Land & Water Law Review

Volume 13
Issue 1 *The Geothermal Resources Development Institute*

Article 13

1977

An Environmental Overview of Geothermal Resources Development

A. Dan Tarlock

Richard L. Waller

University of Wyoming
College of Law
LAND AND WATER
LAW REVIEW
VOLUME XIII 1977 NUMBER 1

While the adverse environmental effects of geothermal resources development appear to be less severe than those created by other energy sources, geothermal development nonetheless poses serious environmental problems. Professor Tarlock and Mr. Waller identify and discuss four categories of potential adverse environmental impacts of geothermal development: land use disturbance, water pollution, air pollution and noise.

AN ENVIRONMENTAL OVERVIEW OF GEOTHERMAL RESOURCES DEVELOPMENT†

*A. Dan Tarlock**

*Richard L. Waller***

I. INTRODUCTION

A large part of the argument for the accelerated development of geothermal resources rests on the assumption that this energy source is environmentally superior to fossil fuels, nuclear energy, and arguably, hydroelectric power. Development of geothermal energy is not without serious environmental problems, but this energy source can be produced with less landscape disturbance and residual discharge than are required for the three primary energy sources.[1] For example,

†This article was originally published in the Rocky Mountain Mineral Law Foundation's Geothermal Resources Development Institute. Reprinted with permission.

*Professor in Residence, Kutak, Rock, Cohen, Campbell, Woodward & Garfinkle, Omaha, Nebraska (Fall 1977); Professor of Law, Indiana University; A.B., 1962, Stanford University; LL.B., 1965, Stanford University; member of the California Bar.

**Third year law student, Indiana University.

The research for this paper was done pursuant to a grant from the Energy Research and Development Administration to Indiana University and the University of Utah for a study of the relationship between geothermal development and state water quality and quantity law, A. Dan Tarlock and Owen Olpin co-principal investigators. The support of the Energy and Research and Development Administration is gratefully acknowledged.

1. As of December 31, 1974, the energy resource mix in the Western States was gas and oil 30.9%; coal 13.5%; hydro 47.1%; nuclear 1.5%; and other sources, including the exotics 7.1%. By 1984, gas, oil and hydro are expected to decrease while coal rises to 23.1% and nuclear 14.2%. Thus, it is reasonable to compare geothermal resources primarily with coal and nuclear power plants because exploitation of these resources must increase if energy demands continue to increase.

The Geysers field in northern California requires about twelve square miles of land for the 150 wells which will eventually be necessary to support 1,000 megawatts of generating capacity.[2] In 1972 the Atomic Energy Commission estimated that the nuclear industry held more than nineteen million acres of land for uranium mining and exploration. When the land use requirements of The Geysers are extrapolated to all geothermal sites that may be in production by 1985, the favorable comparison between geothermal and nuclear energy is clear;[3] similar comparisons can be made between geothermal and coal. The residual discharges of a geothermal plant are significantly less than those of coal fired and nuclear plants. Comparing the discharges of sulfur dioxide from coal fired to the hydrogen sulfide discharges from a geothermal plan Bowen writes:

> To place the release of hydrogen sulfide from geothermal plants in its proper perspective, the release should be compared to that of fossil-fuel plants. Using for comparison a 1,000 Mw plant fired by coal and 1 percent sulfur and the steam conditions at The Geysers, the fossil-fuel plant would release 140 tons of sulfur dioxide per day. By comparison, the geothermal plant with a flow of 430 million pounds of steam per day containing 0.0225 percent hydrogen sulfide would bring to the surface 48.4 tons of hydrogen sulfide per day. If 30 percent is returned to the reservoir with the steam condensate, as seems to be the ratio now, the total release would be 33.9 tons or about one-fourth the sulfur dioxide from the coal plant. This constitutes the release without pre-treatment. . . .[4]

Two major variables govern the level of potential adverse environmental impact of a geothermal development. These are the character of the heat resource and the stage of development. At the present time the heat source with the greatest commercial potential is the hydrothermal convection reservoir.[5] Such reservoirs are either vapor or liquid dominated

2. Bowen, *Environmental Impact of Geothermal Development* in GEOTHERMAL ENERGY: RESOURCES, PRODUCTION, STIMULATION, 197 (Kruger & Otte eds. 1973).
3. *Id.* at 205-207.
4. *Id.* at 208-209.
5. Three classes of geothermal reservoirs have been identified by the U.S. Geological Survey: (1) hydrothermal, (2) hot-igneous, and (3) conduction dominated systems. U.S. GEOLOGICAL SURVEY, ASSESSMENT OF GEOTHERMAL RESOURCES OF THE UNITED STATES—1975 (U.S. Geological Survey Circular 726). Liquid dominated systems, which offer the greatest potential, are further subdivided by temperature

and thus produce either steam or hot liquids. Geothermal development can be divided into five stages: (1) exploration, (2) test drilling, (3) production testing, (4) field development, and (5) power generation. The first section of the paper surveys the major expected physical adverse environmental impacts which can be expected at each stage of development.[6]

II. CLASSIFICATION OF ENVIRONMENTAL IMPACTS

Four categories of potential adverse environmental impacts have been identified: land use disturbance, water pollution, air pollution, and noise. Land use disturbance and water pollution appear to be the most important problems.

A. Land Use Problems

During the exploration and drilling stages there will be various land use disturbances associated with road and well site preparation. These range from short-lived nuisance conditions to the possible permanent displacement of wildlife habitats. If a field proves to be productive, a well will be drilled every one-fourth to one-eighth of a mile, pipelines laid, and a power plant constructed. A geothermal field and associated power plant raise the same land use problems as any other industrial use: Is it or can it be made compatible with surrounding land uses? Since a power plant must be built at the field, geothermal development will generally convert undeveloped land to a more intense use, and the dedication of land to energy development may be opposed on the grounds that maintenance of a natural environment for the enhancement of landscape aesthetics or public or private recreational uses are the preferred uses. Aesthetic conflicts are likely to be most intense if geothermal leasing is allowed in wilderness areas. But, the problem is a general one, since geothermal development will often occur in scenic areas which have no special federal or state legislative protection. Leaving aside the value

range. A surface temperature of greater than 150°C. will be required to produce electricity. Temperatures in the two ranges below 150°C. are useful for space and process heating. *Id.* at 7.

6. These are the stages discussed in U.S. DEPARTMENT OF THE INTERIOR, 1 FINAL ENVIRONMENTAL IMPACT STATEMENT FOR THE GEOTHERMAL LEASING PROGRAM, Chap. 3 (1973) [hereinafter cited as FINAL EIS]. The environmental problems encountered during exploration, test drilling, and field development are also discussed in Reed & Campbell, *Environmental Impact of Development in the Geysers Geothermal Field, USA*, UNITED NATIONS SYMPOSIUM 1399, 1400-1406 (1976).

questions inherent in choosing between preservation and development, the Department of the Interior's Final Impact Statement on the leasing program, quoted below, is optimistic that land use conflicts in connection with geothermal development will be limited,[7] although other studies are somewhat more skeptical:[8]

> The adverse environmental effects of geothermal development may decline as the field comes into full-scale production. If proper environmental measures have been fully implemented during the construction phase, vegetative cover will begin to cover exposed soils where conditions are conducive to plant growth, drainage and soil erosion measures will control runoff to minimize both on and off-site damage. The physical disturbances and activities associated with construction will have ended. During the production period, activities primarily will consist of the operation and maintenance of the power plant and related facilities and the drilling, redrilling, and workover of geothermal wells to maintain production capacity. Overall activity will be considerably reduced over that required during field development and the construction of power generation, power transmission and related facilities. A state of use equilibrium will be reached which will be conducive to broader multiple land uses such as wild life habitat, grazing and agriculture. For example, the Larderello field in Italy is in an area of intensive agricultural development. Within the confine of the field there are many farms, vineyards and orchards adjacent to producing wells, pipelines and power plants.

Two other land use problems have been mentioned. These are subsidence and seismic activity. Subsidence can occur when fluids supporting the overlying lands are withdrawn, and seismic activity is a possibility when waste fluids are injected into a reservoir.

---

7. FINAL EIS at III-33.
8. STANFORD ENVIRONMENTAL LAW SOCIETY, GEOTHERMAL ENERGY: LEGAL PROBLEMS OF RESOURCE DEVELOPMENT 23-24 (1976). There is increasing recognition of the role of scenic preservation in the states' land management system. ALASKA STAT. 38.05.181(c) (1975) provides that preservation of the state's natural scenic values in those areas where geothermal resources are found is a factor to be taken into account in leasing decisions. Consideration of scenic values extends beyond the protection of geysers and hot springs which are specially mentioned in the section. *See also* the Montana Natural Areas Act of 1974, REV. CODES MONT. ANN. 81-2701 (Supp. 1975), which authorizes the state to set aside natural areas it owns or acquire them by purchase.

B. Water Pollution Problems

During the drilling phases the most serious water (and air) pollution problems will occur if there is a blow out. This danger is greatest during test drilling due to the limited available knowledge about subsurface reservoir geological and thermal conditions, although a blow out could occur at any subsequent stage. In addition to blow outs in the immediate vicinity of the well, other areas some distance away can be affected by a well experiencing difficulties; cratering and mud ejection could cause local property damage and water pollution could occur because of brine disposal. Considerable experience about blow outs has been gained in New Zealand, at The Geysers, and in the Imperial Valley so that more is now known about the proper technology to be applied during drilling.[9]

Water pollution problems during power generation may arise in connection with the disposal of cooling waters and the disposal of wastes from liquid dominated systems. The latter is by far the most serious problem, since although a geothermal plant is less efficient than a nuclear or coal-fired plant, it does not require a supplementary source of cooling water. Dry steam systems present almost no environmental hazard since the steam can be either evaporated through a cooling tower or reinjected into the reservoir. Waste from liquid-dominated systems can also be recycled but more risk of pollution is associated with the reinjection of saline brines back into the reservoir. If these saline brines are allowed to mix with groundwater acquifers tapped for municipal or irrigation users, serious water pollution would result. The problem of brine disposal is further complicated by the fact that reinjection may be necessary to prevent subsidence. "Hot water fields, by contrast" to dry steam fields "could behave like unconsolidated petroleum reservoirs, and unless pressures are maintained by fluid return there may be subsidence."[10] Further, the presence of silica polymer in the reinjection water may limit the usefulness of this pollution control technique. Concern has also been expressed that reinjection will trigger seismic activity in the area.

9. FINAL EIS at III-4-11 contains a good discussion of the problem, and analysis of why specific blow outs have occurred, and suggestions as to corrective measures which should be taken during drilling.
10. Bowen, *supra* note 2, at 204. *See Id.* at 210-213 for a discussion of the impact of geothermal development on conventional surface water and groundwater uses.

