²⁷⁶ The planners provided quantitative estimates of emissions reductions, timelines for when those reductions

271. See DaMassa et al., *supra* note 267, at 44–53 (describing modeling inputs preparation, including meteorology, emissions and boundary and initial conditions).

272. See ATTAINMENT PLAN, *supra* note 15, at 2-1 (“To develop a strategy to provide healthy air, the District relies on preparation of inventories that identify the sources of emissions and their contribution to local air pollution.”); *id.* at app. D (describing the preparation of emissions estimates); *id.* ch. 3 (discussing emissions controls already planned, and their air quality effects. Pages 3-1 to 3-4, notably Table 3-2 on page 3-2, identify anticipated emissions reductions, and model simulation results 3-4 to 3-14 of the “1999 Base Case.”).

273. Interview with James Sweet, Air Quality Planner, SJVUAPCD, Fresno, Cal. (June 20, 2001). Mr. Sweet explained the process of information exchange between himself, analysts at CARB, and consultants:

[T]he way the emissions inventory worked at that time, all we could do is send up submittals to ARB. ARB put it into their system. They then had to send that information off to Alpine Geophysics to get the gridding done. They sent that back to ARB. We got ARB staff in the modeling section to do the summary reports for us so we could do QA. We then had to contact the emissions sections and Alpine to figure out why the numbers weren’t what we expected, produce a recommendation for change, send it back to ARB. That was our process.

Id.

274. See THE ENDS OF UNCERTAINTY, *supra* note 130, at 262–73 (describing the networks involved in the production of the Attainment Plan).

275. See *id.* at 272–73 (describing the iterative process of developing and checking the “approved” inventory, and public notice steps that hindered modifications to the inventory).

276. See ATTAINMENT PLAN, *supra* note 15, at 4-2 to 4-13 (describing proposed local rules), 4-13 to 4-16 (describing proposed state and federal rules). Both EPA and CARB provide guidance for developing rules. For example, EPA’s “Bluebook” and “Little Bluebook” provide guidance for use by air districts in developing rules that meet federal requirements for inclusion in SIPs. See OFFICE OF AIR QUALITY PLANNING, EPA, ISSUES RELATING TO VOC REGULATION CUTPOINTS, DEFICIENCIES AND DEVIATIONS—CLARIFICATION TO APPENDIX D OF NOV. 24, 1987 FEDERAL REGISTER (1988) (the “Bluebook”), available at <http://www.epa.gov/oar/oaqps/bluebook/>; Rulemaking Office, Air Division, Region IX, EPA, *Guidance Document for Correcting VOC and Other Rule Deficiencies* (2001) (the “Little Bluebook”), available at <http://www.epa.gov/Region9/air/sips/littlebluebook2001.pdf>.

would be achieved, and estimates of how much the reductions would cost.²⁷⁷

Once the modelers had chosen their modeling event, and once the planners believed they had run out of time to continue improving the emissions inventory, the modelers began executing the modeling simulations. Their first task was to determine the adequacy of the model itself, which they did by evaluating its ability to simulate observations gathered during the August 1990 ozone event. The modelers had not completed model performance evaluation to their satisfaction when time constraints necessitated initiating the planning simulations.²⁷⁸ The simulation was sufficiently accurate to meet EPA and CARB guidelines for model approval, however, and, with the knowledge the models necessarily do imperfect work, the modelers decided to proceed with simulating the 1999 predictions.²⁷⁹ Using the approved emissions inventories and the emissions reduction options developed by the control rules group, the modelers predicted air quality in the absence of additional emissions controls and using various combinations of proposed rules, with the goal of finding a set of rules sufficient to efficiently achieve compliance.²⁸⁰

Again, regulated groups were heavily involved. The planners and modelers consulted the advisory committees throughout this process,²⁸¹

²⁷⁷. The SJVUAPCD, CARB, neighboring air districts, and transportation planning agencies are all involved in identifying, promulgating and implementing emissions control rules. See ATTAINMENT PLAN, *supra* note 15, at iii-vi (discussing federal, state and other air districts' responsibilities).

²⁷⁸. *Id.* at 2-10 to 2-13, 5-13 ("Full performance evaluation of the model has not been completed.").

²⁷⁹. See Interview with Steve Ziman, *supra* note 253.

We had [SARMAP] developed for [the SJVAQS] and we were comfortable to the extent that we could be. But, we were also uncomfortable because in the midst of trying to do a reasonable performance evaluation we were forced by the agency to drop everything and just do the SIP because of the time frame. And, so we never finished the evaluation to the degree it should have been done.

Id.

²⁸⁰. See ATTAINMENT PLAN, *supra* note 15, at 1-7 (describing the process of using the model to test proposed rules); *id.* at 3-4 to 3-5 (describing simulations that assumed that no controls beyond those already approved would be imposed); *id.* at 4-1 to 4-2 (describing further modeling including proposed rules). Rather than testing rules randomly, the modelers began by running tests designed to determine whether they should primarily target their efforts at reducing NOx or VOC emissions. *Id.* at 2-16 to 2-17. They concluded that they could more efficiently reduce ozone levels by targeting NOx emissions. *Id.* They also determined that they would achieve most of their emissions reductions through existing or already-approved rules; according to the attainment plan, the proposed new rules would play a relatively minor role in achieving compliance. *Id.* at 4-2.

²⁸¹. Unfortunately, SJVAQS meeting minutes and other documentation are not available; SJVUAPCD staff informed one of the authors that CARB had accidentally recycled the boxes containing those records. Two SJVAQS technical committee members—James Sweet, the modeling specialist at the SJVUAPCD, and Andrew Ranzieri, manager of the Planning and Technical Support Division (i.e., modeling division) at CARB—also oversaw the modeling effort for the Attainment Plan development, so there was extensive overlap between the technical committee and agency modelers and planners. When commenting on an early version of this paper, James Sweet further described the

and the Western States Petroleum Association requested specific modeling runs.²⁸² When the modeling runs predicted compliance even without controls on petroleum facilities on the west side of the SJV, controls on those facilities were excluded from the plan.²⁸³

The SJVUAPCD predicted that both existing and future rules would achieve substantial emissions reductions, and it identified several “contingency” measures.²⁸⁴ Nevertheless, a model attainment “demonstration” was not possible until modifications were made to boundary conditions values (i.e., assumptions about upwind air quality conditions).²⁸⁵ Few involved in plan development were particularly

challenges associated with documenting for public review the technical efforts of the staff.

Technical Committee meetings were typically six to eight hour working meetings, which were not documented by detailed minutes but rather by updated version of the related planning or analysis document that reflected discussions. . . . Since the Technical Committee meetings were frequently working sessions or presentations of updates by contractors, minutes cannot effectively capture the proceedings.

Letter from James Sweet, Air Quality Planner, SJVUAPCD, to James Fine (July 15, 2004) (on file with author).

282. Memorandum from David Crow et al. to SJVUAPCD (Nov. 14, 1994) (describing the request for the modeling run, which WSPA made at the Nov. 3 Board meeting); Interview with Steve Ziman, *supra* note 253 (“[SJVAQS participants] agreed that the sponsors of the study had the right to ask for modeling runs to be made to address certain issues. And we took that up in 1994 when the San Joaquin Valley had to decide whether or not to implement NOx controls on sources on the west side of the valley.”).

283. In this modeling simulation, the anticipated NOx reductions from oilfields in the areas west of Interstate 5 in Kern, Kings and Fresno Counties were not included and the simulation still showed attainment, so the SJVUAPCD concluded that the oilfield reductions were “not needed to reach the federal ozone standard.” ATTAINMENT PLAN, *supra* note 15, at 4-34. Consequently, the final plan does not call for implementation of rules 4305, 4702 and 4703 at west side oilfields. Furthermore, staff at the SJVUAPCD saw little reason to seek inclusion of these controls in the Attainment Plan because they were already included amongst the list of control measures to be implemented in pursuit of the state ozone standard. See SAN JOAQUIN VALLEY UNIFIED AIR POLLUTION CONTROL DISTRICT, 1991 AIR QUALITY ATTAINMENT PLAN, *supra* note 260, at 7-91. A coalition of environmental groups subsequently filed a lawsuit that led EPA to overturn this federal exemption. See Revisions to the California State Implementation Plan, San Joaquin Valley Unified Air Pollution Control District, EPA, 40 C.F.R. Part 52 (2002); Earthjustice, *San Joaquin Valley Oil Industry Seeks Oil Pollution Exemption*, July 10, 2002, available at <http://www.earthjustice.org/news/display.html?ID=399>. The Western States Petroleum Association then sued seeking to have the exemption reinstated, and several environmental groups have intervened in the lawsuit. Earthjustice, *supra*. The controls ultimately were imposed pursuant to state law requiring imposition of “every feasible measures” to control emissions. SAN JOAQUIN VALLEY UNIFIED AIR POLLUTION CONTROL DISTRICT, 1991 AIR QUALITY ATTAINMENT PLAN, *supra* note 260, at 1-2.

284. ATTAINMENT PLAN, *supra* note 15, at 4-1 to 4-23 (describing control measures, including summary tables at 4-19 to 4-23); *id.* at 4-24 to 4-30 (describing contingency measures, including a table at 4-30 listing contingency measures).

285. *Id.* at ii (“The model has predicted a District-wide attainment of the federal ozone standard by 1999.”). In an interview at the SJVUAPCD, Mr. David Jones said:

Initially, the modeling didn’t show attainment. When we were contemplating what else we could do, the decision was made to change some of the boundary conditions and some of the wind patterns. When they did that, all of the sudden we were down below 0.120 ppm.

