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Fighting Groundwater Contamination: State Activities To Date and the Need for More Information From EPA

Statement of
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Before the
Subcommittee on Water Resources,
Transportation, and Infrastructure
Committee on Environment and Public Works
United States Senate

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MR. CHAIRMAN AND MEMBERS OF THE SUBCOMMITTEE:

It is a pleasure to be here today to discuss an issue that is of particular importance to this committee and the nation: fighting groundwater contamination. At the request of Senator Baucus, we have evaluated two specific areas of concern. First, the efforts of the state governments to protect groundwater resources. Second, the information available from the Environmental Protection Agency to help state officials set technically sound groundwater protection standards. My testimony today summarizes the information in our two reports to the Subcommittee on Hazardous Wastes and Toxic Substances.

Introduction and Methodology

Groundwater is a major source of fresh water, used for a wide variety of purposes. The use of groundwater has been increasing at a faster rate than the use of surface water. In 1950, 34 billion gallons per day were used in the United States. This doubled to reach 68 billion gallons per day in 1970 and rose again to 89 billion by 1980, an overall increase of 160 percent in 30 years. Almost two-thirds of withdrawn groundwater is used for irrigation; the remainder is predominantly used for public water supplies and industry. Approximately 11.5 billion gallons of groundwater are used every day for public water supplies, one-third of the total water consumed for this purpose. About 50 percent of the population in the United States relies on groundwater for drinking water. This is the part of the population that would be most immediately affected by groundwater contamination. The population of a few states rely almost totally on groundwater for their drinking water (See Table 1.)

Given this context, it is clear that the efforts of the state governments to protect groundwater are very important. Several contamination protection techniques have been used. The one we focused on is the use of groundwater standards. Other measures of prevention (which are essentially controls over the sources of contamination) include reducing the disposal of wastes on or in the land, enforcing strict standards for sources of contamination, and prohibiting the placement of potential contamination sources above aquifers[1] that are particularly vulnerable to contamination. Groundwater standards, which do not themselves prevent contaminants from entering groundwater, become preventive primarily by playing a role in each of the above techniques.

There are two types of groundwater standards used by the states: numeric and narrative. A numeric standard specifies a maximum concentration of a particular contaminant. A narrative standard specifies a general prohibition against particular types of contaminant discharges or identifies a general level of quality to be achieved.

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[1] An aquifer is a subsurface geological formation of layers of sand, gravel or rock bearing quantities of groundwater.

Table 1: State Reliance on Groundwater for Drinking Water

% drinking water from groundwater	Number of states
0- 10%	1
11- 20	1
21- 30	4
31- 40	8
41- 50	10
51- 60	11
61- 70	9
71- 80	4
81- 90	6
91-100	2
Total	**56[a]**

[a]One respondent did not answer this question

Numeric standards are based upon specific information about the effects of contaminants and the level of protection that is being attempted. A numeric standard is usually based on an estimate of the effect on health and public welfare of exposure to specific levels of a contaminant. Once the standard has been established, conditions of applicability are developed. For example, the standard might be applied to specific classes of groundwater or might be used in setting discharge limits. In our work, we were especially interested in ambient standards, that is, standards applied to groundwater in the ground. Ambient standards constitute the reference points by which groundwater quality is measured.

Establishing narrative standards does not require specific knowledge about contaminants. Narrative standards, because of their general wording, are applied case by case. In addition, if a narrative standard is applied in such a way as to make potential polluters responsible for showing that the standard will not be violated, regulators need not anticipate every possible situation in which contamination may occur.

Both numeric and narrative standards have their disadvantages. The number of contaminants that may enter the environment makes the development of numeric standards for any substantial proportion of the relevant chemicals almost completely infeasible, yet many state governments attempt to set such standards. The flexibility of narrative standards places a heavy administrative burden on regulators to evaluate each permit application. Neither approach has emerged as the first choice of state regulators; indeed, both types of standards may be necessary.

Our evaluation of the state programs focused on five areas: First, the context in which state groundwater standards are developed. Next, the description of the state standards themselves. Third, the differences in state standards. Fourth, the states' standard setting processes. Finally, the application of the standards. We conducted a detailed survey of all 50 states and 7 U.S. territories[2]; our response rate was 100 percent. In addition, we reviewed documentation on all the respondents' groundwater protection programs and conducted an in-depth review of the technical literature.

The Context of State Groundwater Standards

In all but 1 state (Georgia), significant groundwater contamination sources had been identified. Each state has been faced with its own unique set of contamination sources. The most significant concern (mentioned by 50 of the 57 respondents) has been contamination from underground storage tanks. Figure 1 presents the contamination sources listed by our respondents.

All states have some sort of authority for protecting

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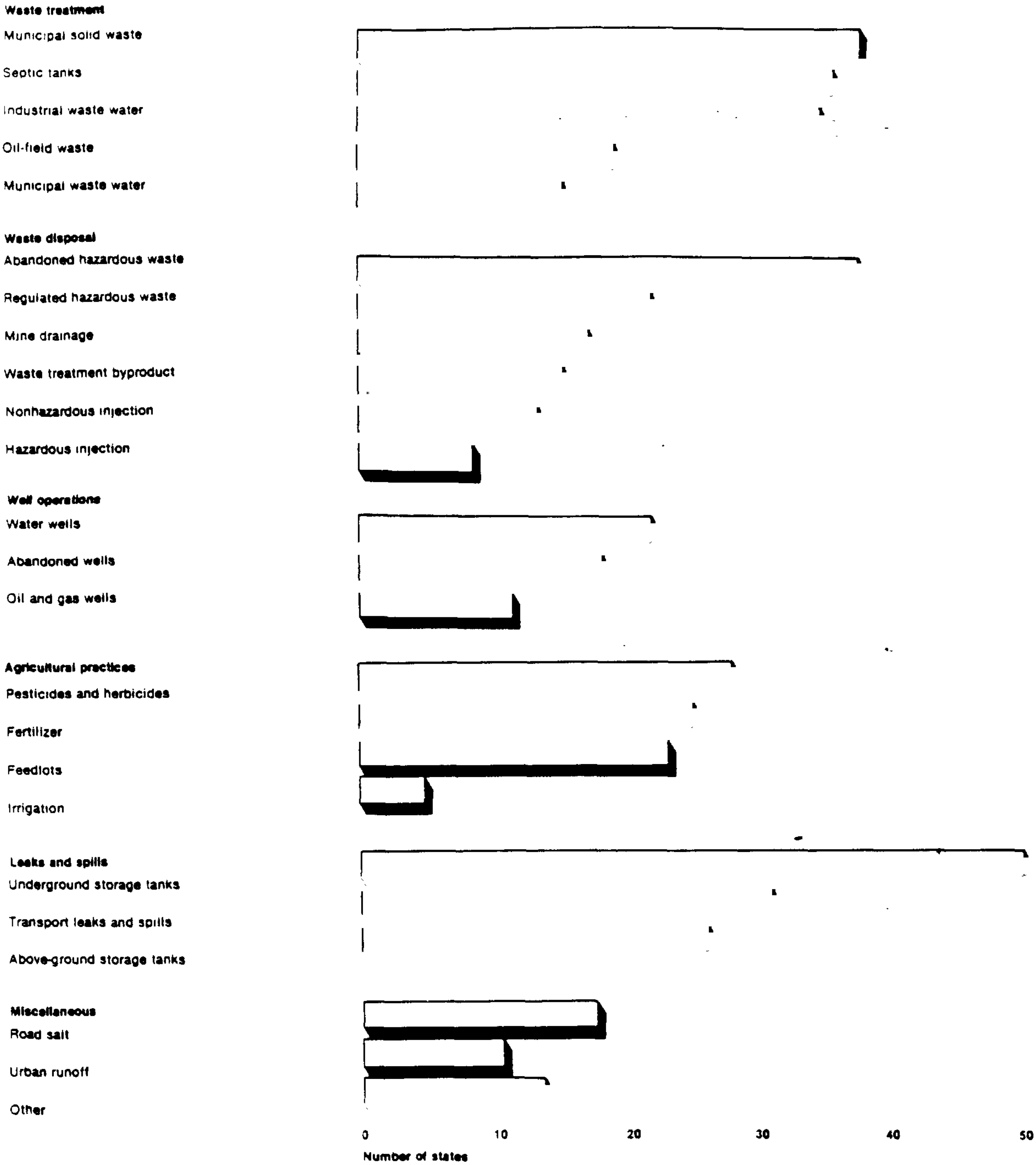
2 American Samoa, District of Columbia, Guam, Northern Marianas, Puerto Rico, Trust Territory of the Pacific Islands, Virgin Islands

Figure 1: Significant Groundwater Contamination Sources[a]



[a]This question was addressed to all 57 state respondents.

groundwater quality: 15 of 57 respondents operate under specific groundwater legislation, 36 under general water quality legislation. Responsibility for protecting groundwater quality has been vested in designated lead agencies or steering committees in 39 of the 57 respondent cases and was diffused among several state agencies in 16 of the remainder. No trends toward particular legislative or organizational approaches were apparent. (See Tables 2 and 3.)