C. *Air Pollution Problems*

A steam or flashed geothermal power plant discharges about 98-99.5 percent water vapor and operates without combustion. Of the small flow of non-condensate gases 1.4 percent of this is hydrogen and 4.5 percent is hydgrogen sulfide, a noxious, highly poisonous gas. Methane and ammonia are also discharged. As mentioned previously, hydrogen sulfide may be transformed into sulfur dioxide as a result of contact with the air. At present the major air pollution problem seems to be that hydrogen sulfide, which is not easily dispersed, can be discharged in amounts above its toxic levels, and at all levels it smells.[11] Still the discharges seem basically a localized nuisance problem and one which is solvable by technology.[12] Still, the lack of scientific research and baseline standards for air emissions will cause concern when geothermal development is proposed. Napa County near The Geysers lists the spectors of acid rain fall, smog, effects from the increased levels on non-condensate emissions and climate modification as the reasons for a new ordinance stringently regulating geothermal development.[13]

D. *Noise Pollution Problems*

The testing and maintenance of geothermal wells present special, localized, noise pollution problems. Wells must be

11. Nevertheless, hydrogen sulfide emission does present a genuine, if localized, problem at The Geysers. Emissions frequently exceed ambient air quality standards for the Northern Sonoma County Air pollution District, and in the resort and residential areas to the east. As of November 1973, The Geysers were releasing some 15 tons per day of hydrogen sulfide, enough to contaminate about 600 cubic miles of air, at least to the extent of causing an odor problem.

So far, then, the problem is a local one; and its severity is a function of the proximity of the observer to the site of generation. If a total of 1000 megawatts were generated to one site, about 97,000 pounds per day of hydrogen sulfide would be released into the atmosphere. This is approximately equal to the amount of sulfur released by a plant of the same capacity burning low sulfur fuels. However, when The Geysers field reaches this size, technology should be available to minimize emission.

STANFORD ENVIRONMENTAL LAW SOCIETY, GEOTHERMAL ENERGY, *supra* note 8, at 28.

12. Pacific Gas and Electric Company is experimenting with altering the water chemistry of the process cycle at The Geysers to convert the hydrogen sulfide to elemental sulfur and sulfides which do not escape into the atmosphere. However, a sludge disposal problem remains. *Id.* at 29. For a more critical discussion of the problem of hydrogen sulfide emissions at Wairakei, New Zealand, a liquid-dominated hydrothermal concetion system, and The Geysers *see* AXTMANN, AN ENVIRONMENTAL STUDY OF THE WAIRAKEI POWER PLANT 15-17 (1974). Professor Axtmann's findings do not contradict other assessments of the hydrogen sulfide problem, but point up the problems of generalizing from the limited experience to date with the environmental aspects of geothermal development.

13. NAPA COUNTY CAL. ORDINANCES Tit. X, art. 3, § 10428(a) in Trower, *An Overview of the California Permitting Process*, 13 LAND & WATER L. REV. 325 (1977).

bled before they go into production and again during production so that they will remain operational. The venting of large amounts of steam can produce a high volume roaring for hours or days at a time.[14] Mufflers are used at The Geysers with considerable success, but nuisance problems remain. Even with the use of mufflers, a geothermal field and associated power plants will change the noise level of an area to that of an industrial area. Cyclonic mufflers can reduce venting sound levels from 120 db(A) at 50 feet to 80-90 db(A) at 50 feet (a sound level between an unmuffled diesel truck and a street corner in a large city.[15] Depending on the location of the field and the character and density of surrounding land uses, noise control will be a major factor in the application of land use regulations.

E. Conclusions Drawn from Available Data on Environmental Impacts

Two conclusions seem to follow from this brief description of the potential adverse environmental impacts of geothermal development. First, most of the impacts seem to be localized and immediate. Geothermal development is not without risks of environmental harm, but it does not present the long term and widespread risks that nuclear energy or the use of chemical pesticides poses. The second and related conclusion is that most environmental problems connected with geothermal use can be solved through the adoption of mitigation measures during the various stages of development. Geothermal development does not force a regulator to make the difficult decision of whether something should be allowed or prohibited entirely. Therefore, because of its favorable environmental impacts compared to coal and nuclear energy, geothermal development ought to be presumed beneficial, and regulatory activities should focus on conditioning the development of the resource at each of the five stages.

III. LAND USE REGULATION

Regulation of land use and development is the least standardized of all environmental controls. The problem is partic-

See also CALIFORNIA INSTITUTE OF TECHNOLOGY, JET PROPULSION LABORATORY, GEOTHERMAL ENERGY RESOURCES IN CALIFORNIA: STATUS REPORT, 5-39 (June 30, 1976). [Hereinafter cited as GEOTHERMAL ENERGY RESOURCES IN CALIFORNIA.]

14. STANFORD ENVIRONMENTAL LAW SOCIETY, GEOTHERMAL ENERGY, *supra* note 9, at 31. *See also* FINAL EIS at III-84.

15. SACARTO, STATE POLICIES FOR GEOTHERMAL DEVELOPMENT 56 (1976).

ularly acute on federal and state owned lands where historic policies of disposal and exploitation subject to scientific conservation constraints are being reevaluated. Mineral exploitation can occur on federal, state, or private land. As owner of the public domain, the federal government has the constitutional authority to decide how the federal lands shall be used.[16] Control over geothermal development on federal lands has been largely delegated to the Bureau of Land Management and the United States Geological Survey in the Department of Interior and the United States Forest Service in the Department of Agriculture. States, however, need not completely rely upon the actions of the Department of the Interior. They can exert indirect controls over development pursuant to federal leases. Compliance with federal *and state* air, noise, and water quality standards are required of all federal leases by the Steam Act regulations.[17] In 1976, the Supreme Court held that this provision is required by the Clean Air Act of 1970 and the Federal Water Pollution Control Act Amendments of 1972.[18] Geothermal development on state lands will be generally controlled by state land departments and other state mission agencies. Control over development on private lands will be shared among state mission agencies, units of local government, and newer regulatory bodies such as energy siting facility agencies, where they exist. The degree of land use regulation at the state and local level varies enormously among the Western States.

Despite the variations which exist among all three levels of government trying to control geothermal development, they all rely upon two principal regulatory techniques: (1) planning and environmental impact assessment followed by the imposition of controls on a case by case basis and (2) conventional land use controls such as zoning. Ideally, planning should be done through an environmental impact assessment

16. "Congress exercises the powers of both a proprietor and of a legislature over the public domain." Kleppe v. New Mexico, ___U.S. ___, 96 S.Ct. 2285, 2292 (1976).
17. 43 C.F.R. § 3204.1(c) (1976).
18. 42 U.S.C. § 1857(f) (1970) and 33 U.S.C. § 1323 (1970) provide that federal installations and activities must comply with state air and water quality standards but both acts fail to specify the method of enforcing this requirement. In 1976, the Supreme Court held, reasoning from general principles of federal supremacy, that neither act requires a federal agency or permitee to obtain a state discharge permit. Rather, state standards must be enforced by the Environmental Protection Agency through the permits and regulations it issues. Hancock v. Train, ___U.S. ___, 96 S.Ct. 2006 (1976) and Environmental Protection Agency v. California Water Resources Control Bd., ___ U.S. ___, 96 S.Ct. 2022 (1976).

process. The resulting federal, state, or local environmental impact statement should serve as the planning predicate for the subsequent exercise of specific controls such as the mapping of a zoning district or the issuance of a conditional use permit. Geothermal development planning is essential if only because the major land use problems facing the developer today are often not making the substantive case for the reasonableness of a particular geothermal exploration or exploitation project but finding the regulator who can give final approval to the project. For example, California has recently identified nine federal, sixteen state, and at least three local agencies with some authority over geothermal development, and there is less than complete coordination among these agencies so the developer is left with the task of not only making the substantive case but stitching together an approval procedure so that the development can proceed. In other states the degree of land use regulations is less, but coordination problems remain. A one-stop licensing process for all phases of geothermal development is not desirable at this stage of the industry's development since consideration of all reasonable consequences of *each* stage of development might unduly prolong permit hearings,[19] but it is the responsibility of governmental units to minimize a developer's coordination problems so that he can concentrate on assembling the information on which the reasonableness of a project can be assessed and mitigation measures imposed. In fairness to the states it must be pointed out that substantial concern over the environmental impact of geothermal development did not start until 1975, and a literature sufficient to use in formulating baseline standards against which to test developments is just emerging.

A. Land Use Controls on Federally Leased Lands

(1) NEPA Problems

In a geothermal development two types of land use conflicts are likely to arise at any stage. The first is obviously whether the development should occur at all, and the second

19. Apparently to avoid such delays Oregon has separated geothermal development into three phases—pre-exploration, exploration, and production—and each phase is evaluated separately. OR. REV. STAT. § § 522 *et seq.* (1975). Thus, the environmental impact of an exploration activity will not be evaluated on the basis of the potential adverse environmental impacts that a geothermal field and power plant might have. Under a one-stop procedure, the impact of one phase would have to be evaluated in terms of the impact of future phases.

is how it should occur. For example, during exploration the haul route to the drilling site must be chosen and in connection with a power plant development measures such as the sloping of cut banks, revegetation, soil stabilization, and drainage must be considered. Generally, geothermal fluids and steam can be transported only about one mile due to temperature and pressure loss constraints, so the question of whether a geothermal development should occur should only be raised when resources devoted to environmental quality maintenance with a nationwide impact must be sacrificed. Otherwise environmental review should focus on the question of how the development should take place. The reason is that an unsightly generating facility must be built somewhere at the reservoir site, and there is comparatively little that can be done to improve the aesthetics of a power plant, cooling towers, and the necessary gathering lines short of asking a pop artist to paint designs on them.

Leasing on federal lands is under the jurisdiction of the Bureau of Land Management and the Forest Service. Environmental controls will, of course, be exercised at all stages of development but the most important regulatory issues currently center around BLM and Forest Services exploration procedures, pre-leasing environmental impact assessment, and the question of whether wilderness areas are open to geothermal leasing.