Interview with David L. Jones, Planning Director, SJVUAPCD, in Fresno, Cal. (June 20, 2001). The decision to change boundary conditions occurred only after extensive dialogue amongst staff at

confident in this assertion; many were skeptical about the ultimate efficacy of the rules they had selected.²⁸⁶ With deadline pressure remaining intense, however, the planners felt obliged to use the modeling as the basis for their plan.²⁸⁷

c. *Approval of the Plan*

In October 1990, the SJVUAPCD made the draft plan available for public comment and held a public workshop.²⁸⁸ A hearing followed, but public comments, other than statements from those already involved to some extent in the process, did not. The minutes from subsequent board hearings reveal an almost complete absence of participation from public interest groups or from the general public, and very little specific criticism of the plan except from regulated industry.²⁸⁹ The interests involved in the hearings were similar to those already represented in the advisory and technical committees.²⁹⁰

SJVUAPCD, CARB and EPA. E-mail from James Sweet, Air Quality Planner, SJVUAPCD, to James Fine (July 17, 2004) (on file with author). Though the change had the convenient result of facilitating the modeled attainment demonstration, staff at the SJVUAPCD note that the intent of these changes was to “let the model speak for itself,” rather than to tinker with assumptions until the model produced desired results. *Id.*

286. See THE ENDS OF UNCERTAINTY, *supra* note 130, at 274.

I’m pretty big on model performance evaluation. Every model should be challenged. In fact, I would like it if, when you pop up a model result, decision-makers would ask, “Why should I believe this modeling?” When asked if decision-makers posed that question for the 94 Ozone Plan, he replied, “No. They didn’t. Hardly anyone asked that question. Most people don’t want to know. They just want the result.”

Id. (quoting Don McNerny, Supervisor, CARB Planning and Technical Support Division.) “[I]f someone was going to bet me a thousand dollars that the plan was going to attain, I would have said, ‘You’ve got to give me long odds.’” Interview with Michael Scheible, Deputy Executive Officer, CARB, in Sacramento, Cal. (Sept. 18, 2001).

287. See THE ENDS OF UNCERTAINTY, *supra* note 130, at 298 (“[W]e’re under a sanctioned timeline to produce a plan that includes modeling. In essence, we don’t have the luxury of time, we don’t have unlimited resources. We’re going to go with what we’ve got when it comes down to it.”) (quoting Scott Nester); Interview with Lynn Terry, *supra* note 138 (“As ARB staff, we tend to be pragmatic; to say, ‘Our basic framework is use the best science you have and meet the deadline.’ Those are the two fundamental goals. So when you come to the Board with a SIP, the Board is assured that, with these drop-dead dates we have to do the SIP, we’ve used the best information we have.”).

288. Crow et al., *supra* note 282, at 1–2.

Due to time constraints imposed by the ARB’s scheduled SIP adoption hearing dates of November 9 and 10, the District held one Valleywide workshop on October 21, 1994, at the District’s central office in Fresno. The Public Notice for this hearing was published on October 3, 1994, in newspapers in the eight county area. However, because the District was awaiting modeling results from ARB, the Plans were not made available to the public until October 11. Therefore, the additional hearing recommended for November 14, 1994, will afford the Board and the public a minimum of 30 days for review of the document. It will also allow the Board to adequately consider testimony concerning the Plan.

Id.

289. See generally *Last Gasp*, *supra* note 215 (stating that “bureaucrats have hardly heard a peep from the public in the board room”).

290. See *id.*; San Joaquin Valley Unified Air Pollution Control District, Action Summary, Minutes for the Governing Board Meeting, Nov. 3, 1994 (Nov. 14, 1994) [hereinafter Action Summary, Minutes for the Governing Board Meeting, Nov. 3, 1994]; San Joaquin Valley Unified Air Pollution Control

Following the public comment period, the SJVUAPCD made limited changes to the plan, submitting it on November 3, 1994, to the SJVUAPCD Board of Directors for final approval.²⁹¹ Unlike the advisory committees, the Board of Directors is not a technical body; most of its members are locally elected political representatives.²⁹² This non-technical review might have provided an opportunity for public advocacy, at least through representative proxies, but the board had little time to conduct a meaningful review. With the compliance deadline looming, and EPA and CARB reviews still pending, the technical staff urged a rapid approval in order to avoid the penalties that would result if the plan were not approved by November 15.²⁹³ The Board held two meetings to discuss the plan, but the only public discussion came from regulators and industry representatives.²⁹⁴ Even the board's decision to exempt the west side petroleum facilities from regulation provoked no meaningful public comment.²⁹⁵

The Board of Directors complied with the staff's request for a quick decision and approved the final attainment plan on November 14, 1994.²⁹⁶ CARB submitted the plan for EPA approval almost immediately thereafter.²⁹⁷

3. *The Contents of the Plan*

Ultimately, the SJVUAPCD Attainment Plan called for a host of

District, Action Summary, Minutes for the Governing Board Meeting, Nov. 14, 1994 (Dec. 15, 1994) [hereinafter Action Summary, Minutes for the Governing Board Meeting, Nov. 14, 1994].

291. See Action Summary, Minutes for the Governing Board Meeting, Nov. 3, 1994, *supra* note 290; Action Summary, Minutes for the Governing Board Meeting, Nov. 14, 1994, *supra* note 290.

292. See ATTAINMENT PLAN, *supra* note 15, cover page (listing members of the Governing Board).

293. Crow et al., *supra* note 282.

The Federal Clean Air Act Amendments (FCAAAA) of 1990 require the District to submit an Attainment Demonstration Plan by Nov. 15, 1994. Failure to submit an Ozone Attainment Demonstration Plan which complies with the provisions of the FCAAAA can lead to sanctions including the imposition of a 2 to 1 emissions offset ration on the District and the loss of federal highway funds.

Id.

294. Action Summary, Minutes for the Governing Board Meeting, Nov. 3, 1994, *supra* note 290; Action Summary, Minutes for the Governing Board Meeting, Nov. 14, 1994, *supra* note 290.

295. Action Summary, Minutes for the Governing Board Meeting, Nov. 14, 1994, *supra* note 290. This absence of comment may be due, in part, to the fact that the modeling runs that facilitated this change were not even requested until the November 3 meeting, and the modeling results were not available until just before the November 14 meeting. Crow et al., *supra* note 282.

296. Action Summary, Minutes for the Governing Board Meeting, Nov. 14, 1994, *supra* note 290.

297. CARB, Air Resources Board Approves the State Implementation Plan (SIP), Nov. 15, 1994.

The California Air Resources Board today approved and submitted to United States Environmental Protection Agency a plan designed to meet federal ozone standards as required by the 1990 Clean Air Act . . . This schedule will allow U.S. EPA to approve California's plan before the harsh FIP [Federal Implementation Plan] is due to be implemented on February 15, 1995.

Id. EPA did not approve the SIP until 1996. See Environmental Protection Agency, Approval and Promulgation of State Implementation Plans: California—Ozone, at <http://www.epa.gov/Region9/air/sipfinal/casip996.html>.

rule changes, and the SJVUAPCD predicted that those changes, in combination with existing rules and anticipated policy decisions by CARB and EPA, would meet the federal ozone standard by 1999.²⁹⁸ The planners sought to reduce both NO_x and VOC emissions by regulating a wide range of industrial activities.²⁹⁹ The planners also placed heavy reliance upon emissions reductions from rules imposed by other regulatory entities,³⁰⁰ and in particular assumed that declining emissions from upwind areas would provide an important boost toward compliance.³⁰¹

The plan quite deliberately did not, however, provide for much margin of error. The SJVUAPCD exempted the petroleum facilities on the west side of the Valley from regulation under the SIP, believing that it could not legally justify controls that were not essential to obtaining a modeled attainment demonstration.³⁰² Similarly, it did not impose any controls designed to provide a margin of error, instead describing controls beyond those necessary to achieve a hairs-breadth compliance margin as “excessive.”³⁰³ The plan noted that efforts to improve the model would be ongoing,³⁰⁴ and included some contingency rules to be developed if further regulation proved necessary.³⁰⁵ Although the contingencies could provide some flexibility in the event that the plan did not succeed, the plan still created very little margin for error.

298. ATTAINMENT PLAN, *supra* note 15, at 4-30.

299. *See id.* at 4-2 to 4-13 (describing proposed local rules).

300. *Id.* at 3-1 (showing anticipated emissions reductions from rules already adopted, as of 1994, both within and outside the district’s jurisdiction); *id.* at 4-1 (anticipating that existing federal, state, and local controls would help facilitate attainment).

301. *Id.* at 4-28 (predicting improvement in boundary conditions based upon statewide emissions reductions).

302. *See supra* notes 283–84 and accompanying text; Interview with James Sweet, *supra* note 273. Mr. Sweet explained how the District’s mission is to plan for no more than the emissions reductions needed to reach the federal ozone goal. “We want the model to tell us what we’re supposed to do. To accomplish our mission, which is to clean up the air without doing more than we need to do, without doing anything that is inappropriate.” *Id.* In an email to the authors, Mr. Sweet suggested that California Health and Safety Code sections 39602 and 40727 prevented the SJVUAPCD from going any further. E-mail from James Sweet, Air Quality Planner, SJVUAPCD, to James Fine (July 17, 2004) (on file with author). Those code sections prohibit the state from including in a SIP regulations that are not “necessary” but do not define what “necessary” means in the context of uncertain predictions. *See* Cal. Health & Safety Code §§ 39602, 40727 (2000). The authors believe that given the uncertainty surrounding the modeled predictions, the SJVUAPCD could reasonably have concluded that emissions control strategies providing for a margin of error were necessary to ensure compliance.

303. *See* ATTAINMENT PLAN, *supra* note 15, at 6-1.

304. *Id.* at 1-7 (predicting that strategy adjustments based upon model improvements would be minor); *id.* at 6-3 to 6-4.

