

Virginia's Most Important Water-Related Problems

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INTRODUCTION

When Congress established the nation's 54 water centers in 1964, it charged them with the responsibility for identifying the most important water problems within their jurisdictions and for sponsoring or conducting research on those problems. These missions have been especially important in states such as Virginia which have opted for a multiagency approach to the protection and development of their water resources. With 11 regulatory agencies overseeing Virginia's waters, and each required to focus on only a part of the water resources problem, the Virginia Water Resources Research Center has had an important role serving as the collecting point for general information about the state's water problems, acting as the facilitator for the exchange of information among the various segments of the water resources community, and serving as a research resource for the community.

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The Center had these missions in mind when it organized in the spring of 1980 a problem identification and ranking process involving nearly 150 academicians, government officials, and interested citizens from industry, agriculture, and environmental groups. Participants were assigned to committees based on their expertise in the following areas: water supply, outdoor recreation, nonpoint source pollution, marine environment, inventory and monitoring, flood damage abatement, resource management, and waste treatment. After the top seven to nine problems were identified in each area, a conference was held at Virginia Tech to rank the problems in order of importance. Using a consensus-building method developed by the Rand Corporation in 1959, conference participants rated 69 problems (later reduced by the Center to 60) according to their magnitude, scope, and urgency. This report looks at these problems, as well as the process used in identifying and ranking them.

Analysis of the Priority Problems

Resource management problems received the highest priority ratings among the 69 individual problems with four among the top 15. Waste treatment problems ranked next, with three among the top 15. When the average ranking of each problem area was calculated, the highest average ranking went to inventory and monitoring, followed in descending order by resource management, nonpoint source pollution, water supply, marine environment, waste treatment, flood damage abatement, and outdoor recreation. The first four categories were closely packed within the rankings. Inventory and monitoring received an average priority of 17.3, while the average for water supply was 20.3. (A more detailed analysis is found in *Appendix B*.)

The Center's Five-Year Plan

With the results of the conference in hand, the Center developed its research goals for 1982-87. During this period the Center plans to sponsor, as resources permit, research which will (1) assist in the development of a comprehensive state water resources management plan, (2) assist in the development of land management measures to protect surface and ground waters, (3) develop cooperation among ongoing water quality monitoring programs in both the public and private sectors, (4) assist in the development of a disposal policy for sludges from publicly owned treatment works, and (5) assist state agencies in the development of a public education program to reduce litter on and vandalism of the property of private landowners who allow access to floatable streams.

Assuming adequate financing, state-of-the-art papers in planning, monitoring, and sludge disposal will be commissioned in the 1982 fiscal year.

VIRGINIA'S MOST IMPORTANT WATER-RELATED PROBLEMS

1. *Virginia cannot avoid crisis-oriented decision making unless it adopts a comprehensive water resources management plan.*

No comprehensive water resources management plan exists in the Commonwealth of Virginia. A variety of state and local agencies and utilities which affect water resources have attacked single problems such as drought conditions in the Tidewater and Northern Virginia areas. However, there has been little coordination among the agencies involved and little planning which integrates known water supplies with projected demand, surface water with groundwater, or water quantity with water quality. The effects of this lack of coordination are apparent in the state's inability to deal with the 1980 drought and in the dispute over water rights among Norfolk and Suffolk and the U.S. Navy. The danger exists that the state will drift from one water crisis to another if coordination problems continue to be ignored.

The State Water Control Board has a statutory mandate to "prepare plans and programs for the management of the water resources of the state" which will produce the maximum beneficial use of the state's waters. However, due to budgetary constraints and the patchwork quality of Virginia's water law which hinders coordinated planning and management, much of the needed work in this area is incomplete.

Thus, the Joint Legislative Audit and Review Commission noted in 1976 that the "low priority" assigned to water resources planning in Virginia "has severely

reduced the Commonwealth's ability to avoid crisis-oriented decision making and to consider the long-range aspects of these types of water related problems."

Thus, an important priority in the Commonwealth should be the development of such a plan. As a preliminary step, a committee of experts and representatives of major water interests could determine the scope of the plan, how to develop it, who should be involved in its preparation, and how the work would be financed. It is essential that a comprehensive plan be developed in order to maximize the uses of the state's vital water resources.