All federal agencies are subject to NEPA, but when do the Section 102(c) duties attach? Geothermal development, because so little is known about field potentials, takes place in more discrete stages than other forms of mineral development. *Sierra Club v. Kleppe*[20] approved the Tenth Circuit's holding in *Davis v. Morton*[21] that federal leases can trigger NEPA. However, unlike other federal mineral leases, a geothermal lease may signify no development as even a lease in a KGRA may be little more than a 20-1 lottery ticket.[22] Thus, it need not be automatically concluded that every pre-lease action or even that every geothermal lease is a major federal action significantly affecting the quality of the human environment which triggers NEPA. Unfortunately, the Depart-

20. ____ U.S. ____, 96 S.Ct. 2718 (1976).
21. 469 F.2d 593 (10th Cir. 1972).
22. Sacarto, *supra* note 15, at 21-22.

ment of the Interior regulations issued pursuant to the Steam Act of 1970 simply pass the problem to the courts by providing that NEPA will apply if the statutory threshold is met.[23]

Strong arguments can be made that pre-leasing exploration actions authorized under Section 3209.0-1 of the regulations should be exempt from NEPA. These activities involve no drilling and little landscape disturbance. Language in the 1973 Final Environmental Impact Statement for the Geothermal Leasing Program might be used to contradict this argument but statements that exploration prior to leasing could have significant environmental impacts can be dismissed as bureaucratic caution.[24] This argument is a hard one, however, given the threshold standards that the courts have set up for up-holding the validity of an agency negative declaration that a full EIS is not required. It will be even more difficult to convince a court that every lease is not a major federal action.[25] Nonetheless, the Forest Service is considering the possibility of postponing preparation of an EIS until after leases are issued to expedite its leasing program. Postponement is arguably inconsistent with the *Greene County* rule which requires agency preparation of an EIS prior to the initial decision.[26] However, the reality that every lease will not result in production provides the basis for exempting geothermal leases from this construction of NEPA. Scarce agency resources devoted to EIS preparation would be better spent on projects that are likely to lead to production or at least sufficient exploratory and testing wells which have the same impacts as production. Some support for this position can be found in the first California case to consider the scope of a state EIS for geothermal development. Lake County issued a conditional permit to drill exploratory wells on the basis of an EIS which did not consider the impact of commercial production in the event that the wells were successful. An intermediate appellate court opinion held that the EIS was sufficient because "without exploratory drillings, full field development remains a mere contingency. . . . At this point no one knows whether the exploratory wells will uncover a reservoir of geothermal energy."[27]

23. 43 C.F.R. § 3200.0-6 (1970).
24. FINAL EIS at III-3.
25. *E.g.*, Simmans v. Grant, 370 F. Supp. 5 (S.D. Tex. 1974) and Save Our Ten Acres v. Kreger, 472 F.2d 463 (5th Cir. 1973).
26. 455 F.2d 412 (2d Cir.), *cert. denied*, 409 U.S. 849 (1972).
27. Lake County Energy Council v. County of Lake, 139 Cal. Rptr. 176 (1977).

To date a programmatic impact statement has been issued for the initial phases of the leasing program which should serve as a partial framework for the issuance of subsequent individual impact statements. After the EIS was prepared, geothermal leasing and development regulations were issued pursuant to the Geothermal Leasing Act of 1970. BLM and U.S.G.S. have opted for the promulgation of generalized environmental standards in the regulations because so little is known about specific geothermal development impacts apart from The Geysers experience.[28] Detailed environmental standards will be developed in connection with individual leases, permits and operating orders so that environmental conditions can be tailored to a particular field. This strategy is confirmed in the August, 1975 Cooperative Procedure Agreement between BLM and U.S.G.S. for coordinating NEPA requirements. U.S.G.S. is primarily responsible for "[e]nvironmental considerations of the proposed action including existing environmental conditions, anticipated impacts from the proposed action, mitigation measures to be applied, recommended additional mitigation measures to be taken, and commitments of natural and human resources." BLM is responsible for "[a]nalysis of the proposed action and alternatives including: anticipated impacts, possible mitigating and enhancing measures, recommendations for mitigation or enhancement of beneficial environmental impacts. . . ."[29]

Assuming that an impact statement must be filed, the question becomes what is an adequate EIS and what is its scope? The law of NEPA rivals the Internal Revenue Code in its subtlety and complexity so only those aspects directly relevant to the preparation of geothermal impact statements will be discussed and adequacy is largely determined by the standards the courts have developed since 1971. However, adequacy also ought to be a function of the role that EIS is expected to play in the regulation of the activity. Environmentalists have had so much success with using the EIS to delay a project that they have somewhat deflected our attention away from the fact that preparation of an EIS is not always the principal environmental check on a federal activity. BLM's

28. FINAL EIS at IV-13.
29. Cooperative Procedures of August 29, 1975, pertaining to Onshore Oil, Gas and Geothermal Resources Operation: Implementation of Secretarial Order No. 2948 between Bureau of Land Management and the Geological Survey, in GEOTHERMAL RESOURCES IN CALIFORNIA, app.

policy with respect to the environmental side-effects of any stage of geothermal development is that mitigation measures exist to minimize adverse environmental impacts and these measures must be tailored to specific leases and permits. Thus, the principal function of the EIS should be to identify potential adverse impacts and to suggest the mitigation conditions for specific permits based on subsequently acquired information as well as to guide BLM and U.S.G.S. officials in making discretionary decisions in administering the permits.

As previously noted, the Final Environmental Impact Statement for the Geothermal Leasing program adopts this theory but will the courts accept the policy? I believe they will as this policy is consistent with the standards the courts have applied to review EIS's. The issue in the ninth and probably tenth circuits is the sufficiency of the impact assessment process rather than the merits of the final decision. Two celebrated early circuit court opinions suggested that beyond the logical requirement of a good faith, objective consideration of the pros and cons, NEPA required a finely tuned and systematic balancing of the costs and benefits of an action and, moreover, that a court can review the merits of the project to determine whether the final balance struck was arbitrary.[30] However, to date, the courts with few exceptions, have confined their review to a rather mechanical check list of the statutory requisites discussed and to reading the statement to insure that the major problems identified are fully discussed. In short, the primary purpose of the EIS remains the disclosure of information about a project and a discussion of the project's pros and cons. For example, the Ninth Circuit has made it clear that the standard of review applied to an EIS is only whether it is procedurally adequate.[31] On the surface

30. Calvert Cliffs' Coordinating Comm., Inc. v. AEC, 449 F.2d 1109 (D.C. Cir. 1971), and Environmental Defense Fund, Inc. v. Corps of Engineers, 470 F.2d 289 (8th Cir. 1972), *cert. denied*, 412 U.S. 931 (1973).

31. Judge Sneed has concisely formulated a workable standard of procedural adequacy:

> It follows, therefore, that in determining whether the appellees prepared an adequate EIS we will be guided in large part by 'procedural rules' rooted in case law. No synthesis of these rules will be attempted other than to point out that all such rules should be designed so as to assure that the EIS serves substantially the two basic purposes for which it was designed. That is, in our opinion an EIS is in compliance with NEPA when its form, content, and preparation substantially (1) provide decisionmakers with an environmental disclosure sufficiently detailed to aid in the substantive decision whether to proceed with the project in the light of its environmental consequences, and (2) make available to the public, information of the proposed project's environmental impact and encourage public participation in the development of that information.

Trout Unlimited v. Morton, 509 F.2d 1276, 1283 (9th Cir. 1974).

procedural adequacy is a meaningless standard because there are no accepted procedures for the preparation of an EIS, but as applied by the courts it is consistent with what other circuits have held to be the standard of an adequate statement which is: "Whether the decision making process adequately took into account environmental considerations and ramifications."[32]

To meet this standard an EIS must be detailed, as the Eighth Circuit recently put it, to insure "the integrity of the process by requiring *reasoned* analysis in response to conflicting data or opinions on environmental issues."[33] The detail requirement has been tempered by a rule of reason, but many hurdles remain for the potential geothermal developer. The degree of specificity of a statement has, of course, not been determined, and the following issues are potential sources of litigation:

(1) Economic and social impacts. Development of a geothermal field will trigger some secondary development in the area. The impact will be much less than the case of coal fired plants and strip mines, but the issue of economic and social impact of energy development is important in the West. The courts, including the Ninth Circuit, have held the socio-economic impacts of urban growth must be taken into account when the project has a primary physical impact on the environment.[34]

(2) Methodology challenges. Land management agencies often use matrices to display the environmental impacts of alternatives and to propose mitigation measures. In this way

32. Concerned About Trident v. Rumsfeld, *aff'd in part, rev'd in part*, ____ F.2d ____, 9 ERC 1370 (D.C. Cir. 1976). Further support for this theory of the EIS is found in the widely accepted rule that "[a]n on-going study does not render a FES [Final Environmental Statement] inadequate so long as the need for the such continuing study is stated in the FES." Sierra Club v. Froehkle, 534 F.2d 1289 (8th Cir. 1976); United Farmers v. Kleppe, ____ F. Supp. ____, 9 ERC 1513 (D.S.D. 1976). *See also* New York v. Kleppe, ____ F. Supp. ____, 9 ERC 1769 (E.D. N.Y. 1976), preliminary injunction stayed, ____ F.2d ____, 9 ERC 1794 (2d Cir. 1976), *aff'd*, ____ U.S. ____, 9 ERC 1795 (1976) where Judge Weinstein ruled that it was reasonable for the Secretary of the Interior to complete baseline studies in the Baltimore Canyon the Outer Continental Shelf after issuing oil and gas leases but prior to any production or development based on information acquired during the exploratory phase of environmental monitoring: "In view of the enormous range of probabilities, an administrator such as the Secretary might well have concluded that the gross data available sufficiently apprised him of the overall dangers, so that further refinements were not worth the delays required to make them." 9 ERC at 1773.

33. Minn. Pub. Interest Research Group v. Butz, 541 F.2d 1292, 1300 (8th Cir. 1976), *cert denied*, ____ U.S. ____, 97 S.Ct. 347 (1976).

34. Breckenridge v. Rumsfeld, ____ F.2d ____, 9 ERC 1059 (6th Cir. 1976) City of Davis v. Coleman, 521 F.2d 661 (9th Cir. 1975).

adverse environmental impacts can be weighted. Occasionally, district courts have held that such matrices are inadequate because they come to the wrong conclusion but the Eighth Circuit has recently held (a) an EIS can contain a matrix chart of potential adverse impacts, (b) narrative paragraphs are not therefore required for each "bit" of information, (c) the preparation of the matrix, *e.g.*, the weight to be assigned to different impacts, is within the discretion of the federal agency in the absence of a showing of arbitrariness or capriciousness, and (d) thus the decision maker can rely on the information contained in the matrices in making its decision.[35]

(3) Alternatives. Geothermal energy is an alternative energy source that ought to be—and has been considered by—federal agencies in discussing other energy programs such as liquid metal fast breeder reactor. But a geothermal EIS might be attacked for failing to consider energy conservation as an alternative. The requirements of an adequate discussion of alternatives are derived from *Natural Resources Defense Council v. Morton*.[36] Recently, the District of Columbia Circuit clarified and expanded *Morton* in *Aeschliman v. Nuclear Regulatory Commission*,[37] which holds that an intervenor must only establish a colorable alternative to trigger an agency affirmative duty to undertake a preliminary investigation of energy alternatives. The NRC had ruled that a plaintiff can trigger a consideration of alternatives only by showing that a threshold test was met. To meet this test an intervenor was required to prove (1) that conservation methods exist which would curtail demand at a level for which the proposed facility would not be needed and (2) that the availability of the alternatives is susceptible to a reasonable degree of proof and thus the proffered alternatives are not speculative. The District of Columbia Circuit held that this standard was inconsistent with *Morton* as it incorrectly placed the burden of proof of alternatives on intervenors.