Only about 40 percent of the respondents (22 of 57) had a groundwater protection plan, but most of the others (31 of 35) had one in development or planned to develop one. Most repondents (50 of 57) indicated that some type of groundwater protection policy guided their groundwater efforts.

A wide range of program activities has been implemented for protecting groundwater quality. In some areas, these activities were better developed than others, yet shortfalls were evident. In particular, about 80 percent of the respondents had made extensive (moderate to very great) efforts to develop groundwater strategies; the extensiveness of this activity may result, at least in part, from the financial support from EPA under the Clean Water Act. About two-thirds of the respondents had made extensive efforts in aquifer mapping and groundwater monitoring, indicating that they were attempting to understand their available resource and contamination problems. However, almost 60 percent of the respondents (33 of 57) had very limited develop-

1 Table 2: Groundwater Protection Legislation in the 57 States

State[a]	Type of legislation: Specific to groundwater	General water	Quantity of groundwater withdrawn	Other
Alabama		•		
Alaska		•		
American Samoa			•	
Arizona	•[b]			
Arkansas		•		
California		•[b]		
Colorado				•
Connecticut		•		
Delaware			•	
District of Columbia		•		
Florida	•[b]			
Georgia		•[b]		
Guam	•			
Hawaii	•			
Idaho		•		
Illinois		•		
Indiana		•		
Iowa		•		
Kansas		•[b]		
Kentucky		•		
Louisiana		•		
Maine	•[b]			
Maryland		•		
Massachusetts		•		
Michigan		•		
Minnesota		•		
Mississippi			•	
Missouri		•		
Montana	•			
Nebraska	•			
Nevada		•		
New Hampshire	•			
New Jersey		•[b]		
New Mexico	•[b]			
New York	•[b]			
North Carolina		•		
North Dakota		•		
Northern Marianas				•
Ohio		•		
Oklahoma		•[b]		
Oregon	•			
Pennsylvania		•		
Puerto Rico				•
Rhode Island		•		
South Carolina		•		
South Dakota		•		
Texas		•		
Tennessee		•		
Trust Territory of the Pacific Islands		•		
Utah		•		
Vermont	•			
Virgin Islands		•[b]		
Virginia	•[b]			
Washington		•		
West Virginia		•		
Wisconsin	•[b]			
Wyoming	•[b]			
Total	**15**	**36**	**3**	**3**

[a]This question was addressed to all 57 state respondents.

[b]EPA reported specific groundwater legislation in State Ground-Water Program Summaries (Washington, D.C. March 1985)

Table 3: Responsibility for Groundwater Protection in the 57 States

State[a]	Lead agency or steering committee	Diffused authority	No agency responsible
Alabama	•		
Alaska	•[b]		
American Samoa			•
Arizona	•		
Arkansas		•	
California	•		
Colorado	•		
Connecticut	•		
Delaware	•		
District of Columbia	•		
Florida	•		
Georgia	•		
Guam	•		
Hawaii	•		
Idaho	•		
Illinois	•		
Indiana		•	
Iowa		•	
Kansas		•	
Kentucky		•	
Louisiana	•		
Maine		•	
Maryland		•	
Massachusetts		•	
Michigan		•	
Minnesota		•	
Mississippi	•		
Missouri	•		
Montana	•		
Nebraska		•	
Nevada	•[b]		
New Hampshire	•		
New Jersey	•		
New Mexico	•		
New York	•		
North Carolina		•	
North Dakota	•		
Northern Marianas	•		
Ohio	•		
Oklahoma		•	
Oregon	•		
Pennsylvania	•		
Puerto Rico	•		
Rhode Island		•	
South Carolina	•		
South Dakota	•		
Texas		•[b]	
Tennessee	•		
Trust Territory of the Pacific Islands			•
Utah	•		
Vermont	•		
Virgin Islands		•[b]	
Virginia	•[b]		
Washington	•		
West Virginia	•[b]		
Wisconsin	•		
Wyoming	•		
Total	**39**	**16**	**2**

[a]This question was addressed to all 57 state respondents

[b]EPA did not report a lead agency or steering committee in State Ground-Water Program Summaries (Washington, D.C. March 1985)

ment of groundwater standards (less than a moderate extent). Since standards play such an important role in the development and application of contamination prevention activities, this means that the latter will be weakened in those areas where development of groundwater standards has been limited. At the time of our survey, the greatest focus for protection was on discharge controls - 80 percent of the respondents had made efforts of moderate or greater extent. That many state programs were still in development may be indicated by relatively little activity reported by 31 of 57 respondents in the interchange of information pertaining to groundwater (less than moderate extent). Tables 4 and 5 respectively characterize the extent of groundwater protection activities and protection policies across the states.

Description of State Standards

At the time of our evaluation, 26 states (of 50 states, 7 territories) had numeric standards specifying quantitative levels for contaminants. Narrative standards had been established in 38 states, many of them the same states that had numeric standards. Only 3 states had numeric standards without also having narrative standards, but 15 states had narrative standards without having numeric standards. Sixteen states had neither numeric nor narrative standards. (See Table 6.)

We found 1,019 numeric standards in 26 states covering 260

Table 4: The Extent of State Groundwater Protection Activities

Activity[a]	No activity	Little	Some	Moderate	Great	Very great
		Extent of activity				
Development of groundwater policy and protection strategy	1	6	5	16	15	14
Development of groundwater standards	7	16	10	5	9	10
Aquifer mapping	2	4	10	23	9	9
Control of discharges to groundwater	1	3	7	13	17	16
Groundwater monitoring	1	8	15	16	14	3
Protection of sole-source aquifers	18	15	10	6	4	2
Contamination response program	2	4	8	14	19	10
Septic management program	1	6	11	16	14	9
Above-ground and underground storage-tank program	4	3	12	13	17	8
Agricultural contamination program	6	8	22	15	5	1
Solid-waste and wastewater disposal program	0	2	6	8	22	19
Underground injection control program	8	1	5	11	18	14
Oil, gas, and water well programs	3	4	6	14	14	13
Exchange of information	4	6	21	13	9	3

[a]This question was addressed to all 57 state respondents. Some did not respond for particular activities.

Table 5: State Groundwater Protection Policies by Type

Policy type	GAO survey[a]	EPA[b]
	Number of states	
Any type	50	31
Nondegradation	29	16
Limited degradation	16	17
Differential protection	16	12
Other	2	•
None	7	•

[a]This question was addressed to all 57 state respondents. More than one policy type could be identified

[b]U S Environmental Protection Agency, State Ground-Water Program Summaries (Washington, D C March 1985)

Table 6: Numeric and Narrative Groundwater Standards in the 57 States

State[a]	Numeric	Narrative	Both	None
Alabama				•
Alaska	•			
American Samoa				•
Arizona	•	•	•	
Arkansas				•
California	•	•	•	
Colorado	•	•	•	
Connecticut		•		
Delaware		•		
District of Columbia		•		
Florida	•	•	•	
Georgia	•	•	•	
Guam		•		
Hawaii				•
Idaho	•	•	•	
Illinois	•	•	•	
Indiana		•		
Iowa				•
Kansas				•
Kentucky				•
Louisiana		•		
Maine	•			
Maryland	•	•	•	
Massachusetts	•	•	•	
Michigan		•		
Minnesota	•	•	•	
Mississippi				•
Missouri	•	•	•	
Montana	•	•	•	
Nebraska	•	•	•	
Nevada				•
New Hampshire	•	•	•	
New Jersey	•	•	•	
New Mexico	•	•	•	
New York	•	•	•	
North Carolina	•	•	•	
North Dakota				•
Northern Marianas				•
Ohio		•		
Oklahoma	•	•	•	
Oregon		•		
Pennsylvania				•
Puerto Rico				•
Rhode Island				•
South Carolina	•	•	•	
South Dakota		•		
Texas	•			
Tennessee				•
Trust Territory of the Pacific Islands		•		
Utah				•
Vermont		•		
Virgin Islands		•		
Virginia	•	•	•	
Washington		•		
West Virginia		•		
Wisconsin	•	•	•	
Wyoming	•	•	•	
Total	**26**	**38**	**23**	**16**

[a]These questions were addressed to all 57 state respondents.

distinct contaminants, with as few as 14 contaminants covered in one state and as many as 190 in another. The contaminants included the physical and radiological characteristics of groundwater, various inorganic compounds, biological substances and, most prominently, organic compounds, including a large number of volatile organic compounds and pesticides. The list included the 34 contaminants covered by EPA's drinking water standards; in fact, these 34 contaminants constituted, on the average, about 62 percent of the numeric standards in each of the states. On the average, 20 states had standards for 19 contaminants not included in EPA's drinking water standards. (See Tables 7 and 8.)