2. *Virginia's surface and ground waters are threatened by current land use practices.*

Although localities are required to have land use plans, Virginia has no method for protecting state concerns through adequate land management. By vesting land use planning in local governments, state interests-at times-have been negated, resulting in conflicts such as the oil refinery controversy at Portsmouth. Statewide, it is estimated that 123,000 acres of pristine land will be developed and that the population will increase by 700,000 during the next decade. Such an impact on the state's water resources will be greater than many individual cities and counties can manage. Some problems of land management need to be addressed at the state level. Statewide standards enforceable at the local level must be determined. A continuation of the present approach will result in conflicts of interest, the indiscriminate development of prime agricultural land, and local disagreements in which the interests of the state as a whole are not represented.

3. *Virginia cannot evaluate the effects of nonpoint source pollution in its streams.*

Before adequate evaluations and predictions can be made on nonpoint source pollution impacts on Virginia streams, the types and amounts of materials entering waterways from undisturbed, or background, areas must be identified and quantified. However, the methodology for making such determinations has not been developed. Stream monitoring programs are needed to determine background pollutant concentrations in receiving streams. The studies should determine the quality of the receiving, water downstream from the nonpoint source discharge. Until such determinations are made on background pollution, any studies to evaluate nonpoint pollution from such sources as agriculture,

silviculture, construction, mining, and urban areas cannot result in accurate findings.

4. Data problems prohibit accurate quality assessments of Virginia's streams.

Water quality information is gathered throughout the state by a variety of private and public organizations and agencies. However, each of these groups has its own function, information requirements, and techniques for data gathering and analysis. These differences, when combined with a lack of historical or baseline data, limit the usefulness of the information. For example, researchers studying pollution in the Chowan River encountered substantial data problems in the attempt to evaluate water quality needs in the river basin.

To alleviate such data problems, existing monitoring practices should be evaluated. A clearinghouse is needed to ensure the utilization of comparable techniques for data collection, analysis, and reporting in the state; to eliminate duplication of effort; and to organize research results. Priority data needs include (1) an expanded, ongoing, routine stream monitoring program and (2) consistent procedures for data collection and analysis. Failure to establish such a program will result in the waste of financial and technical resources.

5. The disposal of municipal and industrial sludges on land cannot become a politically acceptable option until many technical, legal, economic, social, and health-related problems are solved.

Different types of soil react in different ways to the materials in sludge, as do the plants which absorb these materials. The effect of sludge materials accumulating through the food chain has yet to be ascertained. Long-term effects of land application both on the land and affected water supplies are not known. Thus, the problems associated with land application are very complex, and they are compounded by economic factors which must be determined when sludge is applied to croplands or when haul distances are great. The state needs to develop a policy with regard to whether or not it wants these wastes applied to land. As more sludge is generated, pressure to apply it to land will increase. If the indiscriminate use of the sludges continues, land and water supplies in the state could be greatly harmed. Information based on sound research is needed to address this problem.

6. The rational development and balanced protection of the Chesapeake Bay's resources will be left to chance unless Virginia adopts a coordinated management policy.

Virginia needs a coordinated policy on the long-term management of the Chesapeake Bay and its resources. Major effects of this lack of a policy are felt throughout the state. For example, inadequate loading facilities on the coast have hurt Virginia's coal industry, and water use in areas of the state geographically distant from the ocean affects both the amount and quality of the flow into the Bay.

Several types of basic research need to be undertaken as a foundation for development of a comprehensive state policy on the Chesapeake Bay. Basic research is particularly needed in the following areas:

1. the impact of point and nonpoint source pollution on the Bay's receiving waters;
2. the costs and benefits to the public of dredging, port and marine development, and facility siting;
3. the socioeconomic tradeoffs associated with determining the most beneficial use of an area for such activities as fisheries, recreation, transportation, waste disposal, and water supply; and
4. the assessment of the socioeconomic value of shellfish areas.

These studies should stress the social and economic value of the Bay's resources to the state and the interdependence of various uses and resources. Such research will help the state to formulate long-term priorities for the utilization of the Chesapeake Bay and prevent the inefficient and inequitable use of its resources.

7. Failure to assess regional water resources demands will intensify future water supply problems in the state.

Three-fourths of the projected population growth in Virginia-70,000 per year for the next decade-is expected to be in the urban corridor which stretches from Fairfax County down through Fredericksburg, Richmond, and Petersburg to Virginia Beach. Sixty-two percent of the state's residents currently live in this corridor. The additional population will increase this percentage to 64 by 1990 and 65 by the year 2000. Based on its projected growth, Virginia will become more urbanized, more commercial, and more industrialized, resulting in increased demands on vital land and water resources. Since all regions will not increase proportionately, future demands on these

resources need to be assessed on a regional basis. Many water supply problems can be minimized or eliminated if needs are anticipated.