305. *Id.* at 4-24 to 4-30. One of the proposed “contingency rules,” however, is merely a commitment to study additional transportation control measures. *Id.* at 4-24. The SJVUAPCD stated that “[s]ince the District has included all measures currently known to be feasible in its attainment demonstration, these measures have not undergone the review afforded the proposed control measures. Accordingly, their description and estimated reductions are subject to revision.” *Id.* *See generally* 42 U.S.C. §§ 7502(c)(9), 7511a(c)(9) (2000) (requiring contingency measures).

4. *Uncertainty in the Plan*

The attainment plan was based upon a host of uncertain model inputs. Because of deadlines and revisions to emissions estimates, the existing emissions inventory was known to have several uncertainties and omissions. Model predictions were known to be uncertain, but nobody knew how the uncertainties impacted predictions of future conditions.³⁰⁶ Together with assumptions about politics and engineering, unknowable future economic conditions introduced a further element of uncertainty; the planners simply had no way of predicting the economic boom that would create staggering levels of growth in upwind areas, and instead predicated their planning upon the assumption of declining levels of pollution from upwind activity.³⁰⁷ Additionally, like any model, SARMAP's usefulness could be compromised by erroneous or incomplete input data or by the inherent limitations created by basing a model upon just one potentially non-representative weather event.

On top of all of these uncertainties, the model itself, like all models, was a limited tool,³⁰⁸ and the Attainment Plan noted several ways in which the modelers viewed their tool as flawed.³⁰⁹ The modelers acknowledged that in the absence of tight deadlines they might have been able to generate a superior model.³¹⁰

All of these uncertainties threatened the reliability of the model prediction of attainment by 1999, but the plan's uncertainty discussions were far from comprehensive. The plan includes some blanket generalizations about the pervasiveness of uncertainty in modeling, but its discussion of particular sources of uncertainty was too general to allow a reader to discern how those uncertainties were managed or what economic and public health risks they might pose.³¹¹ The authors omitted discussion of some important sources of uncertainty, such as the contingent relationship between emissions reductions and rule enactment or economic growth. They addressed other sources of uncertainty in more detail, but without substantive discussion clarifying how those uncertainties might affect the result.³¹² A reader, even if able

306. See *supra* notes 117–20.

307. See ATTAINMENT PLAN, *supra* note 15, at 4-28 (predicting improvement in boundary conditions).

308. *Id.* at 5-7; see *supra* Part III.A.1.a.

309. ATTAINMENT PLAN, *supra* note 15, at 5-7 to 5-12.

310. Interview with Steve Ziman, *supra* note 253; THE ENDS OF UNCERTAINTY, *supra* note 130, at 298 (quoting Scott Nester).

311. ATTAINMENT PLAN, *supra* note 15, at 4-30 (“a number of uncertainties remain to be evaluated”); *id.* at 5-7 to 5-8 (providing general discussion of uncertainty, but not indicating how that uncertainty could affect regulations or compliance); *id.* at 6-2 to 6-3.

312. *Id.* at 5-8 to 5-9 (providing a list of “modeling caveats” but again not clarifying the ultimate significance of these caveats); *id.* at 5-9 to 5-10 (discussing “concerns” about boundary conditions, but not doing so in terms that allow a reader to understand the implications of these concerns). One

to understand the source of uncertainty, would have had no way of knowing whether it was likely to lead to overestimation or underestimation of actual pollutant levels, and a planner would have been without guidance about how to address model uncertainty when setting policy.

Where the Attainment Plan did identify both the existence and likely effects of major sources of uncertainty, it actually misconstrued the significance. The SJVUAPCD stressed that the model appeared to overestimate the amount of ozone created from precursor emissions.³¹³ Concerned about these overestimates, the SJVUAPCD wrote:

[t]he model replicated the observed levels of ozone using an emissions inventory that is known to have under estimations and omissions. This means that the model produced too much ozone either from the emissions inventory or from other supporting inputs such as the boundary conditions. . . . If the problem is not related to boundary conditions, but is related to the emissions inventory, then the model is overestimating the amount of ozone formed per ton of precursors produced. This would constitute a more severe problem challenging the validity of the basic model formulation. It would also have the effect of making the model predict future year ozone concentrations higher than it should.³¹⁴

The model was indeed overestimating ozone formed per ton of precursor emitted, but this flaw did not “have the effect of making the model predict future year ozone concentrations higher than it should.” Rather than leading to overestimations of future concentrations, and concomitant over-regulation, this model flaw could lead to *underestimation* of future ozone levels. Recall that the modelers’ objective is to show, using modeling, that planned controls will cause needed decreases in peak ozone levels. If ozone production is assumed to be overly sensitive to precursor emissions,³¹⁵ it may also appear, incorrectly, to be overly responsive to emissions reductions, and the effectiveness of future emissions controls will actually be overestimated.³¹⁶ As a result, the model could underestimate, not overestimate, the amount of regulation necessary to achieve

exception to this statement is the plan’s discussion of spatial resolution. The plan suggested that insufficient spatial resolution might lead to overprediction of ozone levels, causing the plan to call for more regulation than was necessary. *Id.* at 7-2. Subsequent events, however, indicate that such overregulation has not been a problem.

³¹³ *Id.* at 5-11.

³¹⁴ *Id.*

³¹⁵ Sensitivity here refers to the extent of change in predicted peak ozone in response to changes in model inputs, such as estimated emissions.

³¹⁶ In effect, the model was assuming that all the emissions came from a subset of the actual sources. Accordingly, it would have overestimated the effect of reducing emissions from that subset of sources, and would not have accounted for continuing emissions from unaddressed sources.

compliance.³¹⁷ Although the plan discussed the model's ability to overproduce ozone, it failed to address this possible consequence.

As a result, the plan, though involving potentially crucial sources of uncertainty, did little to clarify their significance, and where it discussed uncertainty it did so in highly technical or even misleading terms.

D. DISAPPOINTING RESULTS

The Attainment Plan included a modeling prediction that the region would attain the federal ozone standard by 1999.³¹⁸ The planning effort led to several effective emissions controls, and the region has achieved significant emissions reductions.³¹⁹ Nevertheless, unhealthy levels of pollution remain. In 2000, the SJVUAPCD monitoring network measured ozone concentrations that exceeded the federal and state standards on 30 and 114 days, respectively.³²⁰ The region averaged over 30 annual violations of the federal standard from 1999 through 2002, despite the considerable emissions reductions.³²¹

317. Alternatively, the model may actually be insensitive to changes in emissions. This latter possibility is due to the nonlinear and variable response of ozone to emissions. *See* SEINFELD & PANDIS, *supra* note 51, at 299–302 (describing the chemical process of ozone creation).

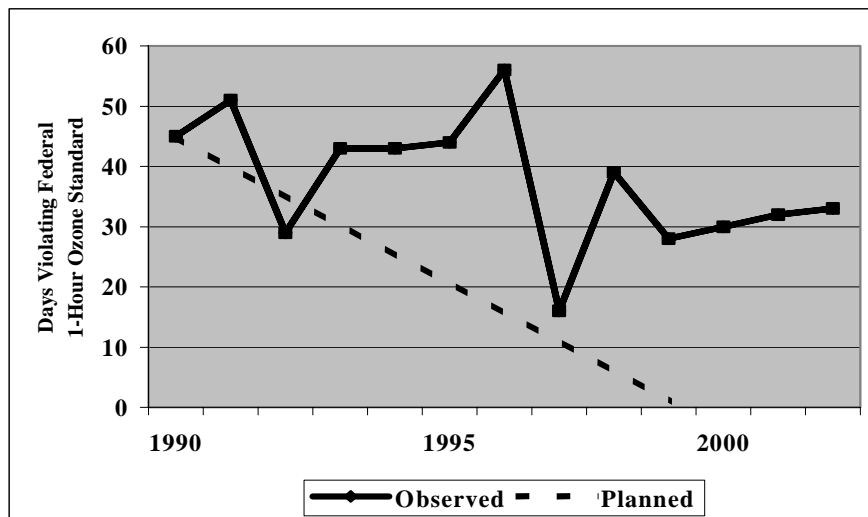
318. ATTAINMENT PLAN, *supra* note 15, at ii.

319. Cal. Air Res. Bd., 2002 Almanac Data: Projected Emissions Inventory: San Joaquin Valley Unified APCD, at <http://www.arb.ca.gov/emisinv/emsmain/emsmain.htm>; SJVUAPCD, Amended 2002 and 2005 Rate of Progress Report of the San Joaquin Valley I-7 to I-9 (2002), available at <http://www.valleyair.org/Workshops/postings/1-23-03/2002%20and%202005%20Rate%20of%20Progress.pdf>; SJVUAPCD, EMISSIONS INVENTORY SUMMARY DATA, at http://www.valleyair.org/Air_Quality_Plans/Emission_Inventory.htm.

320. SJVUAPCD, DRAFT 2002 AMENDMENT TO THE SAN JOAQUIN VALLEY OZONE PLAN (2002). *See also* CARB summary data, at <http://www.arb.ca.gov/adam/cgi-bin/db2www/adamtop4b.d2w/start>.

321. Figure 1 shows ozone observed trends in the San Joaquin Valley (solid line) compared against projections from the Attainment Plan. The data are derived from CARB's website, at <http://www.arb.ca.gov/adam/cgi-bin/db2www/adamtop4b.d2w/start>. The dotted line reflects the Attainment Plan goal of meeting the federal ozone standard by 1999.