For the most part, the numeric standards were intended to protect human health or drinking water, but in many states they were also intended to protect other uses of groundwater. In some states, different contaminant levels had been established for these different uses.

The states' narrative standards differed considerably, usually specifying some standard or quality, or prohibiting some type of contamination. Their differences made it difficult to count and compare them. Most of the states used their narrative standards to protect human health or groundwater uses. Figure 2 presents data on the bases for narrative standards. A substantial number also intended their standards to protect the environment or made a general prohibition against the introduction of

Table 7: Contaminants Regulated by the States

Class	Contaminant
Physical characteristic of groundwater	Alkalinity, biochemical oxygen demand, chemical oxygen demand, color,[a] corrosivity,[a] dissolved oxygen, odor,[a] pH,[a] taste, temperature, total dissolved solids,[a] total hardness, turbidity[a]
Inorganic compound	
Metal	Antimony, arsenic,[a] barium,[a] beryllium, boron, cadmium,[a] calcium, chromium,[a] copper,[a] iron,[a] lead,[a] magnesium, manganese,[a] mercury,[a] nickel, potassium, selenium,[a] silver,[a] sodium, thallium, zinc[a]
Nonmetal	Ammonia, boric acid, borates, and metaborates as boron; bromide; chloride;[a] cyanide; fluoride;[a] hydrogen sulfide; nitrate as N,[a] nitrate + nitrite as N; nitrite; sulfate[a]
Measure of inorganic contamination	Ammonia nitrogen, foaming agents,[a] specific conductance, total nitrogen
Radiological activity and substance	Beta particle and photon radioactivity;[a] cesium 134; gross alpha particle activity;[a] gross beta particle activity; plutonium 238, 239, and 240; radium 226; radium 226 and radium 228 combined;[a] strontium; thorium 230 and 232; tritium; uranium
Biological substance	Coliform bacteria,[a] fecal coliform bacteria
Organic compound	
Volatile	Benzene; carbon tetrachloride, chlorobenzene; chloroform; 1,2-dibromo-3-chloropropane; 1,2-dibromoethane; p-dichlorobenzene; 1,1-dichloroethane; 1,2-dichloroethane; 1,1-dichloroethylene; 1,2-dichloroethylene; trans-1,2-dichloroethylene; dichlorofluoromethane; dichloropropanes; 1,2-dichloropropene; cis-1,3-dichloropropene; trans-1,3-dichloropropene; 1,3-dichloropropylene; ethylbenzene; ethylene dibromide; hexachloroethane; methyl chloride; methylene chloride; nitrobenzene; styrene; tetrachlorobenzenes; 1,1,2,2-tetrachloroethane; tetrachloroethylene; 1,1,2,2-tetrachloroethylene; toluene; trichlorobenzenes; 1,1,1-trichloroethane; 1,1,2-trichloroethane; trichloroethylene; trichlorofluoromethane; trichlorotrifluoroethanes; vinyl chloride; m-xylene + p-xylene; o-xylene; xylenes, total
Nonvolatile	Acenaphthene; acetone; acrylic acid; acrylonitrile; alkyl dimethyl benzyl ammonium chloride; alkyl diphenyl oxide sulfonates; aminomethylene phosphonic acid salts; aminopyridine; aniline; anthracene; aryltriazoles; azobenzene; benz(a)anthracene; benzidene; benzisothiazole; benzo(b)-fluoranthene; benzo(k)-fluoranthene; benzo(a)pyrene; bis (2-chloroethyl) ether; bromodichloromethane; bromoform; bromomethane; butoxyethoxyethanol; butoxypropanol; butyl benzyl phthalate; butyl isopropyl phthalate; carbon disulfide; chloroethane; 2-chloroethylvinyl ether; chloromethane; 2-chloronaphthalene; 2-chlorophenol; 5-chloro-o-toluidine; chrysene; dibromochloromethane; dibromodichloromethane; 2,2-dibromo-3-nitrilopropionamide; 3,3'-dichlorobenzidene; 2,4-dichlorophenol; diethyl phthalate; n,n-dimethyl aniline; dimethylformamide; dimethyl phthalate; 2,6-dinitrotoluene; di-n-butyl phthalate; di-(2-ethylhexyl)-phthalate (DEHP); di-n-octyl phthalate; diphenylhydrazine; dodecylguanidine salts; dyphylline; ethylene chlorohydrin; ethylene glycol; ethylene oxide; ethylene thiouria; fluoranthene; fluorene; guaifenesin; hexachlorobutadiene; hexachlorocyclohexanes; hexachlorocyclopentadiene; hexachlorophene; 2-hexanone; hydroquinone; 2-(2-hydroxy-3,5-di-tert-pentylphenyl) benzotriazole; 1-hydroxyethylidene-1,1-diphosphonic acid; indeno (1,2,3-cd) pyrene; isophorone; mercaptobenzothiazole; methacrylic acid; methoxyethylbenzene; methylbenz(a)anthracenes; methylene bisthiocyanate; 4-(1-methylethoxy)-1-butanol; 2-methylethyl-1,3-dioxolane; methyl ethyl ketone; methyl isobutyl ketone, methylmethacrylate; methyl-n-butyl ketone; monohydric phenol; naphthalene; naphthalene (total) (PAHs); niacinamide; nitrilotriacetic acid; n-nitrosodimethylamine, phenanthrene, phenols (total); phenyl ether; phenylpropanolamine; polychlorinated biphenyls (PCBs); pyrene, pyridine; 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD); tetrahydrofuran; theophylline; o-toluidine; tolyltriazole; tributyltin oxide; trimethylbenzenes; trimethylpyridine; triphenyl phosphate
Pesticide	Alachlor; aldicarb; aldicarb + methomyl; aldrin; amiben; atrazine; benefin; bromacil; butachlor; captan; carbaryl; carbofuran; chlordane; 2,4-D;[a] DDT; diazinon; dicamba; dieldrin; dinoseb; dithane, endrin;[a] ferbam; folpet; guthion; heptachlor; heptachlor epoxide; hexachlorobenzene (HCB); kepone; lindane;[a] malathion; maneb; methoxychlor;[a] 2-methyl-4-chlorophenoxyacetic acid (MCPA); mirex; nitralin; paraquat; parathion; pentachloronitrobenzene (PCNB); pentachlorophenol (PCP); phorate; propachlor; propanil; propazine; simazine; 2,4,5-T, thiram; toxaphene;[a] 2,4,5-TP silvex;[a] trifluralin; zineb; ziram
Measure of organic contamination	Carbon chloroform extract, oil and grease, organic nitrogen, petroleum hydrocarbons, total organic carbon
Other	Total organic halogen, total trihalomethanes[a]

[a]Contaminant also regulated by EPA.