Related to the issue of what action triggers an EIS and what issues must be disused to meet the requirement of adequacy are the questions of the scope and time frame of the EIS. These issues include the geographical area that must be

35. Minn. Pub. Interest Research Group v. Butz, 401 F. Supp. 1276 (D. Minn. 1975), *rev'd*, 541 F.2d 1292 (8th Cir. 1976).
36. 458 F.2d 827 (D.C. Cir. 1972).
37. 547 F.2d 622, 9 ERC 1289 (D.C. Cir. 1976).

discussed and the relationship between the action being reviewed in the EIS and future related actions which may be triggered by the initial action. The Supreme Court held in *Kleppe v. Sierra Club* that a regional EIS must be prepared only if the agency has committed itself to a regional program or has arbitrarily failed to prepare a regional EIS when a series of interrelated impacts are involved. Justice Powell, writing for the majority gave great, if not conclusive, weight to the Department of the Interior's conclusion that a regional impact statement was not feasible for Northern Great Plains coal development. He did, however, indicate that a comprehensive impact statement may be necessary to meet Section 102(c) duties when several proposals for action will have cumulative or synergistic environmental impacts. Thus, it would seem that the Ninth Circuit's opinion in *Cady v. Morton* is still good law.[38] *Cady* held that an EIS had to be prepared for all the contemplated phases of a coal mining program on Indian lands which would ultimately mine some 30,876 acres leased from the Crow Tribe (and approved by BIA) and that each separate mining plan for smaller tracts had to be accompanied by an adequate EIS. The one case to date discussing the scope of a geothermal environmental impact statement, the California state decision in *Lake County Energy Council v. County of Lake*,[39] holds that a statement prepared for an exploratory permit need not discuss the impact of commercial field development because that is a mere contingency. If *Lake County* is followed, it may come to stand for the broad proposition that the assessment of the impact of full field development may be postponed until after there is a reasonable probability that a field will be commercially productive. Such a rule would allow a series of impact statements to be prepared in connection with a lease and should speed exploration and production testing since the initial statements could be less detailed.

(2) Status of Wilderness Areas

Several categories of public lands are excluded from geothermal leasing. As required by the Geothermal Steam Act

38. 514 F.2d 856 (9th Cir. 1975). The Bureau of Indian Affairs planned to prepare EIS's only for mining plans on independent portion of the federal lease. *See generally* Keiner, *NEPA Requirements for Federal Coal Development*, 9 NAT. RESOURCES LAW 491 (1976).

39. 139 Cal. Rptr. 176 (Court of Appeal, 1st Dst. 1977).

of 1970, Section 3201.1-6 excludes national park lands (the fear of a power plant in Yellowstone National Park was a factor in President Johnson's veto of the 1965 version of the Act), national recreation areas, fish and wildlife conservation areas, and individually or tribally owned Indian lands.[40] However, both the Act and the regulations are silent on the question of geothermal leasing in wilderness area.[41] Based on the current controversies there are two sources of legal conflicts that a geothermal developer will face. Exploration applications have already been denied for geothermal exploration in the Glacier Peaks Wilderness Area and further conflicts can be anticipated in Washington and around Mount Hood in Oregon.[42] It can be argued that the Steam Act is *per se* inapplicable to wilderness areas or that even if the Act is applicable, it would be an abuse of discretion to issue a lease for a wilderness area.

The problem is this: The Secretary of Agriculture is authorized to issue leases for exploration and development in national forests and other lands administered by the Secretary of Agriculture. Mining is allowed in wilderness areas until the end of 1983 to the extent that the mineral leasing laws were applicable on the date of the passage of the Wilderness Act. The Geothermal Leasing Act was passed some six years after the Wilderness Act and neither prohibits nor allows geothermal exploitation in wilderness areas. It has recently been argued that because geothermal resources are not authorized to be disposed of under the 1920 Mineral Leasing Act and the Geothermal Leasing Act was passed after the Wilderness Act, the Act is not part of the mining or mineral leasing acts applicable to wilderness areas. Further, it is argued that the later Geothermal Leasing Act should not be interpreted to repeal the general prohibitions against commercial activity in a wilderness area.[43] The Ninth Circuit has recently held that geothermal resources are minerals for the purpose of resolving title disputes between the federal government and a patentee where the minerals were reserved to the United States when the surface was conveyed.[44] *Union Oil* will be used to support

40. Sokol, *Geothermal Leasing in Wilderness Areas*, 6 ENVT'L. L. 489, 492 (1976).
41. 30 U.S.C. § 1014(c) (1970).
42. Sokol, *supra* note 38.
43. *Id.* at 489.
44. United States v. Union Oil Co., 369 F.Supp. 1289 (N.D.Cal. 1973), *rev'd*, 549 F.2d 1271 (9th Cir. 1977).

the argument that geothermal leasing is permitted in wilderness areas. However, this result does not automatically follow from *Union Oil* because the 1970 Steam Act creates a separate leasing regime for post-1970 geothermal activity, and thus the intent of Congress in 1970 remains the crucial issue. It should still follow that Congress considered geothermal resources non-leasable until 1970.

Even if leasing is allowed as a general matter, specific lease applications may still have to be denied. The issuance of a lease by BLM or the Forest Service is a discretionary act and nominations can be rejected because of the environmental consequences of a lease or because other land uses have a higher priority.[45] Thus, even if geothermal exploitation is covered under the mineral leasing acts, substantial questions exist as to whether any mining is allowable in a wilderness area. A series of decisions involving the Boundary Waters Wilderness area in Minnesota suggest that the courts may invalidate specific mining and timber harvesting permits as arbitrary under NEPA and the Wilderness Act.[46] Such results are reasonable in light of the purpose of the Wilderness Act. Wilderness areas were set aside to preserve public lands in their natural condition. Mining was allowed primarily to protect the expectations based on existing claims, and since geothermal development was not widespread at the time of the Wilderness Act, the Geothermal Leasing Act should not be construed to allow development in wilderness areas to further the purpose of the Wilderness Act until Congress specifically resolves the issue.[47]

B. Land Use Controls on State Owned Lands

Jurisdiction over mineral development on state owned lands is generally vested in a state lands commission. In some

45. *See Geothermal Energy Resources and Research: Hearings Before the Senate Committee on Interior and Insular Affairs*, 92d Cong., 2d Sess. 11 (1972).

46. Izaak Walton League v. St. Clair, 353 F. Supp. 698 (D. Minn. 1973), *rev'd.*, 497 F.2d 849 (8th Cir. 1974); Minn. Pub. Interest Research Group v. Butz, 401 F. Supp. 1276 (D. Minn. 1975); *rev'd*, 541 F.2d 1292 (8th Cir. 1976). In *Minn. PIRG* a federal district court judge held that commercial logging was not permitted within both the interior and portal zones of the Boundary Waters Canoe Wilderness Area. 401 F. Supp. 1276 (D. Minn. 1975). On appeal the Eighth Circuit reversed and held that Congress had specifically legislated a different scheme for the Boundary Waters Canoe Area than other wilderness areas because the Boundary Water Area had never been managed as a pure wilderness area. Thus, logging was allowed in non-shoreline areas within the Portal but not Interior one. 541 F.2d 1298 (8th Cir. 1976). The precedential value of the reversal of the district court opinion is not therefore strictly applicable to western wilderness areas without specific statutory exemptions.

47. *See* Schlauch & Worcester, *Geothermal Resources: A Primer for the Practitioner*, 9 LAND & WATER L. REV. 327, 334-35 (1974).

states the commission seems to have exclusive jurisdiction over geothermal development. In Arizona, for example, conditional use permits have not been required for any exploration activity. But because the state supreme court has held that ground water which contains mineral byproducts must be sold at public auction, there has been no activity on state owned lands, however easy development may be in theory.[48] In states which have a little NEPA, an EIS prior to a state lease must generally be prepared by a designated lead agency unless the agency issues a negative declaration that one is not appropriate under the circumstances.[49] Other state agencies such as the air and water quality agency or agencies and fish and wildlife are likely to have an institutionalized role in the preparation of an impact statement so that substantial coordination problems leading to delay can arise. These substantial problems aside, in general the same sorts of controls imposed by BLM and U.S.G.S. are likely to be imposed by the states over their own lands.

C. Local Land Use Controls

Geothermal development on state and privately held land is likely to occur in counties with a low population density and an agricultural, mineral, and recreational economic base. Land use controls will therefore generally be exercised at the county level. Counties have three options open to them. Land can be withdrawn from mineral development through a zoning map, land can be allocated for geothermal use in advance of development—again through a zoning map, or exploration and exploitation proposals can be evaluated on an *ad hoc* basis. In the past twenty years local units of government have shifted from controlling land use through the promulgation of uniform standards in advance of development to procedures which allow *ad hoc* assessment of specific projects.[50] This wait and see attitude is especially attractive to rural counties which are becoming increasingly anxious about the growth that accompanies mineral, industrial or recreational development. There is little evidence that geothermal devel-

48. FICO v. Pema Mining Co., ___ F.2d ___ (Ariz. 1976).
49. California, Montana, and Washington have little NEPAs. CAL. PUB. RES. CODE § 21000-174 (West); MONT. REV. CODE ANN. § 69-6517; WASH. REV. CODES ANN. §§ 4321C.010 *et seq.*.
50. *See* HAGMAN, URBAN PLANNING AND LAND DEVELOPMENT CONTROL LAW 206-211 (1971).

opment will be caught in a no growth vise, but counties are likely to retain the flexibility to approve or disapprove specific projects.[51] In addition to the attractiveness of *ad hoc* review as a means of implementing a county's growth policy, such review is often the only effective technique open to a county. Mapping lands for mineral development and then allowing development as a matter of right gives a county too little flexibility; a zoning map can either withdraw land for mineral development or simply confirm the existence of known or potential deposits.[52] Substantial constitutional problems arise when a county attempts to prohibit mineral exploitation, although recent oil and gas and strip mining cases have increased the discretion of regulatory bodies by increasing the burden of proof a land owner must meet to show that there has been a taking.[53]

Ad hoc county control over geothermal development is exercised through the issuance of a series of conditional use permits. Generally, a permit is required for exploratory wells and for the geothermal field and associated power plant. In California the issuance of a conditional use permit is tied to the preparation of an environmental impact assessment.[54] In other states, such as Oregon, a local EIS is not required. Local units of government are not required to prepare environmental impact statements for zoning permits.[55] In addition to the

51. GEOTHERMAL ENERGY RESOURCES IN CALIFORNIA, *supra* note 13, at 5-11.
52. Imperial County is preparing a geothermal element in its County Plan which will require the establishment of geothermal energy development zones—G zones—based on the information generated in connection with the designation by the state of seven KGRA's. *Id.* at 5-58.
53. Bureau of Mines of Maryland v. George's Creek Coal Co., 272 Md. 143, 321 A.2d 748 (1974).
54. For a summary of the procedures employed by various California counties *see* GEOTHERMAL ENERGY RESOURCES IN CALIFORNIA, *supra* note 13, at Ch. 5.
55. *See* Lyons, *Administrative Requirements for Development of Geothermal Resources: The State of Oregon*, 3 GEOTHERMAL ENERGY, No. 9, at 17 (1975) for a brief description of county land use controls over geothermal development in Oregon.