The consequences of these persistent violations have been severe. Ozone aggravates, and may contribute to the onset of, asthma, and childhood asthma rates in the SJV are now 16%, well over the national average of 5.5%.³²² Severe respiratory ailments affect 10% of the overall population.³²³ No study has strictly tied these numbers to air pollution in general or to ozone in particular, but at the very least the region's smog appears to be an unneeded irritant to an already vulnerable population.³²⁴ Poor environmental quality can drive residents to more rural and less polluted areas, thereby increasing commutes and, ironically, vehicle emissions, while decreasing the quality of life.³²⁵ Even in apparently more idyllic areas, the pollution persists; the ugly smog migrating into Sequoia National Park now causes repeated violations of the federal ozone standard.³²⁶ The necessity of more stringent future emissions controls



322. See Grossi et al., *supra* note 215 (noting that the percentage of children with asthma is higher than anywhere else in the state); *Asthma Steals Joys of Childhood*, *supra* note 231.

323. Grossi et al., *supra* note 215.

324. McConnell et al., *supra* note 231; Anderson *supra* note 231 (quoting researchers about the link between ozone and particulate matter and asthma).

325. See Grossi et al., *supra* note 215.

Paul Price, 38, a California State University, Fresno psychology professor, drives 45 minutes from his pine-surrounded Oakhurst home to his job on the Valley floor. He does it for his 8-year-old son, Joseph. The boy's asthma was almost out of control when they lived within a 15-minute drive of the Fresno State campus.

Id. For scholarly treatments of the relationship between urban sprawl and public health, see Howard Frumpkin, *Urban Sprawl and Public Health*, 117 Public Health Reports 201-17 (2002). For promising work regarding human exposure to vehicle emissions, see J.D. Marshall et al., *Intake Fraction of Primary Pollutants: Motor Vehicle Emissions in the South Coast Air Basin*, 37 ATMOSPHERIC ENV'T 3455-68 (2003).

326. Grossi, *supra* note 229 ("In 1998, Sequoia violated the eight-hour federal ozone standard 30

may raise business costs, driving out existing businesses and deterring new ones from locating in the Valley.³²⁷

In 2001, EPA reclassified part of the Valley as a “severe non-attainment area.”³²⁸ In December, 2003, the SJVUAPCD Board went one step further and voted to request a voluntary reclassification to “extreme” non-attainment.³²⁹ EPA approved the request in April, 2004.³³⁰ This reclassification has several implications for the region, including a longer timeline to plan for and meet the ozone standard.³³¹ Whereas the 1994 Attainment Plan claimed it would achieve the standard by 1999, this recent decision delays the attainment deadline until 2010.³³²

Meanwhile, environmental activists, largely inactive in the 1990s planning efforts, have joined the San Joaquin Valley’s air pollution planning debates. The Center for Race, Poverty, and the Environment has campaigned to increase environmental regulation of agriculture,³³³ and both the Sierra Club and the Earthjustice Legal Defense Fund have become active participants—and litigants—in San Joaquin Valley air quality controversies.³³⁴ Whether their involvement will make a significant difference in future planning efforts remains to be seen; the failure of the plans developed without public-interest-group participation does not imply success with their involvement.³³⁵ But at the very least,

times at the Lookout Point monitoring station.”).

327. Mark Grossi, “Worst” Designation Could Hurt Valley, FRESNO BEE, Dec. 15, 2002, at 4 (discussing the potential for an “extreme” air pollution designation to increase costs, deterring businesses from locating in the Valley).

328. EPA Clean Air Act Reclassification, 40 C.F.R. Part 81 (2001); Ozone, 66 Fed. Reg. 56,476 (Nov. 8, 2001); Earthjustice, *Facing Lawsuit, EPA Reclassifies California Central Valley Air Pollution as “Severe,”* Oct. 23, 2001, at <http://www.earthjustice.org/news/display.html?ID=253>.

329. Grossi, *supra* note 187.

San Joaquin Valley air authorities Thursday made the historic request to join Los Angeles as the country’s worst offenders of federal smog rules. No region ever has asked to be downgraded into the so-called ‘extreme’ polluter category, which has been occupied only by Los Angeles for 13 years. State and federal governments are expected to quickly approve the request, which averts \$36 million in annual fines for the business community. The status also will push the cleanup deadline from 2005 to 2010 and prevent a federal takeover of smog reduction plans in the Valley next year. Oil, agriculture, manufacturing and other industries supported the decision.

Id.; see 42 U.S.C. § 7411(d) (2000) (outlining penalties for severe and extreme nonattainment areas that fail to meet their compliance deadlines).

330. EPA, *U.S. E.P.A. Reclassifies Valley Air to Extreme*, Apr. 9, 2004, at <http://yosemite.epa.gov/>.

331. See 42 U.S.C. § 7511(a)(1).

332. See *id.*

333. *Agriculture a Leading Polluter*, FRESNO BEE, Dec. 15, 2002, at 15.

334. See Mark Grossi, *Kevin Hall: The Unlikely Environmentalist*, FRESNO BEE, Dec. 15, 2002, at 18; Central Valley Air Quality Coalition, *Legal Actions*, at http://www.calcleanair.org/legal_actions.htm (last visited Jan. 16, 2004).

335. Recent events suggest that a rift between planners and the public is ongoing. In 2003, local supervisors launched “Operation Clean Air,” which, according to one reporter, commentators at a public meeting generally characterized as a “sincere-but-hurried push from local politicians, businesses and industry to clean up the San Joaquin Valley’s murky air.” Mark Grossi, *Push for Clean Air Focus of Hearing*, FRESNO BEE, May 8, 2003, at A1. Critics of the effort voiced familiar themes about

their presence should help ensure the inclusion of a broader diversity of viewpoints in the planning process.

E. CRITIQUING THE PLANNING PROCESS

The 1994 Ozone Plan predicted attainment by 1999. The region did not attain the ozone standard by 1999, however. Thus, the modeled prediction was wrong; in that simple sense, the planning process did not succeed. Despite the enormous public health consequences of this failure, very few people questioned the process publicly, and those who did raise concerns were not representing environmentalists or at-risk community groups. The 1994 planning process thus represents a failure both of expert-based planning and of public participation, and provides a real-life context for revisiting many of the previously-discussed problems created by model-based planning.

I. *Models, the San Joaquin Valley, and the Shortcomings of Technocracy*

The SJV ozone planning process exemplifies the ways in which a seemingly objective and simple outcome—a public report predicting attainment—in fact can conceal a host of uncertainties and policy choices.

The emissions predictions were based upon estimates—informed estimates, but estimates nonetheless—about future political conditions, the efficacy of future rules, the strength of future economies, changes to future driving patterns, and a host of other factors.³³⁶ Simulations were conducted using representations and input data that the modelers knew to be uncertain. SARMAP was also vulnerable to errors arising from insufficient input and evaluative data, the impossibility of fully simulating real-world events, and the inherent difficulties of verifying a complex model. Additionally, modelers were well aware of specific flaws in the modeling construct, but they misinterpreted the implications of some of those flaws.³³⁷

Given the uncertainties, planners had no choice but to incorporate assumptions and judgments into the planning process. SJVUAPCD and CARB staff had experience in estimating when future emissions controls would be imposed and how effective those controls would be, but their assessments still necessarily incorporated judgments about future political and economic conditions and human behavior.³³⁸ Likewise, the

exclusion, suggesting that the effort was insufficiently inclusive of the public and would probably create a “quasi-government agency” intent upon soaking up public money. *Id.*

336. See *supra* Part III.A.1 (discussing uncertainties in the modeling).

337. See *supra* Part IV.C.4 (discussing the Attainment Plan’s uncertainty discussion, and the errors in that discussion).

338. See ATTAINMENT PLAN, *supra* note 15, chs. 3–4 (predicting the effectiveness of current and future controls, many of which were not yet fully drafted, and all of which would need to be effectively

modelers' assessment of 1999 boundary conditions was dependent on their judgments about future conditions in the San Francisco Bay Area; those judgments were necessarily based in part on subjective assessments of economic prospects.³³⁹ Unfortunately, as is often the case with air pollution modeling,³⁴⁰ some judgments appear to have led to overoptimistic predictions.

In the SJV the use of models relocated some value choices, hiding them within the black box modeling process. For example, the relatively simple model output—a prediction of compliance—emerged without any meaningful discussion of the uncertainties associated with that prediction.³⁴¹ Accordingly, any discussion of the appropriate level of certainty—in modeling terms, the appropriate ratio of signal to noise—was effectively curtailed.³⁴² The choice to regulate only to the minimum extent necessary to achieve a modeled prediction of compliance was a policy decision with potentially major implications, but the terse and non-comprehensive discussion of uncertainty in the plan relegated consideration of the implications to the technical realm.³⁴³

We know, or should know, that planning agencies must use subjective judgment, that politics will sometimes enter scientific decision-making processes, and that honest, well-intentioned experts will make mistakes. Public participation and judicial review provisions are checks upon such subjectivity and potential fallibility, and also serve the normatively desirable function of allowing public participation in policy choices with potentially significant public effects.³⁴⁴ During the process of reviewing and approving the Attainment Plan, however, these checks went unutilized.

enforced to achieve results).

339. See ATTAINMENT PLAN, *supra* note 15, at 4–28 (assuming improving boundary conditions).

340. See *supra* note 144 and accompanying text (discussing chronically overoptimistic predictions).

341. Any discussion that did occur was mostly confined to the SJVAQS Technical Committee and to dialogue between modelers and planners at the SJVUAPCD and CARB. Commenting on an early draft of this paper, Steve Ziman stated that lack of characterization and explicit management of modeling uncertainties in decision-making is due to a lack of leadership from the EPA, whose formal guidance does not encourage estimation of uncertainty ranges or probabilities with modeling predictions.