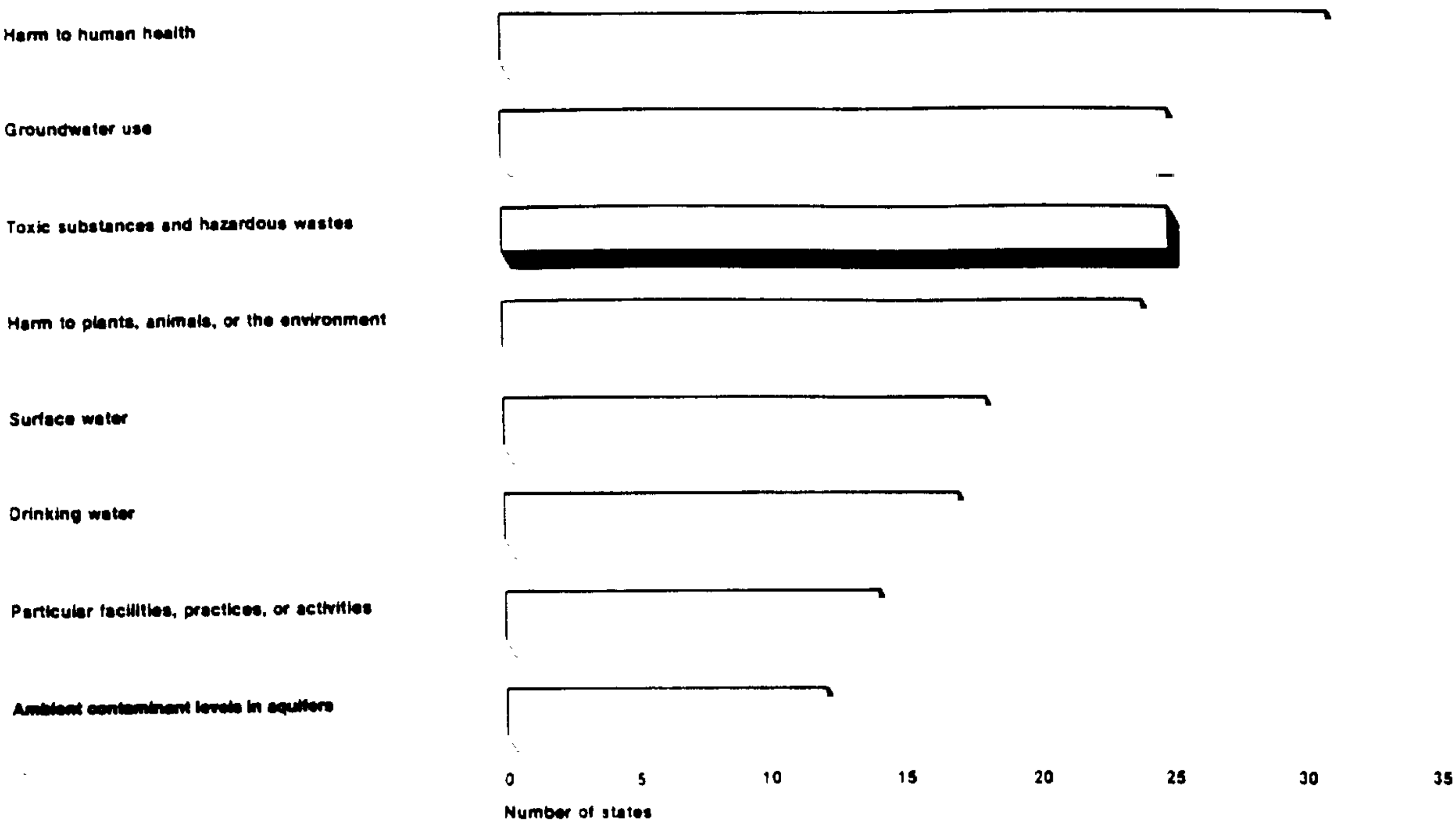
Table 8: The Total Number of Numeric Groundwater Standards by State

State	Primary standards[a]	Secondary standards[a]	Total number
Alaska	21	12	39
Arizona	22	0	22
California[b]	•	•	•
Colorado	20	11	42
Florida	22	12	43
Georgia	22	0	22
Idaho	22	12	35
Illinois	17	10	46
Maine	22	9	33
Maryland	14	0	14
Massachusetts	21	7	28
Minnesota	12	10	25
Missouri	17	6	47
Montana	22	0	25
Nebraska	19	8	28
New Hampshire	22	12	38
New Jersey	16	11	39
New Mexico	11	8	41
New York	16	8	190
North Carolina	20	6	30
Oklahoma	0	0	36
South Carolina	21	12	33
Texas	22	12	35
Virginia	15	4	36
Wisconsin	16	11	63
Wyoming	12	8	29
Total	**444**	**189**	**1,019**

[a]Substances on the list of EPA primary or secondary standards for which the state had a standard

[b]The total number is unknown. California's standards are set regionally and do not apply to the entire state. California's officials did not provide copies of any standards

Figure 2: Narrative Standards by Criterion[a]



[a]This question was addressed only to the 38 respondents whose states had narrative standards

toxic or hazardous substances into groundwater (in contrast to the numeric standards' specification of levels of contaminants that were permissible). Some state standards made general reference to EPA's drinking water or surface water standards (and allowed for future standards EPA may adopt) or to existing or background levels of contaminants in ambient groundwater (thereby covering contaminants not naturally present or present at a specific level). Many of these standards seemed to cover the same situations that were encompassed by specific numeric standards.

The groundwater standards were applied to groundwater in a variety of ways. Many states simply applied their standards to all groundwater; others specified their application to specific types of groundwater. Many states applied the standards to groundwater as a source of drinking water, while another large group of states seemed concerned most with the groundwater around the places where contaminants were likely to be discharged. Several states based the application of their standards on some classification scheme or applied them only to groundwater of a certain quality or to sole-source aquifers.

Eleven of the 26 states had adopted numeric standards since early 1983, only 2 since late 1985. Several other states were considering the adoption of numeric standards. Our data suggest that between 40 and 220 numeric standards were being added each year across all states, with lower numbers in the last 2 years and most of the new standards adopted by states that previously had none. At this rate, it could take as long as 40 years to adopt numeric standards in all states for half of the contaminants now regulated in at least one state. The slow pace at which the states are adopting standards raises the question of whether protection from contamination is adequate.

Differences in State Groundwater Standards

Each state with numeric standards seems to have relied to a great extent on the federal drinking water standards. Approximately 62 percent of the states' numeric standards corresponded to federal drinking water standards. However, adoption of the federal standards was not treated as an absolute rule. On the average, states with numeric standards adopted 18 of the 22 federal primary standards and 8 of the 12 secondary standards. The most notable differences from the federal list were some states' omission of EPA's biological, radiological and physical standards. Five states with numeric standards did not include any of EPA's secondary standards.

We found several differences from the levels of contamination permitted in the federal standards, including some in states that adopted groundwater standards by reference to their drinking water standards. Many differences appeared in the states that adopted their standards some time ago and have not updated them;

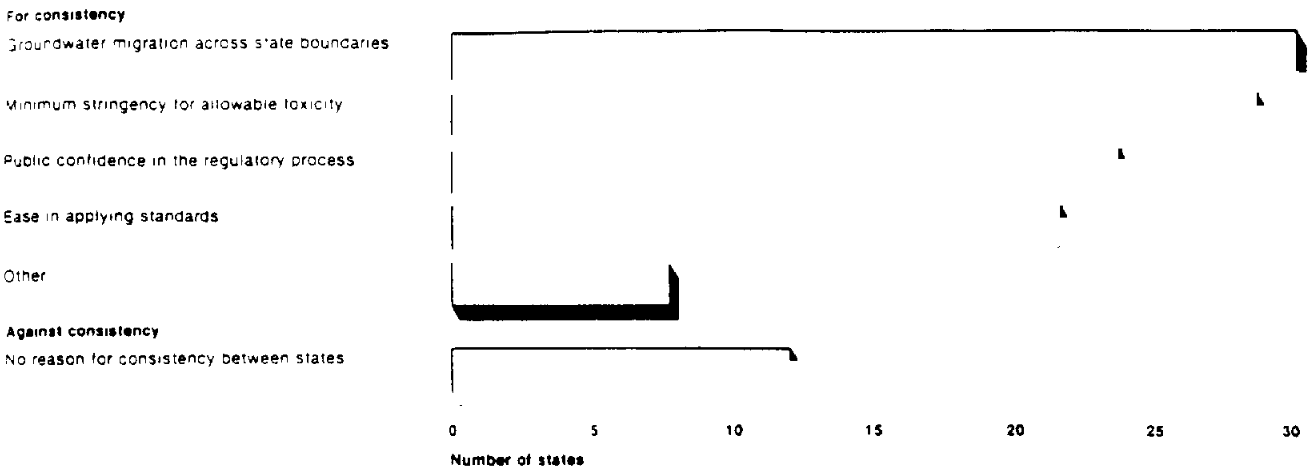
the levels set in these states may not reflect the latest information on the contaminants. Notwithstanding, some states have based levels that are different -- higher for some standards and lower for others -- on the specific consideration of appropriateness of the federal standards to conditions in the states. In general, state officials believed that the federal drinking water standards could be used as the basis for ambient numeric groundwater standards if some consideration were given to (1) uses of groundwater other than for drinking, (2) natural background conditions and, (3) social and economic costs in protecting groundwater to a specified level.

Across the 20 states that adopted standards for contaminants not included in the federal drinking water standards, we found very little consistency as to which other contaminants were included. Beyond those on the EPA list, an additional 226 contaminants were included in 386 state standards, an average of fewer than 2 standards per contaminant. In most of the states, it appears that the additional standards were not based on the actual detection of contaminants. There is apparently a much greater likelihood that the standards that were adopted <u>more recently</u> were based on contaminants actually detected or posing a demonstrated threat. A large portion of these recently adopted standards regulated volatile organic compounds and, in some western states, certain types of radiological substances. No two states had the same set of numeric standards (except states that incorporated the federal standards by reference). Despite this, a large majority of state officials were, for a variety of reasons, in favor of interstate consistency for groundwater standards. (See Figure 3.)

A similar variability appears widespread with respect to narrative standards, for which the states have no federal example to follow. These standards provide case by case criteria, and the criteria vary considerably from state to state. Nonetheless, narrative standards do seem to adhere to an overall structure, specifically covering the discharge of certain amounts of contaminants into groundwater and affecting how the groundwater can be used. These standards give the states considerable flexibility in protecting groundwater but may be unevenly applied.