Geothermal development in Oregon has already produced federal-state conflicts over land use decisionmaking:

> On June 30, 1975, the Governor of Oregon approved Senate Bill 210, which was added to and made a part of the Oregon Land Use Planning Act. This new provision states that no activity on federal land which the State may regulate under the Planning Act may be undertaken without a permit first being issued by the affected local government. While the provision does not explicitly provide authority for rejection of a proposed activity on federal land, local governments are empowered to include in any permit conditions or restrictions that are considered necessary to assure that the activity complies with statewide guidelines and local government comprehensive plans. Any person or agency acting in violation of the provision may be enjoined in civil proceedings brought by the State.
>
> Pursuant to the authority granted by Senate Bill 210, the Harney County, Oregon, Planning Coordinator has attempted to require opera-

imposition of development conditions based on the information displayed in the environmental impact statement, Imperial County, California has gone further and enacted a geothermal ordinance which requires a $50,000 indemnity bond for each well drilled or abandoned well reentered and $1,000,000 insurance against the county's being held liable in tort.[56]

Although a conditional permit can be costly and time consuming to obtain, as a legal matter it offers more advantages to a developer than control of geothermal development through map amendments. The theory of a conditional use permit is that environmentally sensitive uses such as deep wells and power plants can only be compatible with surrounding uses if they are reasonably conditioned. However, once a county makes this decision by making geothermal development a conditional use within certain predesignated districts the county should not be able to re-evaluate the desirability of geothermal development *per se* in the context of an application for a specific permit. A geothermal conditional use permit can only be denied upon a showing that the developer cannot comply with the ordinance standards. The issuance of a conditional use permit is properly characterized as a quasi-judicial proceeding which means that the decision must be made on a record—primarily the impact statement—and that a decision based on other than an application of the ordinance standards is arbitrary.[57] It should also follow from the theory of the conditional use permit that all standards must be consistent with the purpose of the permit—to site extrasensitive uses subject to specific performance conditions[58] —but some

tors under approved BLM geothermal exploration notices of intent to apply to the County Planning Commission for conditional use permits. After BLM officials explained to the Planning Commission the limited nature of the authorized exploration activities, the Commission decided not to require permits for anything less than deep-hole exploration. BLM officials "attempted to explain to the coordinator that where a local ordinance conflicts with a federal project, it must yield to federal law, but have not been successful." This matter is presently under consideration with the Department of the Interior.

Shapiro, *Energy Development on the Public Domain: Federal-State Cooperation and Conflict Regarding Environmental Land Use Control*, 9 NAT. RESOURCES LAW 397, 418-19 (1976).

56. *Terms, Conditions, Standards, and Application Procedures for Initial Geothermal Development, County Ordinances Section 83226a, Imperial County*, in GEOTHERMAL ENERGY RESOURCES IN CALIFORNIA, *supra* note 13, at 5-57.
57. *E.g.*, Western Paving Construction Co. v. Board of County Comm'rs of the County of Boulder, 506 P.2d 1230 (Colo. 1973).
58. *See* Pioneer Trust & Savings Bank v. County of McHenry, 241 N.E.2d 454 (Ill. 1971). *See generally* Comment, *Illinois Zoning: Every Use a Special Use*, 1974 U. ILL. L.F. 340.

states including California have allowed cities to use conditional use permits as zoning map amendment applications and to deny enumerated uses on public interest grounds such as lack of need for the use.[59] Given the ability of an environmental assessment process—either formal or informal—to identify mitigation measures, these precedents should not be applied to geothermal development.

IV. WATER POLLUTION REGULATION

Surface water or groundwater pollution is the most significant known environmental problem associated with geothermal development. Vapor-dominated systems pose some problems but the disposal of brines from liquid-dominated systems presents a serious water pollution risk, since the lower thermal efficiencies of geothermal power plants mean more and hotter water compared to fossil fuel plants. This section will discuss the problems that can arise during the drilling and field development stages.

A. Pollution During Exploration and Drilling

During the exploration and drilling stage of geothermal resource development, pollution of surface water and groundwaters may result from (1) the disposal or escape of drilling muds, cuttings or geothermal fluids, (2) blow outs, and (3) erosion. The combination of mud and cuttings generated in the drilling process is generally deposited in sumps or storage ponds susceptible to seepage or spillage.[60] Uncontrolled blow outs are also a potential hazard during geothermal development.[61] A "blow out" occurs when a well builds up sufficient bottom hole pressure to overcome the well's hydrostatic weight. The result is a sudden, forceful and undesired eruption, cleaning out any controls which are retaining the pressure in the hole, whether liquid (*e.g.* mud), valves or tools, so that pressure is violently released into the air.[62] Many blow outs are

59. Van Sicklen v. Browne, 15 Cal. App. 3rd 122, 92 Cal. Rptr. 786 (1971). *See also* Lucky Stores, Inc. v. Board of Appeals of Montgomery County, 312 A.2d 758 (Md. 1973) and Knight v. Bodkin, 344 N.Y.S.2d 170 (1973).
60. STANFORD ENVIRONMENTAL LAW SOCIETY, GEOTHERMAL ENERGY, *supra* note 9, at 26.
61. U.S. ATOMIC ENERGY COMM'N, III PROPOSED FINAL ENVIRONMENTAL STATEMENT, LIQUID METAL FAST BREEDER REACTOR PROGRAM, WASH 1535 6A 4-26 (Dec. 1974).
62. *See* 5 WORDS AND PHRASES 800 (1968); Aderson-Prichard Oil Corp. v. Parker, 245 F.2d 831, 836 (10th Cir. 1957); Equity Oil Co. v. National Fire Ins. Co. of Hartford, 144 F. Supp. 830, 834 (D. Utah 1956).

caused by well casing failure. Pursuant to their power to prevent waste, both state and federal regulations require minimum casing specifications and quickly operable shutoff equipment at the wellhead to restrain any uncontrolled flow.[63] It is estimated that the flow from a blow out in a liquid-dominated field might amount to as much as ten acre feet/day thus subjecting adjacent areas—especially in an agricultural region—to a severe environmental threat,[64] although proper casing design and drilling execution should prevent most blow outs.[65] Additionally, water pollution may result from excavation at the drilling site. Without careful management construction site water runoff will cause heavy erosion and silting of downstream waterways.[66]

Liability for water pollution during exploration and drilling may be imposed upon the geothermal operator pursuant to federal and state water pollution control laws or by common law causes of action. The Federal Water Pollution Control Act Amendments of 1972[67] prohibit the discharge of any "pollutant"[68] into "navigable water"[69] and some state implementation plans promulgated pursuant to the Act extend the prohibition to groundwater.[70] Additionally, any lease award-

63. A "blowout preventer" is a valve device commonly in use in drilling operations to prevent blowouts, explosions, and fires. Taylor v. Industrial Accident Comm'n, 38 Cal. App. 24, 75, 100 P.2d 511, 512 (1940).
64. STANFORD ENVIRONMENTAL LAW SOCIETY, *supra* note 9, at 32.
65. U.S. ATOMIC ENERGY COMM., PROPOSED FINAL EIS, *supra* note 58, at 6A 4-21.
66. STANFORD ENVIRONMENTAL LAW SOCIETY, *supra* note 9, at 32.
67. 33 U.S.C. § 1251 *et seq.* (Supp. II 1972).
68. 33 U.S.C. § 1362(6) (Supp. II 1972) defines pollutant as:
> The term 'pollutant' means dredged spoil, solid waste, incinerator residue, sewage, garbage, sewage sludge, munitions, chemical wastes, biological materials, radioactive materials, heat, wrecked or discarded equipment, rock, sand, cellar dirt and industrial, municipal, and agricultural waste discharged into water. This term does not mean (A) 'sewage from vessels' within the meaning of section 312 of this Act; or (B) water, gas, or other material which is injected into a well to facilitate production of oil or gas, or water derived in association with oil or gas production and disposed of in a well, if the well used either to facilitate production or for disposal purposes is approved by authority of the State in which the well is located, and if such State determines that such injection or disposal will not result in the degradation of ground or surface water resources.
69. United States v. GAF Corp., 389 F. Supp. 1379 at 1383 (S.D. Tex. 1975) holds that the disposal of wastes into nontributory groundwater is not covered by the FWPCA because it is not within the § 1362(7) definition of "navigable waters": "There term 'navigable waters' means the waters of the United States, including the territorial seas."
70. *E.g.*, MONT. REV. CODES ANN. § 69-4806(1) (Cum. Supp. 1975) provides "It is unlawful to . . . cause pollution as defined in section 69-4802(5) R.C.M. 1947, of any state waters or to place or cause to be placed any wastes in a location where they are likely to cause pollution of any state waters. . . ." MONT. REV. CODES ANN. § 69-4802(5) (Cum. Supp. 1975) defines pollution as:
> (5) . . . contamination, or other alteration of the physical, chemical, or biological properties of any state waters, which exceeds that permitted by Montana water quality standards, including, but not limited to, stan-

ed pursuant to the Federal Geothermal Leasing Program[71] requires the submission of a "proposed plan"[72] containing measures for the prevention of environmental damage and prohibits a lessee from entering upon the leases premises except for "casual use" until a "plan of operations has been approved by a Department supervisor," specifying in detail methods of waste disposal and other environmental precautions.[73]

In the same fashion as oil and gas operators are held liable,[74] common law actions based upon nuisance, negligence or strict liability may also subject the geothermal operator to injunctive relief or damages. Nuisance actions are based on proof of negligence, breach of duty imposed by statute, or violation of an administrative order.[75] Typical situations analogous to geothermal development where liability has been imposed upon the oil and gas developer included permitting overflow from a salt water disposal pit[76] and the failure to guard against the escape of gas from a well.[77] Strict liability has been limited in oil and gas law to cases involving breach of duty imposed by statute, a valid order or a regulation of an administrative agency.[78] The "[g]reatest litigation in this regard has involved breach of a statute or order requiring the impounding and safe disposal of salt water . . . and for breach of a statutory duty not to permit . . . refuse to flow over the lands."[79] Where liability is found to exist the appropriate

---

dards relating to change in temperature, taste, color, turbidity, or odor; or discharge of any liquid gaseous, solid, radioactive, or other substance into any state water which will or is likely to create a nuisance or render the waters harmful, detrimental, or injurious to public health, recreation, safety, welfare, livestock, wild animals, birds, fish, or other wildlife. A discharge which is authorized under the pollution discharge permit rules of the board is not 'pollution' under this chapter.

and MONT. REV. CODES ANN. § 69-4802(9) (Cum. Supp. 1975) defines "state water" as:

. . . any body of water, irrigation system, or drainage system either surface or underground; however, this subsection does not apply to irrigation waters where the waters are used up within the irrigation system and the waters are not returned to any other state waters.