Indeed, the EPA's guidance does equivocate on the advisability of probabilistic determinations, ultimately declining to require or prohibit them. See *supra* note 161 and accompanying text. As a result, modelers typically default to simple deterministic modeling demonstrations, in which models are used to indicate that an attainment plan offers one plausible path toward attainment of air quality standards, but are not used to estimate the probability of attainment.

342. See *supra* Part III.B.2.e (discussing signal-to-noise ratios).

343. Indeed, the modeling process appears to have hidden this choice not merely from the public, but also from the planners themselves. SJVUAPCD staff believed that they would be unable to legally defend any "over-regulation," that is, any regulation beyond that necessary to attain a modeled prediction of compliance. See *supra* note 302 and accompanying text.

344. See *supra* Parts II.B and II.C; JASANOFF, *supra* note 145, at 11.

2. *Models and the Absence of Inclusion*

Public participants had, in theory, several ways to engage in the SJV planning process, but none occurred.³⁴⁵ Discussion of the plan through notice and comment proceedings was muted. Indeed, the only group that questioned the SARMAP prediction publicly was the petroleum industry, which suggested that some emissions controls were unnecessary.³⁴⁶ Likewise, the minutes from the Board of Directors' meetings evince no real attempt to include a general-public or environmentalist perspective; instead, the Board primarily deferred to the technical decision-makers.³⁴⁷ The public was underrepresented on the advisory committees; the policy committee contained only three public representatives, none of whom had a technical background, and the technical committee was composed exclusively of regulators and industry representatives.³⁴⁸

This lack of participation may be attributable, in part, to apathy; there is little record of any public attempt to engage the planning process, and environmental groups' lack of focus upon SJV air quality in the 90s is well documented.³⁴⁹ Nevertheless, apathy may have been caused, in part, by the difficulties inherent in becoming involved in model-based planning.

The absence of significant public discussion of the Attainment Plan, for example, is not hard to explain; the Attainment Plan is very difficult to understand. It does not provide a qualitative overview of the attainment strategy.³⁵⁰ Proposed rules are described in terse fashion.³⁵¹ Uncertainties are ignored, mischaracterized, or described without any meaningful discussion of their implications.³⁵² Policy choices, like the decision to regulate only to the minimum extent necessary, are not explained.³⁵³ And the model itself—the tool at the heart of the planning process—would remain, for almost any reader, an inscrutable black box producing an unassailable prediction of attainment. The Attainment Plan, in short, is a document that few non-experts could meaningfully

345. First, through notice and comment proceedings, the public should have been able to engage in discussion of the Attainment Plan. Second, elected officials on the SJVUAPCD board could, by proxy, have addressed public concerns about the planning process. Third, though no legal requirement mandates such involvement, public advocates could have been included in the technical and advisory committees that played such an important role in the research and planning processes. Finally, had it chosen to do so, the SJVUAPCD could have engaged in an extensive public outreach effort.

346. *See supra* note 283 and accompanying text.

347. *See supra* notes 291–95 and accompanying text.

348. *See supra* notes 264–65 and accompanying text.

349. *See, e.g.,* Grossi et al., *supra* note 215 (“Big-city environmentalists, who do understand air-pollution speak, just didn’t show up for the conversation.”).

350. *See* ATTAINMENT PLAN, *supra* note 15.

351. *See id.* chs. 3–4.

352. *See supra* Part IV.C.4.

353. *See supra* notes 302–05 and accompanying text.

critique, and it should be no surprise that the lay public did not try.

Likewise, the absence of significant debate at the board meetings is unsurprising. The same problems preventing participation by the public compromised any attempts by members of the board to engage in critical review of the document. Given their limited technical training and the deadlines they faced, the board had little opportunity to scrutinize the decisions of its expert staff.³⁵⁴ An independent assessment might have provided the basis for the board to exercise more critical judgment, but by the time the plan was ready for board review, time for such an independent assessment had run out.

Finally, the lack of lay public representation on the review committees is easy to understand. The SJVUAPCD and CARB attempts to include either individual members of the public or environmental or public advocacy groups to participate on those boards were unsuccessful.³⁵⁵ If invited, these individuals and groups might have been reluctant to participate. The boards discussed complex technical issues, and those discussions would have been daunting to most potential individual participants. Likewise, unless environmental groups had or could hire modeling experts, their representatives would have been unable to offer meaningful input.³⁵⁶ Their presence might, however, have lent the advisory committees an aura of balance and fairness, and the groups' representatives would have risked allowing their presence to be

354. In addition, political decisionmakers may have been uninterested in technical nuances. As one modeler from the Bay Area Air Quality Management District noted,

As you go up the ladder to the Executive and Board level, you're more and more affected by and aware of the practical considerations, the legal considerations, the time constraints. Some of the political realities have to do with how the public is going to react to what we're putting out and how other agencies are going to react. Down at my level, we're almost entirely focused on technical issues. We the technical people may say we don't have confidence in this analysis. The management may say, "Well, give us the best analysis that you have because we have to meet this requirement. We have to submit our plan on time."

Interview with Robin DeMandel, Research and Modeling Manager, BAAQMD, San Francisco, Cal., Apr. 12, 2001, who directed the modeling staff at the BAAQMD for 16 years from 1988 to 2004.

355. Ziman Interview, *supra* note 253. Ziman said:

My role is not only reviewing. My role has been interacting and participating with the agencies in the development of the information that provides the technical basis on which a policy decision is made on a clean air plan. By this, what I mean is that in the State of California over the last 16 or 17 years, there has been a group that came together initially to fund a field program in 1990. That was referred to as SARMAP. That group consisted of a policy and a technical committee, of which representatives from the state local agencies, environmental . . . no, there were no environmental groups . . . industry, other interested parties, were involved and continue to be involved over the course of this 16 years.

Subsequently, when commenting on an earlier draft, Ziman described another reason why environmental representation was absent during Attainment Plan development: to date, no member of an environmental group active in San Joaquin Valley air quality planning has had the expertise to constructively participate in highly technical discussion.

356. See Grossi et al., *supra* note 215 ("Valley air district staff members have been pleading the dirty-air case for years, but their discussions are complex and jargon-laced. The details are all but impenetrable for the public without a steep learning curve.").

interpreted as implicit approval of the committees' work.

3. *Distributional Impacts and the Absence of Exclusion*

In some respects, the San Joaquin Valley's air pollution problem is different than a classic case of environmental injustice. Literature and the limited case law on environmental injustice often focus upon small, discrete areas of pollution—a poor community containing too many Superfund sites, or an African American neighborhood bisected by a highway.³⁵⁷ Likewise, traditional definitions of environmental justice often focus on impacts disproportionately borne by a historically disadvantaged group.³⁵⁸ The San Joaquin Valley's problems, by contrast, impact broader areas, affecting rich and poor residents alike. Though there is little conclusive information on the subject, the burdens of air pollution in the San Joaquin Valley do not appear to be disproportionately borne by a particular demographic segment of the San Joaquin Valley's population.

Some traditional environmental justice concerns are nevertheless present. The population of the San Joaquin Valley is generally poorer, less educated, and less white, than that of California as a whole.³⁵⁹ Additionally, few of the people impacted by the Valley's air pollution reap the benefits of pollution profits. The San Joaquin Valley's residents have contributed to fouling their own nest, but they also can blame the residents of upwind, wealthier areas for some of their troubles.³⁶⁰ Additionally, some of the businesses that cause many of the Valley's emissions take their profits elsewhere; many of the giant west side farming operations, for example, are headquartered outside of the Valley, and the Kern County oil businesses are neither locally owned nor important sources of local employment.³⁶¹ Even the pollution profits that

357. See, e.g., Eileen G. Jones, *Environmental Justice in the New Millennium*, at <http://www.agecon.lsu.edu/ESOS-V%20Proceedings/pdf/Jones.pdf> (last visited May 21, 2004) (discussing recent environmental justice cases).

358. See U.S. EPA Environmental Justice, *Basic Information* ("Fair treatment means that no group of people should bear a disproportionate share of the negative environmental consequences resulting from industrial, governmental and commercial operations or policies.") available at <http://www.epa.gov/compliance/basics/ej.html> (last visited Apr. 20, 2005); see also NAT'L ENVTL. JUSTICE ADVISORY COUNCIL, STRATEGIC PLAN 6 (Regarding strategic goals for public participation: "Obtaining the views of minority, low-income, indigenous and agricultural-worker populations and of federally recognized tribes is a critical component of the deliberative process . . ."), available at http://www.epa.gov/compliance/resources/publications/ej/nejac/nejac_strplan_package111601.pdf (last visited Apr. 20, 2005).

359. See *supra* Part III.C.3 (discussing environmental injustice and model-based planning) and Part IV.B.2 (discussing the San Joaquin Valley's demographics, economy, and history).

360. CARB's latest assessment of the impact of San Francisco Bay Area emissions on the SJV concluded that the Bay Area is "at times" an "overwhelming" source of air pollution in the northern SJV. See CARB, *Ozone Transport Review*, Apr. 2001, at 43-48.

361. See Mark Grossi, *A Rush of Water, A Flourish of Crops*, FRESNO BEE, June 20, 1999, at 4, at <http://www.fresnobee.com/man/projects/savesjr/rush.html> (stating that "east-side-type communities are more solid financially than west-side communities, where absentee ownership prevails"); QUINN,

stay in the Valley are unlikely to find their way, in any significant amount, to many of those who suffer. Finally, the Valley is not a place where the participatory political processes that ought to serve as an antidote to environmental injustice have traditionally functioned well. The Valley's history is one of coinciding disparities of wealth and power.³⁶² This context indicates that when an exclusive group of industry representatives and regulators develop, without significant public input, a plan that fails to solve a major pollution problem, the level and distribution of impacts should be causes for serious concern.