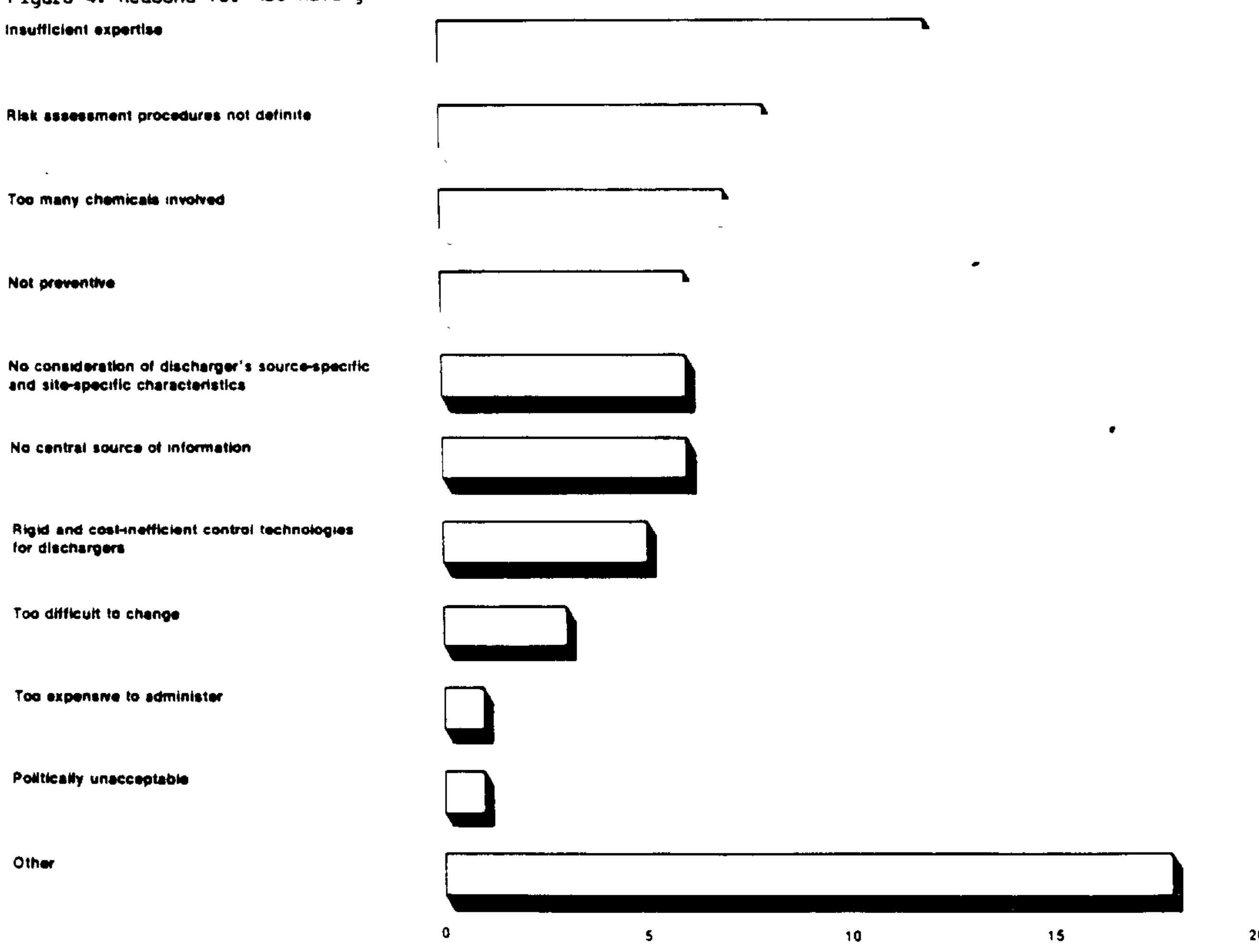
No factor seems directly linked to the establishment of numeric or narrative standards or both. The existence of standards -- or conversely, the absence of standards in 16 states -- did not seem to be related to the types of groundwater problems within a state or the extent to which a state relied on groundwater for its drinking water. The best explanation, one that has been posited in the literature, is that the development of standards is based on the political orientation of a state. In other words, it appears that a concern about potential groundwater contamination leads to the implementation of protective measures that invariably reflect some standard of acceptable groundwater quality. Figure 4 details the reasons our respondents

Figure 3: Reasons For and Against Consistency Between the States on Ambient Groundwater Standards[a]



[a]This question was addressed to all 57 state respondents. If a respondent's position was for consistency, more than one reason could be given.

Figure 4: Reasons for Not Having Numeric Standards[a]



[a]This question was addressed only to the 31 respondents whose states did not have numeric standards. Respondents from 2 territories did not answer the question.

gave for not having numeric standards.

Most states that had numeric standards also had narrative standards, but not vice versa, raising the question of whether there might be a trend toward using narrative standards rather than numeric ones. The states generally had the authority to develop groundwater standards and did not seem to need specific legislation in order to enact groundwater standards, particularly numeric standards. Some states were in the process of developing or considering the development of standards, although some of these had been slowed by technical or informational constraints. However, some states seemed to believe that numeric standards are not the best choice and that narrative standards should be used instead.

We found that groundwater programs with standards appeared in states where responsibility for groundwater protection was <u>not</u> assigned to a lead agency, where groundwater protection plans had <u>not</u> been developed and where they were <u>not</u> independent of the groundwater protection policy that had been established. This runs counter to predictive relationships involving these indicators that have been hypothesized in the literature. That is, while these indicators may well describe what is happening within a state, our data do not support the idea that they are prerequisites for developing groundwater standards.

The States' Standard-Setting Processes

Most of the states with numeric standards did not have well-developed procedures for setting their standards by themselves. Respondents from only a few states indicated that their states' procedures could be considered well-developed; the remainder indicated that they relied substantially on the federal government or others for primary information concerning contaminants. Most of the states involved the public in the standard-setting activities, primarily to ascertain whether there was sufficient public support for the establishment of standards. For most of the states, the major activity seemed to be the development of conditions for permits and responses to contamination incidents. In this regard, it appears that the states relied to a great extent on permit holders to demonstrate that their activities would not violate standards. Table 9 characterizes the procedures for setting and applying standards.

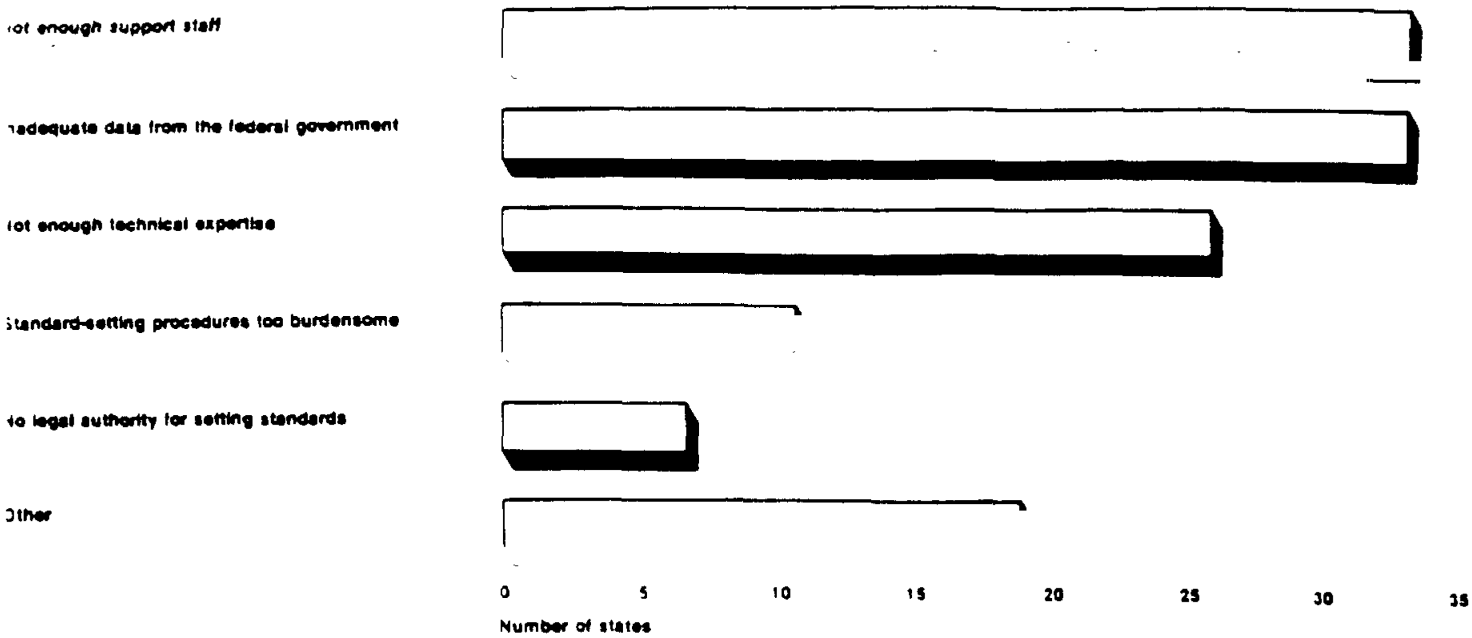
The major limitations on the standard-setting process were resource constraints, including insufficient finances and technical and support staff, along with a perceived inadequacy of information from the federal government. (See Figure 5.) For these reasons, officials from some states believed their states would have a difficult time implementing standards for 100 contaminants, as has been proposed in some legislation.