Therefore, since the type of pollution generated during exploration and drilling is a contamination of "state waters" (either surface or groundwater) it would be prohibited by state law.

71. 30 U.S.C. §§ 1001 *et seq.*
72. 43 C.F.R. § 3210.2-1(d) (1976).
73. 43 C.F.R. § 3202.6 (1976).
74. *See* 1 WILLIAMS & MEYERS, OIL AND GAS LAW § 218.10 (1975); 4 SUMMERS, THE LAW OF OIL AND GAS §§ 652-661 (1962).
75. 1 WILLIAMS & MEYERS; *supra* note 71, at 229.
76. *Id.* at 232.
77. *See, e.g.*, Sunray DX Oil Co. v. Thurman, 238 Ark., 789, 384 S.W.2d 482 (1964); Gulf Refining Co. v. Daub, 224 Miss. 464, 80 So.2d 467 (1955).
78. Mazda Oil Corp. v. Gauley, 290 P.2d 143, (Okla. 1955).
79. 1 WILLIAMS & MEYERS, *supra* note 71, at 234-237.

remedy—injunctive or damages—should be determined in the same fashion as it currently is done in oil and gas law.[80]

B. State and Federal Regulation of Brine Disposal

Large quantities of saline wastes and perhaps heated wawater must be disposed from a single producing facility which taps a liquid dominated system.[81] Although pollution prevention technologies exist, "prevention of water pollution will materially add to production costs and consequently may affect the economic feasibility of development programs."[82] Pollution prevention is further complicated by the fact that there is no clear federal or state regulatory approach to geothermal brine disposal. Once the necessary heat is extracted from a geothermal resource (liquid or vapor dominated), the remaining liquid residue is waste water. This water must be disposed of either at the surface, into a shallow ground water aquifer, or back into the geothermal reservoir through deep well injection.

Surface disposal is regulated by the Federal Water Pollution Control Act Amendments of 1972[83] which implement a "no discharge" policy, and state programs. The FWPCA controls of surface discharges through effluent limitation guidelines. These guidelines purport to set effluent limitation floors[84] which the states can raise by setting higher standards.[85] All point sources of discharge, defined as "any discernible . . . conveyance . . . from which pollutants are or may be discharged,"[86] must obtain a discharge permit. Permits are issued either by the EPA or the state if EPA has approved the state's National Pollution Elimination Discharge System. In this case an approved NPDES program supercedes the federal program in the state.[87] However, the state cannot vary

80. *Id.* at 236-37.
81. STANFORD ENVIRONMENTAL LAW SOCIETY GEOTHERMAL ENERGY, *supra* note 8, at 26; INSTITUTIONAL AND ENVIRONMENTAL CENTER FOR ENERGY STUDIES, PROCEEDINGS OF THE SECOND GEOTHERMAL CONFERENCE 3 (1976); U.S. ATOMIC ENERGY COMM'N, PROPOSED FINAL EIS, *supra* note 58, at 6A 4-24.
82. Proceedings of the Second Geopressured Geothermal Energy Conference *supra*, note 59, at 3: "Commercially viable generating facilities will have to be supplied by 5 to 10 wells, each capable of producing 3.8n³ per minute (1000 gal) or about 5,500n³ (34,000 bbls) per day (Approximately 170,000 to 340,000 bbls per day per a single generating facility)." U.S. DEPT. OF THE INTERIOR, PRELIMINARY APPRAISAL OF GROUND WATER IN STORAGE WITH REFERENCE TO GEOTHERMAL RESOURCES IN THE IMPERIAL VALLEY AREA, CALIFORNIA GEOLOGICAL SURVEY. CIRCULAR 649, 53 (1972).
83. 33 U.S.C. §§ 1251 *et seq.* (Supp. II 1972).
84. 33 U.S.C. § 1313(e) (3) (A).
85. 33 U.S.C. §§ 1313(a), (b).
86. 33 U.S.C. § 1362(14).
87. 33 U.S.C. § 1342(c) (1).

the EPA's effluent limitation guidelines for existing sources in an individual permit on an *ad hoc* basis.[88] The limitations of the state's power to factor economic and technical considerations into the permit process are not of direct relevance to the geothermal industry because the Administrator has clear authority under Section 30b to issue national "standards" for new sources. No effluent guidelines presently exist for geothermal brines discharged into surface waters, but a geothermal operator contemplating a point source surface discharge must still obtain an NPDES permit.[89] The permit will be conditioned on effluent limitations set by the Administrator or the state[90] according to the applicable agency's "best engineering judgment."[91]

If heated waters are discharged into a surface system, then the plant will be controlled by the Thermal Pollution effluent standards set by the EPA. EPA originally tried to treat heat as more or less another pollutant, dispite the separate treatment accorded thermal pollution in the FWPCA. Secondary treatment was construed to require the installation of cooling towers, lakes or ponds for all 500 plus megawatt plants (a limitation that might exclude most geothermal power plants from the regulations). EPA's guidelines were recently reviewed and remanded in *Appalachian Power v. Train.*[92] Two aspects of the opinion are relevant to geothermal development. First, the Fourth Circuit held that the EPA had to calculate, as best as possible, the costs of achieving a heat level reduction and the ecological benefits which would be derived from the reduction as well as the costs and benefits of alternative methods of heat reduction. Second, the court approved EPA's decision to allow cooling ponds to be used as methods of waste disposal. The court also required EPA to evaluate its ban on

88. E.I. DuPont de Nemours v. Train, ___ U.S. ___, 97 S.Ct. 967 (1977). The Court's only qualification on the EPA's power to issue effluent guidelines within industrial classes was the cryptic statement "so long as some allowance is made for variations by individual plants." *See* Comment, *The EPA's Power to Establish National Effluent Limitations for Existing Water Pollution Sources*, 125 U. PA. L. REV. 120 (1976).

89. 33 U.S.C. § 1342(k).

90. 33 U.S.C. § 1342(a)(1).

91. United States v. Cutter Laboratories, ___ F. Supp. ___, 9 ERC 1209, (E.D. Tenn. 1976). An enforcement action was brought by the Federal Government under section 309 of the Federal Water Pollution Control Act for an alleged violation of a National Pollutant Discharge Elimination System Permit and the court held that the action can be maintained even though the Environmental Protection Agency has not yet established effluent limitation guidelines for the applicable point source category, but instead has based permit limitations on the agency's "best engineering judgment."

92. ___ F.2d ___, 9 ERC 1033, *modified*, 9 ERC 1274 (4th Cir. 1976).

cooling lakes (defined as lakes which impede the flow of a navigable water course) on the grounds that the ban was inconsistent with Congressional directives that water be conserved in the arid west. Cooling towers and holding ponds undoubtedly will be imposed on geothermal power plants in pursuit of the no-discharge goal. For example, the California Regional Water Quality Board for the Colorado River Region allowed a geothermal driller to discharge his brine wastes into two holding ponds provided that the "[g]eothermal wastes shall not enter Salton Sea, canals, drains . . . or any subsurface strata that could provide flow or seepage into the Salton Sea."[93]

Liquid geothermal wastes contain brines as well as heat, and implementation of the no-discharge goal will almost certainly force the use of deep reinjection to dispose of these brines. Happily, deep well reinjection is the preferred method of disposing of brines because surface and ground water contamination are prevented and reservoir pressure maintained. Reinjection poses many environmental, in-plant, and recovery hazards, but most reinjection experiments evaluated in the Second United Nations Symposium on Geothermal Energy report that the problems can be overcome, and it has been described as an "environmental imperative." All reinjection must be carried out at sufficiently high temperatures so that the bore hole and surface installations are not clogged by scaling and the deposit of minerals, mainly silica and calcium carbonate. Other problems depend on the individual formation. Cooler reinjection water must not be allowed the productive part of the formation until it has been heated by contact with the reservoir rock. Unless there is a sufficient distance, 1.1 - 1.5 km, between the reinjection and production zones, the capacity of the field could suffer from the lowering of the temperature of the production water.[94]

Reinjection may also conserve energy by increasing the productive life of the reservoir. In a dry steam field reinjection of the condensate will help maintain the reservoir pressure, but the greatest conservation benefits will occur in water-

93. CALIFORNIA REGIONAL WATER QUALITY BOARD, COLORADO RIVER BASIN REGION ORDER NO. 72-50, *Waste Discharge Requirements for Geothermal Energy and Mineral Corporation*, in FINAL EIS at III-80.

94. Einarsson, Vides & Cuellar, *Disposal of Geothermal Waste Water by Reinjection*, UNITED NATIONS SYMPOSIUM 1349, 1360 (1975). *See also*, Kubota & Aosaki, *Reinjection of Geothermal Hot Water at Otake Geothermal Field*, *Id.* at 1379.

dominated reservoirs. Although the reinjected water will be colder than the water being withdrawn to produce energy, the reinjected water will be hotter than the natural recharge water which must originate in a relatively cold environment and be heated by the reservoir rocks. Reinjection "means reduction of the heat need from the reservoir in order to bring it up to high temperature. These two factors could conserve energy in a very significant way, increase the total potential production of useful energy over the life of the field and in fact, make the efficiency of the conversion of extracted heat energy to electric energy comparable to the generally higher efficiency of vapor dominated steam fields."