F. SAN JOAQUIN VALLEY STUDY SUMMARY

The story of air quality planning in the San Joaquin Valley is, to date, a depressing one. The experts have not solved the problem and the public has not been meaningfully involved. Fortunately, the story is not over. Efforts to achieve compliance are ongoing, activist participation is on the rise, and the successes of nearby Los Angeles suggest that even the most polluted areas can, with concerted effort, make dramatic gains.³⁶³ Progress, however, will probably require some reconciliation of model-based decision-making and public participation, and the failings of past planning processes in the San Joaquin Valley illustrate how difficult that reconciliation can be to achieve.

V. RECONCILING MODELING AND PUBLIC PARTICIPATION

As the San Joaquin Valley ozone story illustrates, science-based planning and public participation, though both desirable and mandated by law, come into conflict when planners use complex models. To some extent, this paradox is unavoidable. We are unlikely to eliminate either technical decision-making from our environmental planning or public participation provisions from our environmental laws. But even if this paradox cannot be entirely resolved, it can be ameliorated; we can retain the benefits of both participation and modeling while reducing their conflicts. This section recommends several ways of making such improvements.

supra note 206 and accompanying text.

362. *See id.* (discussing the Valley's history). We have no evidence of malice or bad faith, and the disparate impact of the Valley's pollution, to the extent that there is one, is not nearly stark enough for a successful civil rights claim. *See Arlington Heights v. Metro. Hous. Dev. Corp.*, 429 U.S. 252, 264-65 (1977) (holding that a discrimination claim requires some evidence of discriminatory intent unless the disparity in impact is extraordinarily stark). Nevertheless, we believe that situations that might not be sufficiently acute to qualify, under our current precedents, as judicially remediable nevertheless qualify as unfair and unjust and merit our concern.

363. *See Polakovic, supra* note 212; Mark Grossi et al., *Smoggiest in the State*, FRESNO BEE, Dec. 15, 2002, at 4 (describing air quality improvements in the Los Angeles area).

A. UNDERSTANDING MODELING

Many of the tensions between model-based planning and public participation arise out of the difficulties participants face in trying to understand model-based decisions.³⁶⁴ One obvious solution to this lack of understanding, therefore, is to improve modelers' and planners' communication of information about the use of modeling. This is not an easy task,³⁶⁵ but there are several straightforward ways in which discussions of modeling could be improved.

1. *Discussing Uncertainty*

A public participant cannot effectively scrutinize a model-based decision without having some understanding of the uncertainties involved, and both modelers and planners therefore ought to be explicit and comprehensive in their discussions of uncertainty.

Uncertainty discussions permeate science; even most high school students have written "sources of error" sections in lab reports, and when scientists communicate with each other, discussion of limits of knowledge and potential biases is a normal part of the dialogue.³⁶⁶ In model-based planning, however, the discussion of uncertainty can disappear or be translated into vague and meaningless form before reaching the public.³⁶⁷ As a result, the public often receives unqualified predictions, depriving it

364. This misunderstanding can occur on several different levels. First, participants may not understand how the model itself works. Second, they may not understand how the model was used within the decisionmaking process. For example, they may not be able to discern where subjective decisions were made and where planners or modelers instead relied on the programmed workings of the model itself. Third, they may not understand the limitations of the model, as used in that particular planning process. Finally, they may not understand the decision risks—both in terms of public health and cost-effective pursuit of goals—associated with reliance upon that model. Ideally, none of this misunderstanding would occur. In reality, however, most models are too complicated for an average person to develop an in-depth understanding of the functioning of the model as a tool. The average participant will probably have to settle for a generalized, qualitative understanding, and will be able to criticize the construction of the model itself only through the proxy services of an expert. The latter three types of misunderstanding, however, we believe can and should be effectively addressed.

365. See GARRY BREWER, *POLITICIANS, BUREAUCRATS, AND CONSULTANTS: A CRITIQUE OF URBAN PROBLEM SOLVING* 238, 241 (1973) (suggesting standards for documentation, and estimating that the communication effort could cost as much as the model development); MORGAN & HENRION, *supra* note 10, at 40–43 (expressing the need for documentation and discussing the information to be documented).

366. See MORGAN & HENRION, *supra* note 10, at 2 (1990) ("Natural scientists are expected as a matter of course to include an estimate of the probable error when they report the value of quantities they have measured.").

367. See *supra* Part IV.C.4 (discussing the treatment of uncertainty in the 1994 Attainment Plan, and pointing out that while uncertainty was mentioned in general terms, the Plan did not clarify the implications of specific sources of uncertainty). This absence of uncertainty communication may be partly due to the absence of regulatory guidance about what to do with such information. See *Requirements for Preparations, Adoption, & Submittal of Implementation Plans*, *supra* note 151 (discussing conventional understanding among modelers of legal requirements and uncertainty discussion). Nevertheless, EPA's guidance clearly does require that such information be made available to decisionmakers.

of any means of evaluating risks associated with decisions based upon modeling.³⁶⁸

This lack of information renders the statutory provisions for public participation meaningless. A modeling prediction unqualified by disclosure of known, or knowable,³⁶⁹ sources of error is fundamentally deceptive. It conveys a level of certainty that does not exist, hides real risks, and fails to explain key information that ought to be factored into policy choices and decisions.³⁷⁰ Without such information, public debate may be pointless.³⁷¹ Existing environmental laws and regulations do not contain clear guidance on how uncertainties should be communicated, or what level³⁷² or type³⁷³ of uncertainty should be considered significant, but neither do they provide for uncertainty to be ignored or swept under the rug.³⁷⁴ Accordingly, a statement of results unqualified by known errors can create a legal violation.³⁷⁵

In addition to being potentially illegal, this insufficient communication of uncertainties in modeling is avoidable. Communicating uncertainties and associated decision risks along with

368. See *supra* Part IV.C.4 (criticizing the discussion of uncertainty in the 1994 Attainment Plan).

369. Determining error ranges, even where possible, can require an intensive effort, and we do not suggest that agencies must double their expenditures of time and money in order to produce quantified error calculations as part of every planning effort. See BREWER, *supra* note 365, at 241 (noting that sometimes the error analysis can be as resource-intensive as the modeling process itself). Nevertheless, such calculations, where technically and financially feasible, should be enormously helpful. See Kuehn, *supra* note 142, at 158–59. If agencies cannot make such calculations, they should candidly acknowledge the lack of error analysis.

370. See *Sierra Club v. Costle*, 657 F.2d 298, 332–35 (D.C. Cir. 1981) (discussing the need for publicly available information about the limitations of models); *supra* Part III.B.2.c (discussing the ways in which a lack of information about uncertainty can skew public perceptions).

371. See, e.g., *Lands Council v. Forester of Region One of the U.S. Forest Serv.*, 395 F.3d 1019, 1031–32 (9th Cir. 2004) (holding that inadequate disclosure of model limitations constituted a violation of NEPA).

372. For a discussion of the significance of uncertainty levels, see *supra* part III.B.2.e (discussing signal-to-noise problems).

373. In some circumstances, laws and regulations deliberately prioritize avoiding certain kinds of error. In the criminal justice system, for example, the beyond a reasonable doubt standard of proof embodies a preference for one type of error—freeing a guilty person—over the error of incarcerating the innocent. The Clean Air Act, or its enforcement regulations, could in theory express a similar preference by favoring errors of overregulation over errors of non-compliance, but in fact the act states no such preference. As a result, the selection of an error preference is choice—and a potentially unacknowledged choice—left to the planning agencies.

374. The Clean Air Act, for example, lacks guidance about how certain an attainment prediction must be. This lack of guidance, however, does not mean that uncertainty cannot or need not be discussed.

375. See *Appalachian Power Co. v. EPA*, 249 F.3d 1032, 1054 (D.C. Cir. 2001); *Costle*, 657 F.2d at 332–35; *Lands Council*, 395 F.3d at 1031–32; McGarity & Wagner, *supra* note 13, at 10771 (stating that “if the agency explains its choices and makes the scientific and policy bases for the assumptions that it employs in its modeling exercises transparent, the courts are less likely to engage in overt usurpation of the agency’s properly delegated decisionmaking power”).

modeling results is quite possible.³⁷⁶ For some processes, analytical, brute force, or expert elicitation methods are feasible and should be used to generate quantitative estimates. These estimates should be made available to the public; even if their mathematical basis is difficult to understand, an error range is comprehensible even for a layperson.³⁷⁷ Where such analysis is impossible,³⁷⁸ modelers can and should acknowledge the absence of formal error analysis, but can still include informal analyses of error. Similarly, modelers and planners also should emphasize and highlight, in both written documents and public discussions, significant assumptions, uncertainties and other contingencies, and they should explain their potential to affect outcomes and associated risks.

In the 1994 Attainment Plan, planners might have explained that modelers were unsure about the magnitudes, locations and timing of potentially major sources of emissions and then described the implications of those uncertainties for the modeled attainment demonstration.³⁷⁹ For example, they could have discussed the uncertainties surrounding their vehicle emissions estimates, and could have explained how error in those estimates could affect the attainment prediction.³⁸⁰ Instead, although the Attainment Plan emphasized that the modeling was uncertain, the *implications* of uncertainties were not explained to the public.³⁸¹

2. *Discussing Subjectivity*

Subjectivity is an inherent part of modeling, and modelers cannot work without making assumptions. It also is not necessarily a problem since many of the modelers' assumptions are likely to be well-informed

376. See generally MORGAN & HENRION, *supra* note 10, at 183–219 (discussing model uncertainty analysis techniques), 220–52 (showing methods for graphically communicating uncertainty).

377. A statement that a model has predicted compliance with sixty percent confidence is no more complex than a weatherman's prediction that there is a forty percent chance of rain. The public routinely makes decisions based on the latter type of prediction and should also be able to understand the former.