Table 9: The Number of States Using Nine Procedures in Setting and Applying Standards

Type of procedure	Extent of use[a]: Little or none	Some	Moderate	Great	Very great
Identify possible additions to a list of contaminants	10	6	5	4	5
Assess risks, including effects on health, costs and benefits and technical feasibility and practicability	7	8	6	4	5
Obtain information on the environmental source and fate of a substance and measures for minimizing its concentration in groundwater	5	7	11	4	3
Develop proposed standard from existing federal or state standards	3	0	3	8	15
Develop a standard from medical evidence, such as dose response	11	8	4	2	4
Prepare a document proposing a standard, present evidence, and request public comment	10	3	5	3	7
Hold public hearings or otherwise obtain public comment	4	4	5	5	11
Develop conditions for permits to ensure a standard is not exceeded	3	2	6	10	9
Develop responses to exceeding a standard	4	2	9	10	5

[a]This question was addressed only to the 41 states with numeric or narrative standards. Many of the states with narrative standards only chose not to respond to this question. Thirty respondents answered the question.

igure 5: Constraints on Setting Groundwater Standards[a]



[a]Respondents could indicate more than one type of constraint.

It appears that 20 of the 26 states with numeric standards had relatively minimal standard-setting processes and relied primarily on federal drinking water or surface water standards, substantially incorporating them as state numeric groundwater standards either by reference or without referring to groundwater. Five of the 6 remaining states seemed to have considerably stronger standard-setting procedures.

In the more advanced states, procedures for identifying new contaminants to add to the list of numeric standards were fairly consistent. They relied to a great extent on the detection of contaminants through monitoring. At least 2 states made use of such information as data on the use of chemicals and land-use records to augment their ability to identify likely contaminants. Once the threat of particular contaminants had been recognized, these states based their priorities for setting standards on an assessment of their relative threat. These states used federally developed evidence for setting levels for standards when such information was available. When it was not, they set the levels themselves, using procedures specified in regulations or laws and usually taking uncertainty factors into account. There would be considerable duplication of effort across the states in developing this information for contaminants for which information was not available from other sources.

The lack of available information for setting standards seemed to represent one of the biggest problems for state officials. They reported that they did not have the resources to gather primary medical and chemical information on contaminants. Their belief is that much of this type of information should be provided by the federal government, preferably through a single source, such as a criteria document. They did not believe that the information they were presently receiving was adequate and in many cases thought that the federal government had a primary responsibility for providing specific information.

The information state officials thought was most important to receive concerned the effects of the contaminants on health and existing guidelines and standards pertaining to these contaminants. Their view was that states did not have the resources or the technical skills to develop toxicological data or information on risks to health or effects on health, seemingly relying as much as possible on federal sources, preferably guidelines and standards. The respondents to our survey viewed as important other information specific to contaminants, including information on the environmental fate of contaminants, analytical chemistry, human exposure, the technological feasibility of controlling contaminants, and monitoring methods. Most of our respondents seemed to believe that criteria documents would be a useful vehicle for these types of information. However, they also seemed to believe that the states can obtain necessary information on the potential sources of contaminants and assessments of their threats within the states. The gap between what the states needed when we made our survey and what they received seemed to be rather large.

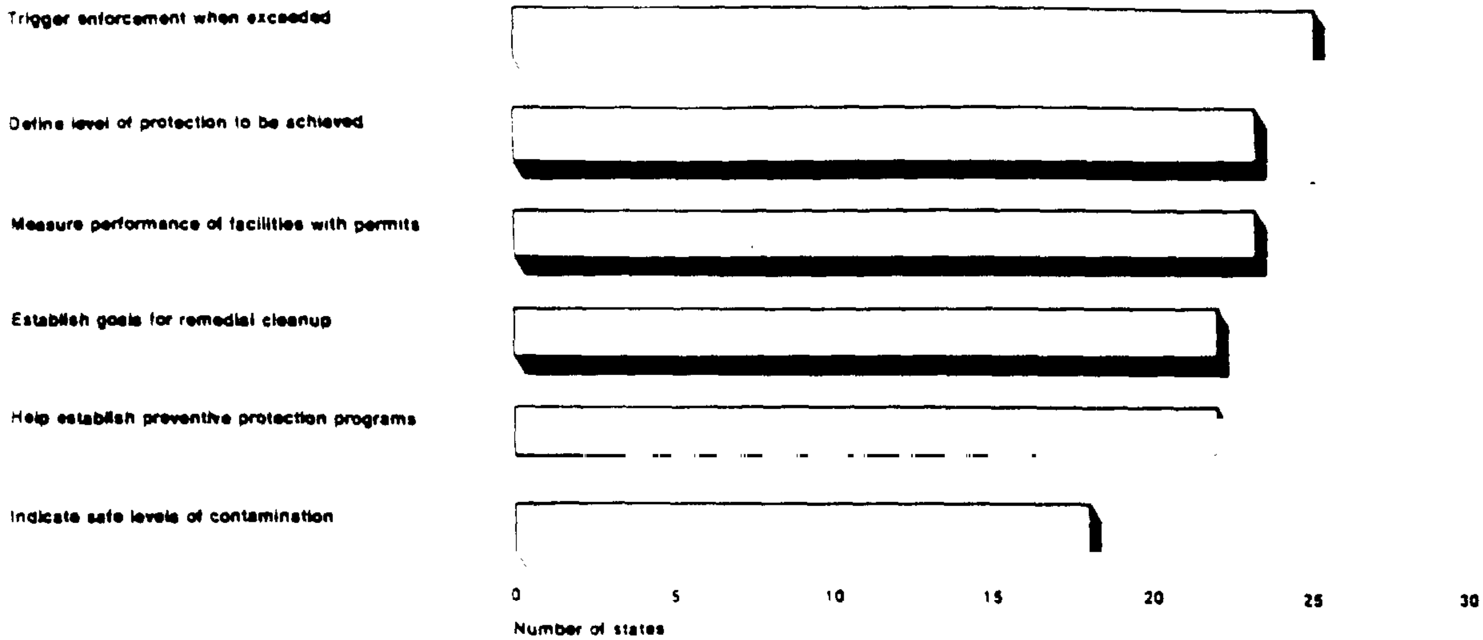
<u>The Application of Standards</u>

It is very difficult to know precisely how the states' standards were used. However, our study does allow us to identify the principal areas where they were used. Figure 6 characterizes the states' use of groundwater standards. The standards were used in most states to trigger enforcement and to assess permit performance for those who might discharge contaminants. In addition, the standards were used to define the level of protection a state intended to achieve, indicate safe levels of contamination, establish preventive programs, and establish goals for remedial actions. However, how the states actually implemented these objectives in state programs and how well the objectives were met is completely unknown at the present time.

Groundwater standards were used in most states as a guide for permit applicants and for those who established allowable levels of contamination under permit programs. The standards were also sometimes used in establishing discharge permits and in shutting down wells to protect the public. However, in many states, variances to standards were allowed for specific reasons; the extent to which variances weakened the force of the groundwater standards or permit conditions is unknown.

The extent to which standards are used in permit programs

Figure 6: State Use of Groundwater Standards[a]



[a]This question was addressed to the 26 states that had numeric standards.