BLM geothermal supervisors can allow reinjection of brines by federal leases.[95] Any orders are subject to compliance with state and federal water quality requirements and BLM's power to condition leases and permits with more stringent standards. Whatever federal requirements evolve are likely to be set by the Department of the Interior under its general supervisory powers over geothermal leases rather than by the Environmental Protection Agency. The EPA has asserted jurisdiction under the FWPLA over deep well injections but the extent of its authority remains unclear. In 1973 the agency issued a Decision Statement asserting that subsurface injection "will cease or be modified when a hazard to a natural reservoir is imminent."[96] This statement would have allowed EPA to assert jurisdiction over ground water use but would have allowed deep well injection discharges pending the accumulation of more experience with this increasingly widely used but little understood or regulated form of pollution control. However, in *United States v. GAF*, EPA's discretion was limited to deep well injections which threaten to cause surface water pollution. A Texas district court held: "The disposal of chemical wastes into underground waters which have not been allowed to flow into or otherwise contaminate surface waters does not constitute a 'discharge or pollutant' within the meaning of 1311(a)."[97] *GAF* holds only

95. 40 C.F.R. § 124.80 (1975), 40 C.F.R. § 125.26 (1975).
96. Environmental Protection Agency Administrator's Decision Statement No. 5 on Subsurface Emplacement by Well Injection. Feb. 6, 1973 ¶ 21: 2081 BNA FEDERAL WATER REGULATION REPORTER.
97. 389 F. Supp. 1379, 1383 (S.D. Tex. 1975). GAF was followed by the Fourth Circuit in Exxon Corp. v. Train,___ F.2d___, (5th Cir. 1977) which reasoned that Congress intended to leave the regulation of subsurface pollution to the states pending further study of the problem.

that non-tributary groundwater discharges are not within the Act, and the decision is based on a reading of the legislative history[98] so EPA's jurisdictional policy had not yet been litigated. The EPA can, however, regulate these discharges under the Safe Drinking Water Act,[99] but so long as geothermal brines are injected into the reservoir from which they came and no pollution threat to surface waters is present, the EPA's role under FWPCA may be limited to approving state plans which do regulate non-tributary groundwater.[100] States are required by Section 402 of FWPCA of 1972 to have the authority to issue permits for the disposal of pollutants into wells, but beyond this section the Act does not adequately define the relationship between federal and state regulation of groundwater pollution.

EPA's lack of authority under the Federal Water Pollution Control Act Amendments of 1972 is relatively unimportant because of their great power to regulate underground waste disposal under the Safe Drinking Water Act. This Act is designed to protect, *inter alia*, underground drinking water sources from contamination. These sources are broadly defined as either aquifers supplying a public water system or ones containing less than 10,000 mg/1 total dissolved solids.[101] The EPA cannot approve state plans which fail to protect these sources from contamination unless a state can show that the aquifer is not an underground drinking water supply source because it is oil producing, too contaminated, or is in a location which makes its future use as a source of drinking water impractical and further that injection into such an

98. Note, *United States v. GAF Corp.: A Leak in the FWPCA?* 6 ENVIR'L. L. 561, 564 (1976):
> On its face, the Act is ambiguous as to whether groundwaters are included within the definition of "navigable waters". First, since navigable waters are defined in the Act as "the waters of the U.S., including the territorial seas," groundwater arguably falls within that definition. But, the court correctly interpreted the meaning of navigable waters by closely examining the legislative history which appears to be unequivocal in its rejection of groundwater regulation by the EPA. A proposed house amendment to the Act which would have included the word "groundwater" in the definition "navigable waters" was rejected. The Senate Public Works Committee felt that the jurisdictional problem concerning regulation of groundwater pollution were so complex that regulation of groundwater was better left to the states.

99. 42 U.S.C. § 300h, Pub. L. 93-523, [1974] U.S. CODE CONG. & AD. NEWS 1909. This Act is administered similar to the FWPCA with enforcement controlled through EPA approved state permit programs analogous to the NPDES. *See* Eckert, *EPA Jurisdiction Over Well Injection Under the Federal Water Pollution Control Act*, NAT. RESOURCES LAW 455, 463-64 (1976).

100. *United States v. GAF Corp: A Leak in the FWPCA?*, *supra* note 98 at 566.

101. 41 Fed. Reg. 36738 (1976).

aquifer will not endanger water in another part of the aquifer or in another aquifer.[102] The mining industry—including geothermal interests—have argued to EPA that the proposed rules will inhibit activities such as geothermal development and in situ uranium leach mining because the injection of any contaminant into an aquifer will often be prohibited even though the injection will simply replace fluids which were in the reservoir instead of adding waste fluids to the reservoir. In March of 1977 the EPA announced its intention to revise its regulations to accommodate the mining industry and that mining well permits would be issued on a field or case by case basis.[103] However, EPA's ultimate policy toward geothermal reinjection has not yet been formulated.

Delineation of the relationship between geothermal brine disposal and general state water pollution regulation is not easy since the problem of geothermal disposal was not expressly considered by the states with known geothermal areas when they enacted legislation to implement the Federal Water Pollution Control Act Amendments of 1972.[104] Clearly a state discharge permit is required when geothermal brines are discharged into surface waters.[105] Jurisdiction over deep well injections is less clear: "The injection of cooled (geothermal brine) water into a subsurface reservoir from which it was extracted is the reverse of injection of heated water, which in some states is subject to state pollution control regulation to avoid harm to other water users. As the question has not been raised vis-a-vis cooled geothermal fluids, there is no indication of what direction state rulings might take. However, we must keep in mind that injection of cooled water could have significant mechanical effects on the reservoir through thermal contraction."[106]

102. 41 Fed. Reg. 36738 (1976).
103. *See* Friedman, Environmental Problems Relating to Uranium Mining and Milling 17-24 (unpublished paper prepared for Energy and the Public Lands II, Park City, Utah, August 17-20, 1977) for a discussion of the mining industry's objections to the proposed Safe Drinking Water Act regulations and EPA's response to date.
104. ARIZ. REV. STAT. §§ 36-1851 *et seq.*; CAL. WATER CODE §§ 1242.5, 1243, 1243.5, 1257, 1258 and 2100 *et seq.*; COLO. REV. STAT. §§ 25-8 *et seq.*; IDAHO CODE §§ 39-36 *et seq.*; MONT. REV. CODES ANN. §§ 69-4800 *et seq.*; NEV. REV. STAT. §§ 556.131 *et seq.*; N.M. STAT. ANN. §§ 75-39 *et seq.*; OR. REV. STAT. § § 468.7 *et seq.*; UTAH CODE ANN. §§ 73-73-14 *et seq.*; S.D. COMPILED LAWS ANN. §§ 46-25 *et seq.*; WASH. REV. CODE ANN. §§ 80.51 *et seq.*; WYO. STAT. §§ 35-502 *et seq.*
105. 40 C.F.R. § 100-149 (1976). Davis, Issues in Coordinating Geothermal Development with Local Water Law 3 (Memorandum prepared for a Workshop on Geothermal Energy and the Law, University of Southern California, Santa Barbara, California, Feb. 3-5 (1975).
106. Davis, Memo, *supra* note 74 at 2.

Some states have solved the legal problems by exempting deep well brine injection, which has generally been thought of as an oil and gas problem, from their water pollution statutes. New Mexico, for example, has vested jurisdiction over brine injections in the state oil and gas commission.[107] Other states include disposal wells in their definitions of "disposal system"[108] but convincing arguments can be made that either (1) the injection of geothermal brines is not within the definition of "waters of the state"[109] because the liquid dominated system is a closed reservoir or (2) the injection of geothermal brines is not within the definition of "pollution or pollutant" because disposal in this manner is not "likely to create a public nuisance or render such waters harmful, detrimental, or injurious to public health, safety, or welfare. . . ."[110] One principle which ought to be followed in solving geothermal problems is that geothermal reservoirs should be presumed *separate* from conventional groundwater aquifers. This principle was recognized in the well reasoned California superior court opinion in *Geothermal Kinetics* which held that the mineral owner was entitled to the geothermal resource because, in part, the reservoir litigated (at The Geysers) was sealed from shallower groundwater aquifers.[111]

---

107. N.M. STAT. ANN. § 79-39-11(G) (Supp. 1975) states:
> The Water Quality Act does not permit the adoption of regulations . . . which would interfere with the exclusive authority of the oil conservation commission. . . .

Geothermal resources are regulated pursuant to N.M. STAT. ANN. §§ 65-3 *et seq.*, Regulation of Oil and Gas Wells.

108. *E.g.*, OR. REV. STAT. § 449.075(a) (1974), *recodified as*, OR. REV. STAT. § 468.700 (1975): " 'Disposal system' means a system for disposing of waters, either by surface or underground methods and includes . . . disposal wells. . . ."

109. *E.g.*, UTAH CODE ANN. § 73-14-2(f) (1953):
> 'Waters of the state' means all streams, lakes, ponds, marshes, watercourses, waterways, wells, springs, irrigation systems, drainage systems, and all other bodies or accumulations of water, surface and underground, . . . except that bodies of water confined to and retained within the limit of private property, and which do not develop into or constitute a nuisance, or a public health hazard, or a menace to fish and wildlife, shall not be considered to be 'waters of the state' under the definition.

Although this exclusion probably was aimed at private sewage disposal systems (*e.g.* fingering systems or dry wells) it could be argued that it is equally applicable to deep well brine disposal.

110. ARIZ. REV. STAT. § 36-1851(8) (1974):
> 'Pollution' means such contamination, or other alteration of the physical, chemical or biological properties of any waters of the state, including change in temperature, taste, color, turbidity, or odors of the waters, or such discharge of any liquid, gaseous, solid, radioactive, or other substance into any waters of the state as will or is likely to create a public nuisance or render such waters harmful, detrimental, or injurious to public health, safety, or welfare, or to domestic, agricultural, commercial, industrial, recreational, or other beneficial uses, or to livestock, wild animals, birds, fish or other aquatic life.

It should be noted that Arizona has recently adopted a new definition of "pollution." Specifically, " 'Pollution' means the man-made or man-induced alteration of the chemical, physical, biological and radiological integrity of water." ARIZ. REV. STAT. § 36-1851(12) (Cum. Supp. 1976).

111. Geothermal Kinetics, Inc. v. Berry, No. 75314 (Sup. Ct. Sonoma County, Calif. 1976).

This analysis ought to apply by analogy to states such as Wyoming which allow injection for secondary recovery of oil and gas production so long as the state determines that no degradation of groundwater will result.[112] The argument should also apply in Nevada which excludes replacement of "natural waters" from its definition of pollution.[113] A closer case is presented in Idaho because waste disposal well injections are specifically regulated. However, a reading of the statute indicates that the purpose of regulation is only to prevent pollution of waters used for domestic, recreational or aesthetic purposes. Irrigation waste water disposal is excluded from the requirement that the discharges be treated to bring them into conformity with Idaho Drinking Water Standards "so long as the disposal does not adversely affect drinking water resources,"[114] and a geothermal operator ought to be allowed to make the same showing.