378. Unfortunately, modelers often lack the time or the financial resources, or even the technological capability, to quantitatively analyze potential modeling error. We do not suggest that a failure to do the impossible should constitute a legal violation. Instead, we argue that where such analysis is feasible—and to the extent that it is feasible—it should be performed, and that even if comprehensive, quantitative analysis of error is infeasible, modelers and planners should still provide detailed qualitative descriptions of the potential errors that exist and the ways in which those errors might affect outcomes.

379. See *supra* notes 306–10 and accompanying text (discussing uncertainty in the Attainment Plan); Russell Clemings, *Smog Check Fails to Get Gross Polluters*, FRESNO BEE, Dec. 15, 2002, at 19 (describing some of the problems encountered by smog check programs).

380. See *supra* notes 306–17 and accompanying text (discussing the limitations of the emission inventory). The modelers and planners also could have explained the ways in which time constraints had limited their ability to test the model.

381. See *supra* notes 311–17 and accompanying text.

and reasonable.³⁸² Nevertheless, even reasonable assumptions may incorporate value judgments that public participants would wish to discuss. Moreover, some of these subjective judgments may concern matters about which the modelers have no particular expertise; a modeler or planner, for example, may be no better informed about societal views on the proper level of risk than the public at large.³⁸³

Accordingly, where modelers make assumptions about political, social, or economic trends—such as assuming that the economy will continue to grow at a certain rate, or that driving habits will follow certain trends—the assumptions can and ought to be acknowledged. If modelers make value choices about acceptable levels of risk, these decisions ought to be placed in public view.³⁸⁴

Improved discussions of uncertainty, subjectivity, and associated decision risks would represent substantial steps toward more inclusive model-based decision-making processes. Such discussions will not always be sufficient to assure that model-based planning is transparent; with additional discussion, environmental documents will become longer and potentially more intimidating to read.³⁸⁵ Nevertheless, more complete discussion would allow public participants to better understand the reasoning behind, and the risks underlying, model-based decisions.

B. PROVIDING RESOURCES FOR UNDERSTANDING

By improving their discussions of modeling, agencies will increase public opportunities to understand and critique model-based decisions. This constitutes only a partial solution to the paradox, however, and understanding models will remain a daunting challenge, particularly for poorly-funded participants. Both agencies and others intent on fostering informed, productive dialogue therefore must recognize that many public participants—often the very community group opposing a new operating permit, land development, or other proposed project—ought to be given the resources to develop their own understanding or to acquire trusted expert representatives or advisors. This can be accomplished in several ways.

382. Modelers often have substantial experience in making these subjective judgments. Nevertheless, experience cannot remove the inherent subjectivity of these judgments.

383. Indeed, a substantial body of literature documents that public perceptions of risk, and opinions about appropriate levels of risk, differ markedly from the perceptions and opinions of technical experts. For a seminal discussion of the differences between public and expert perceptions of risks, see PAUL SLOVIC, *PERCEPTION OF RISK* (2000); see also DANIEL KAMMEN AND DAVID HASSENZAH, *SHOULD WE RISK IT? EXPLORING ENVIRONMENTAL, HEALTH, & TECHNOLOGICAL PROBLEM SOLVING* 353–92 (Princeton Univ. Press 2001).

384. See *Sierra Club v. Costle*, 657 F.2d 298, 334–35 (D.C. Cir. 1981).

385. See MARSH, *supra* note 177, at 7 (noting that participants may shy away from involvement because of “overwhelming amounts of reading”).

I. *Educating the Public*

One direct way to improve public understanding of model-based decisions is to provide, particularly early in the planning process, education about how the relevant models work and how they will be used.

As a supplement to their legally-mandated public participation obligations, agencies often engage in public outreach efforts early in decision-making processes. These outreach meetings typically involve preliminary discussions about the proposed projects, at which the agency explains its plans and solicits information about public concerns.³⁸⁶ As a result of such meetings, the affected public is less likely to be surprised by subsequent decisions, and the agency is less likely to be blindsided by unanticipated public concerns.

In model-based decision processes, layperson-level tutorials about model uses could be included within these preliminary outreach efforts. Such early meetings could increase participants' awareness about what the models can and cannot do, what types of decisions the relevant model can support, and, at least qualitatively, the types of uncertainties to which the model is prone.³⁸⁷ This education could reduce some participants' distrust of science, giving them the confidence to become involved in the more technical details of decision-making.³⁸⁸ Likewise, early meetings could give modelers a chance to hear public concerns and

386. *See id.* at 10, 16–18; EPA, IMPROVED SCIENCE-BASED ENVIRONMENTAL STAKEHOLDER PROCESSES: A COMMENTARY BY THE EPA SCIENCE ADVISORY BOARD 8 (2001), available at www.epa.gov/sab/pdf/eccmo1006.pdf (noting that successful processes involved “substantial resources to support the review of relevant scientific evidence and development of scientific summary materials in a form that was intelligible to stakeholders”).

387. Realistically, such meetings might provide public participants with a generalized understanding of the models themselves; most models are far too complex for their inner workings to be explained in a community outreach meeting. However, even a generalized, qualitative understanding of the ways in which a model will be used could allow a public participant to make important contributions to a planning process. Additionally, to the extent that affected communities have retained experts with modeling expertise, such meetings could be used to learn and respond to the preliminary concerns of those experts.

We do not believe that all model-based planning is likely to become accessible to a lay observer with just a passing interest. The processes we describe are too complicated for someone to become effectively involved without sustained effort. Our concern, however, is that without better information about modeling, even a motivated participant—a person who is committed to spending time (or working with an expert who will spend time) to understand the technical issues at stake—still could not effectively engage the process. Our public participation schemes are not predicated upon the notion that anyone, regardless of their level of commitment or engagement, should be heard, but a process that is closed even to motivated participants does not meet the participatory mandates of our environmental laws.

388. *See, e.g.,* MARSH, *supra* note 177, at 13, at www.epa.gov/publicinvolvement/pdf/sipp.pdf (describing a planning process in which a “Communication and Outreach working group” focused on “creating an Internet site where information could be posted and by producing ‘plain English’ summaries of issue papers”); JASANOFF, *supra* note 145, at 11 (noting the public tendency to distrust processes that laypersons cannot understand).

help the agencies frame later discussions of model results.³⁸⁹

Agencies also could make general information about models more accessible. Agencies make repeated use of the same or similar models for certain types of planning, and standardized discussions about those models' functions and limitations would be inexpensive to prepare and make available.³⁹⁰ EPA, for example, could publish explanations of models, and peer reviews of models,³⁹¹ in much the same way that it creates and publishes model performance standards.³⁹² EPA could also require such publication as a precondition for model approval.³⁹³

2. *Increasing Expert Representation*

Increased public outreach and more accessible explanations of modeling will expand the number of potential participants in model-based planning, but these measures alone will not make all model-based decisionmaking understandable. Even with these increased resources, achieving more than just a superficial understanding of complex modeling will require expertise, and such expertise is usually costly. For poor communities, participation therefore may remain prohibitively difficult. Accordingly, agencies also should consider, in selected cases, making funds available to support public participation.

Such funding mechanisms are not unprecedented. EPA has experimented, with some success, with "technical assistance grants" that provide funding for communities affected by Superfund cleanups.³⁹⁴ These grants, according to EPA, proved to be "a considerable success[.]

389. See Marsh, *supra* note 177, at 10, 16–18. See generally Simon, *supra* note 75 (emphasizing that often regulatory processes benefit from the surprising contributions of public participants; obviously such surprises are better received early in the decisionmaking process).

390. For example, EPA's urban airshed model has been used numerous planning processes.

391. Agencies do sometimes post such peer reviews. See, e.g., EPA, *Peer Review of the EPA Analytical Model: Mercury Emissions from the Disposal of Fluorescent Lamps* (Mar. 1998), at www.epa.gov/epaoswer/hazwaste/id/merc-emi/merc-pgs/peerrev.pdf.

392. Developing outside expert understanding will be far easier if experts can delve into the guts of the models, and for this reason agencies should eschew proprietary models in favor of those that are open code. The EPA's regulations establish such a requirement, see Revision to the Guideline on Air Quality Models: Adoption of a Preferred Long Range Transport Model and Other Revisions, 68 Fed. Reg. 18,440, 18,451 (Apr. 15, 2003) ("the model cannot be proprietary"), but EPA does at times approve proprietary models for use. Some of those models are widely applied, such as privately modified versions of the Urban Airshed Model used for urban air quality planning. In these cases, model limitations may be well understood by the user community, but not by lay stakeholders.

393. Some information about models, and model-based planning processes, is currently available on the Internet, but such information could be presented more accessibly. CARB and EPA already provide considerable guidance. See, e.g., California Air Resources Board, Software—Utilities and Modeling, at <http://www.arb.ca.gov/html/soft.htm> (last visited June 2, 2004); U.S. Environmental Protection Agency, Support Center for Regulatory Air Models, at <http://www.epa.gov/scram001/> (last visited May 9, 2004). Most regulatory guidance is intended for use by regulators and modelers, however, and we propose that these same agencies provide descriptions in lay terms and include discussion of the implications of model limitations for decision-making.

394. See MARSH, *supra* note 177, at 5.

making it easier for community groups to interpret data and reports, understand technical issues, improve dialogue with EPA, educate nearby residents about the issues, and establish credibility of the group.”³⁹⁵ Likewise, under Project XL,³⁹⁶ EPA has offered grants to facilitate community participation.³⁹⁷

Model-based decision processes ought to be prime candidates for similar grants. If provided with the resources to facilitate such sustained involvement, community groups may come to see the modeling process as something to be engaged rather than distrusted and rejected, with resulting gains in understanding, efficiency, and fairness for all sides. In the San Joaquin Valley, for example, participant funding might have provided public advocacy groups an opportunity to contribute to the technical and policy advisory committees. Such funding might have allowed public participants to develop and voice concerns that instead went unheard.