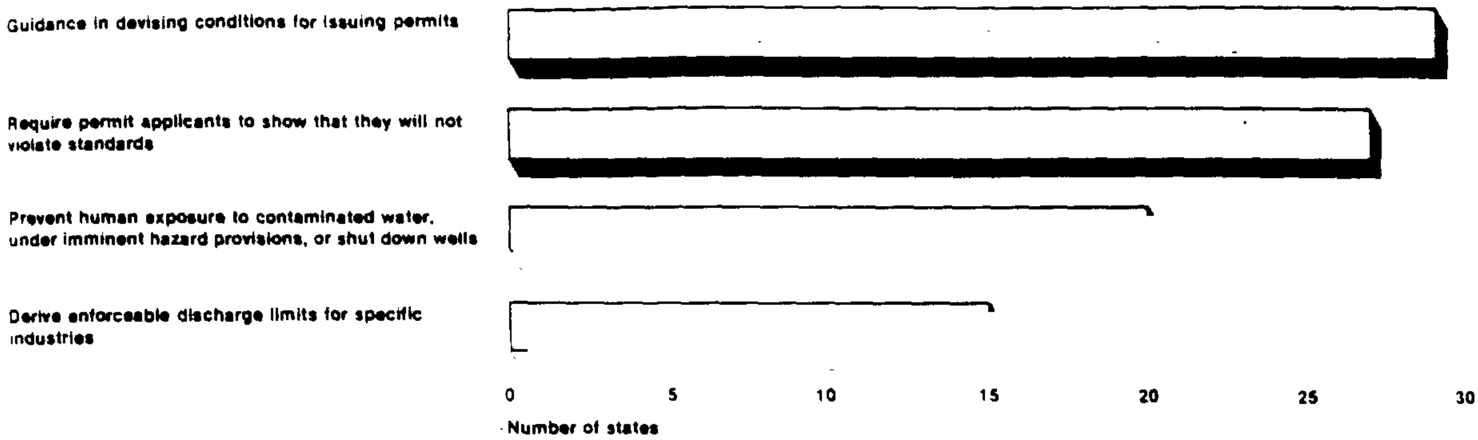
makes it important to determine the extent to which permits cover discharges that may affect groundwater, how these permits are used in conjunction with other programs that control discharges, and the extent to which standards used in this way prevent or mitigate groundwater contamination. (See Figure 7.) A significant question raised by this last point is whether states with numeric standards experience less contamination than states with narrative standards or states without any standards.

Most of the states with groundwater standards seemed to have monitoring programs, apparently recognizing that groundwater standards would be largely meaningless without monitoring. (See Figure 8.) Groundwater standards had also been incorporated into groundwater classification systems, in states that had both, either by requiring specifically classified groundwater to meet these standards or by setting up different standards for different categories. The incorporation of standards into classification systems provided a concrete guide for the states in determining the value of particular groundwater. The evolution of a classification system apparently goes hand-in-hand with the evolution of a state's groundwater standards. Figure 9 presents the bases for state classification systems.

Information States Need to Develop Standards

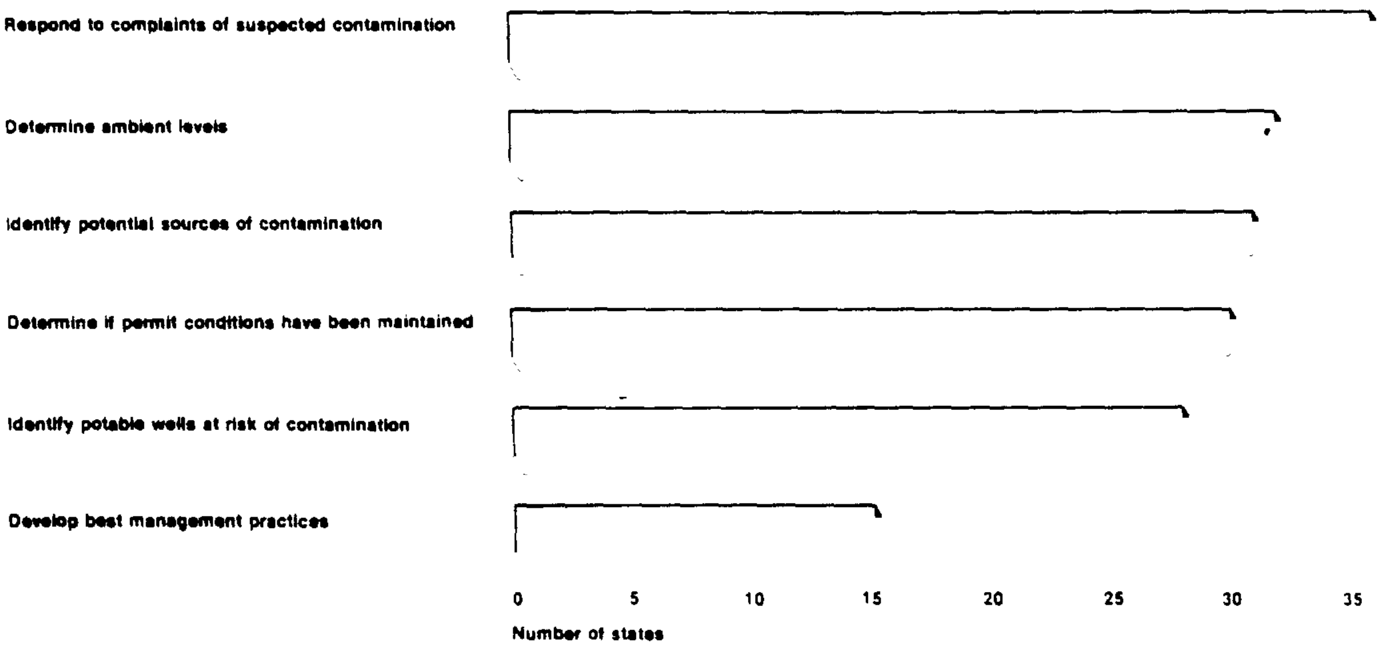
Our second evaluation was designed to examine what information the states need to develop technically sound standards and

Figure 7: State Use of Standards in Permit Programs[a]



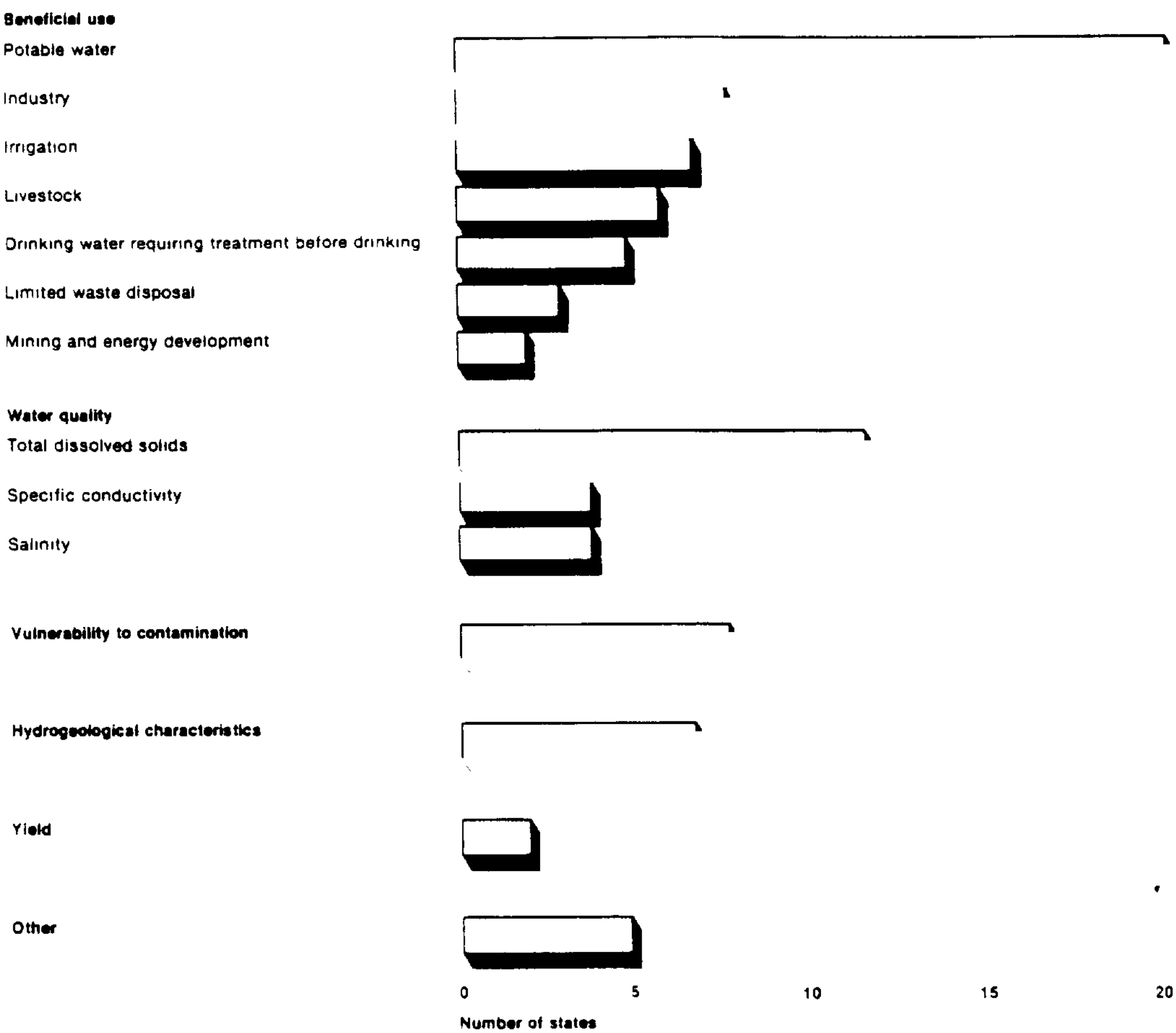
[a]This question was addressed to the 41 states that had numeric or narrative standards; 6 did not answer.