---

112. WYO. STAT. § 35-502.3(c) (i) (Supp. 1975):
(c) Specific definitions applying to water quality
(i) 'Pollution' means contamination or other alteration of the physical, chemical or biological properties of any waters of the state, including change in temperature, taste, color, turbidity or odor of the waters or any discharge of any acid or toxic material, chemical or chemical compound, whether it be liquid, gaseous, solid, radioactive or other substance, including wastes, into any waters of the state which creates a nuisance or renders any waters harmful, detrimental or injurious to public health, safety or welfare, to domestic, commercial, industrial, agricultural, recreational or other legitimate beneficial uses, or to livestock, wildlife or aquatic life, or which degrades the water for its intended use, or adversely affects the environment. This term does not mean water, gas or other material which is injected into a well to facilitate production of oil, or gas or water, derived in association with oil or gas production of oil, or gas or water, derived in association with oil or gas production and disposed of in a well, if the well used either to facilitate production or for disposal purposes is approved by authority of the state, and if the state determines that such injection or disposal well will not result in the degradation of ground or surface or water resources.

113. Nevada Water Pollution Control Regulations Article 1: 1.12 'Natural Waters' means waters which have not been degraded or enhanced by actions attributable to man.

114. Idaho Water Quality Standards and Wastewater Treatment Requirements, Sec. X:
E. In cases of subsurface sewage or waste disposal such disposal facilities shall be so designed and located that such sources of water pollution including bacteriological, organic and/or inorganic nutrients will not enter adjacent waters. Disposal systems shall not be located within 300 feet of the shores of lakes and impoundments, including tributary streams, used for domestic, recreational or aesthetic purposes, as determined from the known highest water level of such water course, lake or reservoir. A variance may be granted on an individual basis provided that the proposed variance does not alter the intended results obtained by the requirement.
Improperly and/or inadequately treated sewage shall not be allowed to accumulate on the ground surface in such a manner that it may create a health hazard and/or a nuisance condition.
* * *
I. Wastewater discharged to disposal wells for underground disposal shall receive, prior to discharge of such wastewaters, such treatment as is necessary to render them equal in quality to existing underground waters or such treatment as is necessary to bring such discharge into conformance with the *Idaho Drinking Water Standards*. The provisions of Paragraph XH will not be considered as strictly applicable to the existing sink wells used exclusively for irrigation wastewater disposal where such disposal

In the late 1960's, concern was expressed over the discharge of heated water from thermal power plants. As a result, a number of states adopted thermal power plant siting agencies. These now exist in Arizona, California, Washington and Oregon.[115] Because a geothermal power plant must be built at the field, these agencies will exercise little influence over the siting of geothermal plants. These agencies will, on the other hand, exercise substantial control over the character of air and water discharges of a plant. The objective of a power plant siting agency is to facilitate one-stop licensing of power plants. The agency coordinates permit approval from various state mission agencies, and in some states such as Washington it seems clear that the siting agency can supercede air and water quality standards imposed by the applicable state agency,[116] the Department of Ecology. In practice, coordination among the agencies ought to result in the application of the state's adopted air and water quality standards to a geothermal plant.[117]

Besides the threat of surface water and groundwater pollution, geothermal production poses a risk of subsidence and seismic activity. The withdrawal of geothermal fluids may cause or contribute to subsidence being caused by Natural causes unrelated to thermal production. Land surface level networks are being established in California by the state and the National Geodetic Survey will provide standards so that withdrawal and reinjection rates can be monitored and corrective steps, such as an increase in the reinjection rate, can be taken. In general, lease and GRO order stipulations ought to be able to control subsidence on federal, state, and private lands, but as the Final EIS for the Geothermal Leasing Pro-

does not adversely affect domestic water sources. However, it should be recognized that the long-term preservation of Idaho's vast underground water resources is of great importance and that every reasonable effort should be made to restrict pollutants from entering underground waters and that a long-term research and development program should be established that will lead to the total elimination of disposal wells that directly affect underground aquifers that are not subject to adequate filtration and percolation to eliminate significant pollutants.

115. ARIZ. REV. STAT. § 40-360-360.12 (1974); CAL. PUB. RES. CODE §§ 25000 to 25542 (West. 1975); OR. REV. STAT. 453. 305-.575 (1974); and WASH. REV. CODE ANN. § 80.50.010-.901 (Supp. 1974). In addition Montana, Nevada, and Wyoming have industrial siting acts which include electrical generation facilities. MONT. REV. CODES ANN. § 70-801 to -823 (Cum. Supp. 1974); NEV. REV. STAT. §§ 704.820-.900 (1973); and WYO. STAT. §§ 35-502 .75-94 (Supp. 1975).

116. WASH. REV. CODE ANN. § 80.50.110 (Supp. 1974). *See* Van Baalen, *Industrial Siting Legislation: The Wyoming Industrial Development Information and Siting Act—Advance or Retreat?*, 11 LAND & WATER L. REV. 27, 56 (1976).

117. WASH. REV. CODE ANN. § 90.48(2); WAC §§ 173-10 *et seq.*.

gram points out, "[i]n areas where subsidence cannot be tolerated, geothermal leasing may not be environmentally feasible."[118]

V. AIR POLLUTION REGULATION

A geothermal developer must comply with national and state air quality standards during all stages of development. In addition to complying with two applicable standards the developer must not violate the EPA's non-degradation policies which are in the process of Congressional revision.

During the exploration and drilling phases the developer must comply with applicable particulate matter standards which exist in all states. Oiling and chemical treatment should be able to control this problem.[119]

Only one national standard applicable to geothermal development has been set. The National Primary Standard for Carbon Monoxide permits ten milligrams per cubic meter as a maximum one hour concentration not to be exceeded more than once per year. Secondary national Carbon Monoxide Standards allow forty milligrams per cubic meter in a maximum one hour concentration not to be exceeded more than once per year.[120]

Hydrogen sulfide discharges have been identified as the major potential air pollution problem in connection with gethermal development. As of January, 1977, only four western states—California, Montana, New Mexico, and Wyoming—have set hydrogen sulfide standards.[121] However, related standards may be applicable to a geothermal power plant. Utah limits sulfur compound emissions generally,[122] and Idaho limits sulfuric acid mist.[123] The major problem with hydrogen sulfide emissions is, of course, their odor. In addition to objective standards which exist in four states, all states have subjective prohibitions against odor causing emissions which could be a basis for regulatory action against a geothermal de-

118. FINAL EIS at III-53.
119. *See* FINAL EIS at III 53-59.
120. *Id.* at III-54.
121. CAL. ADMIN. CODE § 70200(1); MONT. ADMIN. CODE § 14-S1410; N.M. Environmental Improvement Board Ambient Air Quality Standards and Air Quality Control Regulations § 201; and Wyo. Air Quality Standards and Regulations, Chapter 1 § 7.
122. Utah Air Conservation Regulations, Part II § 2.5.
123. Rules and Regulations for the Control of Air Pollution in Idaho, Reg. C.

velopment.[124] Furthermore, a strong localized order is a traditional basis for a private or statutory public nuisance action.[125]

VI. NOISE REGULATION

Noise is a localized impact of all geothermal development. Both the states and federal government are in the early stages of developing a non-transportation noise strategy. At the present time noise standards will be imposed on federal leasees through lease stipulations and GRO orders and on developers on non-federal lands through local land use controls which include noise reduction standards.

Noise regulation is moving from subjective to objective criteria. The undesirable environmental impact of noise is a function of two factors: the character of the sound emission and the character of surrounding land uses. The objectionableness of sound is in turn a function of the sound pressure and the frequency response of the human ear to the emission so weighted scales can be formulated. Based on a scale proscribed emission levels can be formulated and applied depending on the land uses in the area surrounding the geothermal field. Imperial County, California has a noise abatement component to its geothermal ordinance. Drilling and production noise standards are measured according to the A-weighting scale which is an approximation of an equal loudness judgment for sound of different frequencies. A procedure for making corrections for factors such as duration is included. BLM also has developed noise standards.

Objectionable noise associated with the venting of steam wells can often be controlled by mufflers. Techniques being developed to reduce drilling noise include acoustical materials, mufflers, and sound attenuating practices. Substantial technological problems still must be solved before devices such as mufflers will control noise in all frequencies, but it does not appear that there are any technological barriers to compliance with geothermal drilling and production noise standards.[126]

124. *E.g.*, Colo. Regulation No. 2, Odor Emission Regulations.
125. *E.g.*, Chapter 18-04 WAC, Washington Regulations for Air Pollution Sources, § 18-04-040(5).
126. FINAL EIS at III-59-73. For comprehensive survey of the regulation of nontransportation noise *see* Findley and Plager, *State Regulation of Nontransportation Noise: Law and Technology*, 48 S. CAL. L. REV. 209 (1974).

VII. CONCLUSION

If the current aggregation of environmental regulations had been in effect when the earth was created, the first chapter of Genesis might begin and end with the sentence: "And on the first day God applied to the Bureau of Land Management for a full environmental evaluation of 'the potential effect of the leasing program on the total environment, fish and other aquatic resources, wildlife habitat and populations, aesthetics, recreation, and other resources in the entire area during exploratory, developmental, and operational phases."[127] Our rule of law tradition demands that if an agency has jurisdiction over an activity, it should exercise that jurisdiction. This paper has indicated that there are serious environmental impacts in connection with geothermal development[128] but that the federal government, the states, and local government have not yet evolved a clear regulatory strategy that focuses on the more important impacts. Instead, at all levels of government there is the potential that regulation will create a costly obstacle which yields no corresponding gains in environmental quality. To induce geothermal development we need federal, state, and local acceptance of what the most serious impacts of development are likely to be, a commitment to allow geothermal development subject to mitigation measures, and a pre-development assessment process that focuses on mitigating the most serious problems and the closing the critical information gaps. It is no longer fashionable—as it once was—to bet on technology both to provide us with the energy we need and do it in socially acceptable ways—but at the present time this assumption seems warranted with respect to geothermal resources.

127. FINAL EIS at III-47.
128. Perhaps the leading expert on the environmental aspects of geothermal power plants has written: "1975 marked the end of the romantic era during which geothermal resources were received as 'fonts of clean power' from inside the earth." Axtmann & Peck, *Geothermal Chemical Engineering*, 22 AM. INST. CH. ENG. J. 817, 823 (1976). Professor Axtmann's analysis of the Waikekie Power Plant is the best critical discussion of the environmental aspects of geothermal development to date. AXTMANN, AN ENVIRONMENTAL STUDY OF A GEOTHERMAL POWER PLANT (1974).