C. IMPROVING JUDICIAL UNDERSTANDING OF MODELING

Improved communication about modeling and increased resources for public understanding can make environmental planning processes more inclusive. Both, however, require a commitment to inclusion on the part of the planning agency, and sometimes, whether because of distrust of public participants or because of time or cost constraints, that commitment will be ineffectual or nonexistent. In such situations, citizen suits and judicial review of model-based decisions may be the only avenue for facilitating public participation. Obtaining effective review, however, will be difficult if judges are not sophisticated about the limits of models.

Conducting judicial review of a model-based decision is not an easy task. Understanding modeling is typically just as difficult for a judge as for a would-be participant, if not more so, since the judge is likely to have little time to develop a sophisticated understanding. Additionally, potential challengers may be forced to bring arguments on questions of degree—that the model was not explained clearly enough, for example, or that disclosure of error was too general. Prevailing on these arguments is inherently more difficult than prevailing on more black-and-white claims of error. A challenger who believes models were misused or inadequately explained will reasonably fear that she can hope for no

395. *Id.*

396. Project XL is an EPA program designed to allow regulated groups to develop and implement innovative regulatory programs. See EPA, *What is Project XL?*, at <http://www.epa.gov/projectxl/file2.htm> (last visited Apr. 12, 2004).

397. MARSH, *supra* note 177, at 5. Such funding also need not come from agency sources; private organizations could make similar “understanding grants” available, and technical experts could volunteer services on a pro bono basis.

more than rubber-stamp review. Conversely, an agency that forthrightly discloses the limitations of its model may reasonably worry that an opportunistic petitioner may persuade a judge to latch onto those disclosures and ignore the model's overall utility.

Nevertheless, courts have long provided a blueprint for effective judicial review. Perhaps the most cogent judicial discussion of modeling is contained in *Sierra Club v. Costle*, in which the D.C. Circuit, after providing an extensive discussion of both the utility and limitations of models, stated:

The safety valves in the use of such sophisticated methodology are the requirement of public exposure of the assumptions and data incorporated into the analysis and the acceptance and consideration of public comment, the admission of uncertainties where they exist, and the insistence that ultimate responsibility for the policy decision remains with the agency rather than the computer. With these precautions the tools of econometric computer analysis can intelligently broaden rather than constrain the policymaker's options and avoid the "artificial narrowing of options that (can be) arbitrary and capricious."³⁹⁸

Employing this standard allows judges to provide effective but restrained review of model use. The standard does not usurp agency discretion; its "precautions" focus on ensuring healthy respect for and public explanation of the limits of models, and would not limit agencies' abilities to use models even where those models are acknowledged to be far from perfect. Indeed, the *Costle* court upheld EPA's model use.³⁹⁹ Under this standard, non-disclosure of uncertainties or concealment of policy choices from public view would be suspect.⁴⁰⁰ On the other hand, candid disclosure of assumptions, uncertainties, policy choices, and potential model flaws would not leave an agency legally vulnerable.⁴⁰¹ Accordingly, an agency would be mandated to convey, but not be punished for explaining, the limitations of its tools.⁴⁰²

398. 657 F.2d 298, 334-35 (D.C. Cir. 1981).

399. See *id.* at 332-35. In addition, the likely remedy in a case where model uses are insufficiently explained—a remand to the agency for reconsideration and a clearer explanation—would usurp none of the agency's traditional discretion.

400. See *id.*

401. See *id.* at 332-35 & n.131.

[M]odels are robbed in the elegance of high-speed computers, but they are at base extrapolations from past experience, projections that must undergo continual examination and revision. They do not always have the reassuring concreteness of empirical observations, but they are the best we have to work with in casting our programs. Provided that the assumptions on which a model is based are adequately explained and justified, we see no reason why this type of evidence may not be used

Id. (quoting *Am. Public Gas Ass'n v. Fed. Power Comm'n*, 567 F.2d 1016, 1037 (D.C. Cir. 1977), *cert. denied*, 435 U.S. 907 (1978)); see also *Sierra Club v. U.S. Forest Serv.*, 878 F. Supp. 1295, 1310 (D.S.D. 1993), *aff'd*, 46 F.3d 835 (8th Cir. 1995).

402. See McGarity & Wagner, *supra* note 13, at section IV (discussing the importance of judicial understanding that agencies must use imperfect models and uncertain information to make policy).

Review under the D.C. Circuit's standard requires a certain level of judicial sophistication. Judges must, as the D.C. Circuit did in *Costle*, understand that models are both highly useful and inherently imperfect, and must be willing to assess the ways in which agencies address those limitations without completely dismissing a models' utility. They must go further than asking merely whether the model itself bore some rational correspondence with reality and must also scrutinize how the model was used and how its uses were explained.⁴⁰³ Nevertheless, the sophistication of the discussion in both *Costle* and a series of subsequent cases suggests that such review certainly is possible, and often does occur.⁴⁰⁴

In combination, clearer discussion of modeling processes, improved resources for public understanding, and sophisticated judicial review⁴⁰⁵ could make model-based planning substantially more inclusive, thereby ameliorating the tension between legal imperatives for both model use and meaningful public involvement. This combination will not, of course, be a magic solution. Models will remain complicated, and model-based decisions will continue to be difficult to critique. In some processes, agencies will be unable to convey sufficient explanations to the public, and in other situations, agencies may provide excellent explanation of modeling to potential participants who remain too daunted by the apparent technicality of the process to meaningfully participate.⁴⁰⁶ Nevertheless, these improvements would create greater opportunities for participation, even if those opportunities are not always exploited, and would represent substantial steps toward more inclusive model-based decisions.

VI. CONCLUSION

Our environmental laws create a paradox for public participants. On one hand, these laws, drawing on a longstanding respect for science, mandate decision-making informed by scientific understanding and, hence, technical experts. On the other hand, many of the same laws reflect a similarly longstanding tradition of distrust of government by calling for public participation. As a result, environmental laws provide

403. See *Chem. Mfrs. Ass'n v. EPA*, 28 F.3d 1259, 1265 (D.C. Cir. 1994).

404. See *Lands Council v. Forester of Region One of the U.S. Forest Serv.*, 395 F.3d 1019, 1031-32 (9th Cir. 2004); *Appalachian Power Co. v. EPA*, 249 F.3d 1032, 1051-53 (D.C. Cir. 2001); *Costle*, 657 F.2d at 332-35; McGarity & Wagner, *supra* note 13 (summarizing cases reviewing models, and general principles arising out of those cases, and concluding that, despite some outlying results, most courts have adopted reasonable standards of review).

405. Even if model-based decisions are never subject to legal challenge, the prospect of such review will provide a powerful incentive for agencies to more clearly explain their uses of models. See *Virginia v. Browner*, 80 F.3d 869, 880 (4th Cir. 1996).

406. Potential participants may also remain uninvolved for a variety of other reasons, ranging from inertia to conflict-aversion to a lack of confidence that their participation can have any real effects. See MARSH, *supra* note 177, at 7 (describing reasons for non-participation).

for extensive public involvement in processes that the public may find difficult to understand and affect.

This tension is acute when agencies make decisions using models. Models are a practical and, in some situations, legal necessity in environmental planning, and planners often could not accomplish their goals without some use of modeling. Models also are difficult for even sophisticated participants to understand. Moreover, despite their utility, they are inherently limited, uncertain tools that cannot be used without making subjective assumptions, and their complexity and opacity may hinder public understanding of their proper uses and limitations. Accordingly, effective public participation in model-based planning processes, though legally required and potentially important, is difficult to achieve.

The San Joaquin Valley's efforts to plan for compliance with the federal ozone standard illustrate the challenges facing would-be participants in model-based planning processes. Modelers and planners in the San Joaquin Valley engaged in a relatively well-funded effort to develop plans that would achieve attainment of the federal standard by 1999. Despite the Clean Air Act's mandate for public involvement, their efforts involved participation only from the agency staff and industry. Publicly available documents did not contain readily understandable discussions of uncertainties and subjectivity, and the agencies did not employ mechanisms, such as educational outreach or participation grants, for improving public understanding of modeling. As a result, the process was, as a practical matter, closed.

This closure was unfortunate. By providing a means for skeptical review of the plan, greater public participation might have led to revisions that would have allowed the plan to succeed. Even if greater public participation had not led to attainment of air quality goals, it could have increased public understanding of the Valley's air pollution problems, creating the foundations for successful collaboration in future planning efforts. Finally, regardless of any substantive outcome that greater public participation might have achieved, such participation would have allowed the public more say in decisions that directly affected its quality of life. Such a change would have made the process, if not more effective, at least more consistent with legal mandates for participation, and also more democratic and just.

Mechanisms for avoiding such closure, without compromising the technical rigor of planning decisions, do exist. By providing more complete disclosure of uncertainties and assumptions, modelers and planners may allow public participants to achieve more thorough understanding of the uses and limitations of models and the associated decision risks. Likewise, by providing resources to promote public understanding, modelers and planners can support public participation;

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outreach efforts, publicly available model critiques, peer reviews, and participant funding mechanisms all can increase the utility of public-expert dialogue. Finally, sophisticated judicial review of the ways in which models are used and discussed can provide public participants with the leverage to more effectively use their participatory rights while also allowing agencies the flexibility to be candid about the strengths and weaknesses of their models.

These mechanisms will not be perfect solutions; participating in model-based planning processes will remain challenging. Nevertheless, these improvements should help model-based planning to become both more democratic and more compliant with conflicting mandates of environmental law.