Failure to determine future demands and to make adequate plans to meet these demands may result in water supply shortages in some areas, while other regions enjoy abundant supplies.

8. Urban encroachment and uncontrolled pollution threaten existing water sources and future water supply reservoir sites.

Many water treatment problems would be reduced or eliminated if the pollution level of the water reaching a treatment facility were lower. This is especially true for such nonconventional pollutants as pesticides, herbicides, and other complex organic chemicals. It may be more cost-effective to remove the sources of these pollutants than to remove the pollutants at the water treatment facility.

There is a need for information on how governments might best incorporate watershed planning and water supply protection principles in their comprehensive plans. In particular, ways to protect reservoirs and future reservoir sites from the effects of urban encroachment, pipeline breaks (as occurred near Fredericksburg in 1980), and railroad and highway spills need to be studied.

9. Groundwater is being wasted and polluted as a result of inefficient management.

Pollution and waste of groundwater are statewide problems. Landfills, surface waste lagoons, and other types of waste disposal facilities designed to protect surface water often pollute groundwater. Procedures used in the handling and storage of gasoline and chemical products can result in groundwater contamination. In some sections of the state, groundwater levels are so high during certain seasons that septic tanks may discharge directly into the groundwater. In addition, the existing common law, which applies outside designated groundwater management areas, imposes few restraints on the amount of groundwater used. The Groundwater Act of 1973 at best offers protection to existing industrial users against encroachment by other industrial users. The exemptions in the Act make it meaningless from a management perspective. Adding to these problems is the fact that the 1980 drought increased already heavy pressures on the pumping of groundwater in water-short areas of the state. Future problems are forecast as the use of groundwater-using heat pump installations increases. If the groundwater is pumped to and discharged on the surface, the

resource is wasted. If the water is injected into the ground, contamination may occur.

To prevent the waste and pollution of this vital resource, the protection of groundwater should be given equal emphasis with the protection of surface water. Aquifers and recharge areas should be identified and protected from contaminating activities. The underground discharge of materials needs to be monitored and evaluated. Research is needed on the movement of various materials through bedrock, soil, and groundwater. The Groundwater Act should be revamped to make it an effective management tool. If the problems resulting in waste and pollution are not addressed, additional groundwater will become polluted, and groundwater resources in some areas may become depleted.

10. Virginia's water quality standards and criteria need to be reevaluated

Although the 1977 Clean Water Act incorporates both effluent limitations and stream standards, it places major emphasis on those technology-based standards which limit effluent discharges. The national permit system set up by the Act to regulate the discharge of pollutants—the National Pollutant Discharge Elimination System (NPDES) is administered in Virginia by the State Water Control Board. Average and maximum daily quality parameters for effluent discharges are specified by the permits. Because of the stringent requirements incorporated to meet specified water quality standards, questions have been raised regarding the economic feasibility of a high degree of treatment. Cost-benefit analyses in other states have shown only a small percentage of benefit to water quality for each dollar spent on higher levels of treatment. Thus, Virginia's water quality standards and criteria need to be reevaluated, focusing on cost-benefit analyses, development of an alternative critical design parameter for estuarine waters, and development of criteria for defining mixing zones.

11. Upstream pollution, both point and nonpoint, is contaminating the marine environment.

Most water quality problems in the marine environment originate upstream. An estimated 60 percent of petrochemicals in the ocean are from urban runoff. Herbicides entering the Chesapeake Bay from storm runoff have killed the Bay grasses which are important to the life cycle of fish and shellfish. Fecal coliform from pasturelands washoff and improperly treated sewage pollute the water, resulting in the contamination of oyster and clam beds. Silt washes into marine waters from farmlands. In addition, chemicals, many of whose effects on the ecosystem remain undetermined, enter the marine environment

through feeder streams. These problems are compounded by increased development pressures on land bordering the seacoast.

In order to alleviate these problems, more information on the impact of such pollutants is necessary. Therefore, criteria should be developed to measure substances and to determine which are pollutants, and marine waters need to be monitored.

12. *The lack of regional sanitary landfills or burial sites for low-level radioactive and toxic wastes in Virginia threatens the state's ground and surface water supplies.*

Virginia needs regional sanitary landfills and burial sites for low-level radioactive and toxic wastes. This problem has been accentuated within the last year by the closing of several out-of-state disposal sites. Difficulty in finding legal disposal methods increases the potential for illegal dumping which often threatens ground and surface water supplies.