Figure 8: The Purposes of Groundwater Monitoring Programs[a]



[a]This question was addressed to the 41 states that had numeric or narrative standards; 2 did not answer.

Figure 9: The Bases for State Classification Systems[a]



[a]This question was addressed to the 25 states that had numeric or narrative standards and a classification system.

whether that information is currently available from EPA. More precisely, we wanted to determine what types of information the states need to set groundwater standards, to what extent the information is currently available in EPA technical documents, whether there is a need for more information on groundwater contaminants and, if so, how that need can be met. Since the states readily adopt drinking water standards as groundwater standards, we were also interested in what drinking water standards had been set and what standards were planned for development. Our methodology included the use of the same survey mentioned earlier as well as a detailed review of technical documents developed by EPA.

Information Needs

We asked the state respondents to consider 12 information areas that, with the assistance of members of the Committee on Groundwater of the National Academy of Sciences, we had identified as being important for setting groundwater standards. The areas were:

1. the analytical chemistry of substances,
2. the environmental fate of substances,
3. the presence of substances in groundwater and their proximity to groundwater users,
4. the amount and location of the production and disposal of substances in the states,

5. monitoring methods for contaminants,
6. the technological feasibility of control,
7. human exposure,
8. the effects of contaminants on human health,
9. existing guidelines and standards,
10. references for further information,
11. contacts for additional information, and
12. how to use the information to set groundwater standards.

The respondents from the majority of the states cited all but the third and fourth information areas as "moderately important," "very important," or "essential." They also viewed the federal government as the principal source of this information.

Extent to Which Information is Available from EPA

The most basic type of information that the states have used for setting groundwater standards is drinking water standards. Twenty-two drinking water standards for individual contaminants had been issued prior to July 1987; 20 of the 22 are being revised. In 1982 and 1983, EPA's Office of Drinking Water announced that it was reviewing 63 other contaminants for possible regulation. In July, 1987, EPA issued standards for 8 of these contaminants. Consequently, we focused our evaluation of what information is available on the 83 contaminants which were being revised or newly established. Table 10 provides a

Table 10: EPA's Statutory Dates for Regulating 83 Contaminants

Date	Type	Contaminant
June 1987[a]	Volatile organic compounds and fluoride	Benzene; carbon tetrachloride, 1,2-dichloroethane; 1,1-dichloroethylene; fluoride; paradichlorobenzene; 1,1,1-trichloroethane; trichloroethylene; vinyl chloride
June 1988[b]	Inorganic compound	Arsenic, asbestos, barium, cadmium, chromium, copper, lead, mercury, nitrate, selenium
	Organic compound	Acrylamide; alachlor; aldicarb; carbofuran, chlordane; chlorobenzene, 2,4-D, dibromochloroproprane (DBCP), cis-1,2-dichloroethylene, trans-1,2-dichloroethylene; 1,2-dichloropropane, epichlorohydrin, ethylene dibromide; lindane; methoxychlor; ortho-dichlorobenzene; pentachlorophenol; polychlorinated biphenyls (PCBs), tetrachloroethylene; toluene; toxaphene; 2,4,5-TP; xylene
	Microbiological or physical characteristic	Coliform bacteria, giardia lamblia, legionella, standard plate count, turbidity, viruses
June 1989[c]	Inorganic compound	Antimony, beryllium, cyanide, nickel, nitrite,[c] sulfate, thallium
	Organic compound	Adipates; aldicarb sulfone,[c] aldicarb sulfoxide;[c] atrazine; dalapon; dinoseb; diquat; endothall; endrin; ethylbenzene;[c] glyphosate; heptachlor;[c] heptachlor epoxide;[c] hexachlorocyclopentadiene; methylene chloride; PAHs; phthalates; pichloram; simazine;, styrene,[c] 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD), trichlorobenzenes; 1,1,2-trichloroethane; vydate
	Radiological activity or substance	Beta particle and photon activity, gross alpha particle activity, radium 226 and 228, radon, uranium

[a]EPA issued regulations for these contaminants by July 1987

[b]Advance notice has been published for these 39 compounds; EPA proposes to meet the requirement that 40 be regulated by June 1988 by adding one compound not in the statutory list

[c]Substituted in the list in July 1987

list of the contaminants and EPA's statutory dates for their regulation.

We reviewed EPA's published technical documents on the 83 contaminants. In the opinion of the Director of EPA's Office of Groundwater Protection, this office would consider these 83 contaminants first, were it directed to issue criteria documents for groundwater contaminants. Criteria documents reporting information on contaminants of concern are issued by a number of program offices within EPA. They may be prepared as background to a regulatory action or as general information, and they vary in breadth and detail. EPA does not issue criteria documents on pollutants as contaminants of groundwater resources.

We identified 247 documents that deal with 1 or more of the 83 contaminants. We examined them for the 12 types of information applicable to setting groundwater standards. Some information areas were fairly well-covered for the 83 contaminants. However, we identified a substantial gap between what is currently available on the 83 contaminants and what would be needed if groundwater standards were to be developed. That gap was the most significant for 8 of the 83 contaminants; we found <u>no</u> information for these 8. For an additional 15 substances, fewer than 6 of the 12 areas were covered. We found <u>no</u> information on how to set groundwater standards. We also found that no collection of documents (or document series) for a single contaminant covered all 12 areas of information.

If the states are to set technically sound groundwater standards, they will need more information from EPA or elsewhere. Working with current information resources is difficult because, although many of the 247 EPA documents provide some information related to groundwater contaminants, no single document series is devoted specifically to groundwater contaminants. A substantial effort would be required to synthesize information for any one contaminant.

As mentioned earlier, we found that 260 substances are regulated by one or more states as groundwater contaminants. There is a significant difference between that number and the number of contaminants regulated as drinking water contaminants. If EPA meets the timetable set out in the Safe Drinking Water Act Amendments of 1986, and sets standards for the 83 substances, the gap will be narrowed. However, there will very likely still be a gap between the number of groundwater contaminants the states are concerned with and the number that EPA regulates as drinking water contaminants. Therefore, the states' requirements for information upon which to set groundwater standards cannot be fully met by the information to be developed by EPA in the near term.

The Need for More Information and How It Can Be Met

In the absence of a federal program to establish groundwater standards, 41 of the 57 respondents have set their own numeric or narrative standards for some contaminants. (The median number of contaminants regulated by state statute is 35.) Many state officials believe they are prevented from effectively setting standards by a lack of information on groundwater contaminants. When the states do proceed on their own, they often duplicate one another's efforts in collecting and analyzing information. A substantial gap exists between the information requirements of the states for setting groundwater standards and the information that is available from the federal sector. Additional information about contaminants should be developed and disseminated if state standards are to be developed in an efficient and technically sound fashion.

Because information on given contaminants is often dispersed in several different documents, it is harder to use and some information may be overlooked altogether. The states' standard-setting programs would benefit most from a single, centralized reference source for groundwater contaminants--that is, a criteria document series. The Environmental Protection Agency is clearly the appropriate organization to develop such information.

EPA has a history of serving as a reference source for drinking water, surface water, and other regulatory areas. In addition, EPA has some regulatory responsibilities for groundwater, has developed and provided a national groundwater protection strategy to state governments, and continues to work closely with the states. During fiscal years 1985 and 1986, EPA dispensed approximately $14 million in grants to assist the states in designing and implementing groundwater protection programs, many of which rely on EPA's standards. EPA recognizes the use of standards as tools for establishing specific goals for groundwater protection, determining compliance with and enforcing those goals, and assessing the success of protection programs. Providing the information the states need to establish groundwater protection standards would be consistent with EPA's current goals and efforts.

Finally, we do not believe that groundwater criteria documents should necessarily be established for the contaminants that EPA has proposed to regulate under the drinking water program. The risks that some substances pose for groundwater may be different from the risks they pose for drinking water.

We recommend that EPA establish a criteria document program specifically for groundwater contaminants. The groundwater contaminants addressed should be those that pose the greatest risks.

This concludes my remarks. I would be happy to answer any questions you might have.