Thus, Virginia needs to develop a central site or several regional disposal sites within its own borders, perhaps utilizing abandoned mines or quarry pits. This would reduce the damages from improper disposal and accidents during transportation. Failure to develop sites within the state could result in the curtailment of medical research, the elimination of nuclear power plants, and the closing of businesses which generate toxic substances in their operations.

13. *The short- and long-term impacts of heavy withdrawals of groundwater are unknown.*

Information is lacking on the short- and long-term impacts caused by groundwater withdrawals. Thus, the degree to which other groundwater users will be affected cannot be predetermined. Such insufficient knowledge was a key element in the dispute over groundwater withdrawals between Norfolk and Suffolk which followed the 1980 drought. While it is known that continued heavy withdrawals may cause shallow wells to go dry within a cone of depression a situation which has occurred in Franklin technical knowledge is lacking on other problems which may occur. For example:

1. In the Tidewater area, where groundwater is in heavy demand, the pumping of an aquifer in excess of its recharge capacity results in saltwater intrusion. However, the rate of movement of the salt water and the effect of changes in pumping rates on the intrusion have not been ascertained.
2. Another problem which can result is the lowering of the storage potential of an aquifer

when the aquifer is dewatered or there are significant changes in artesian pressures. If such a change occurs, the aquifer usually cannot be recharged to its original capacity.

3. Excessive pumping also can lead to subsidence of the surface, a problem which cannot be foretold.

Data are needed on (1) the impact of additional withdrawals on existing users, (2) the effects of withdrawals on neighboring users, and (3) the safe withdrawal level before the impact is felt by other users. Although such research is particularly important in areas where drought conditions have necessitated heavy pumping of aquifers, studies are needed throughout the state. These studies will facilitate planning for future commercial, industrial, and home development to maximize the equitable and beneficial use of the Commonwealth's groundwater reserves.

14. *Insufficient Best Management Practices (BMP's) data on the performance, costs, and maintenance requirements hinder the effectiveness of a voluntary nonpoint source pollution control program.*

Nonpoint source pollution control is an area in which cost-benefit analysis would be very helpful in choosing among available techniques-especially since more than one BMP often can attain the desired effect. However, at the present time Virginia lacks data on which to make a rational assessment of these costs and benefits. Although some studies are under way to collect BMP data-such as one by the National Urban Runoff Program-more are needed which will compare the costs and effects of different practices on one site and similar practices on different sites. Information on the performance, maintenance, and costs of BMP's should be required for new BMP projects supported by public funds. The most cost-effective management practices cannot be determined and implemented until this information is available.

15. *Virginia lacks the legal and institutional arrangements to acquire reservoir sites to meet future public water supply needs*

The construction of reservoirs is a solution to a number of water supply problems in Virginia. However, the state's best reservoir sites have already been utilized and few topographically suitable locations remain. Population growth and development may take these sites as well. At the present time, Virginia has no mechanisms whereby these sites can be acquired and preserved for future use.

Failure to prepare for future water supply needs through storage may eliminate such storage as a feasible option for meeting drought needs and force reliance on more costly options. Since the higher costs of other options would delay their implementation, the state could face severe water shortages in the future.

16. *Storm runoff in many areas of Virginia creates pollution problems which are as serious in their effect as point source discharges.*

As development increases, so do problems caused by runoff, but information on the extent of these problems is incomplete. Several areas of the state, where different types of nonpoint runoff occur, should be studied to develop a data base on the extent of the stormwater runoff problem in Virginia. Such studies should focus on the relationship between basin and/or land use characteristics and the export of stormwater-borne pollutants. The ultimate goal of this research would be to develop a procedure for estimating the relative contributions of individual pollution sources to stream quality.

17. *Enforcement agencies are implementing water quality standards at levels that cannot be achieved with state-of-the-art treatment techniques*

Allowable federal pollutant levels in streams are, at times, below those which occur naturally, making it difficult, if not impossible, to meet the standards. For example, 86 percent of the benchmarks in the nation have failed to meet EPA's copper level criterion, and Virginia's New River has failed to meet the criterion 76 percent of the time. Although the natural level of copper in the New River is higher than EPA standards allow, no discernible biological impacts on the aquatic community have been detected. Imposing unrealistically high standards is detrimental to attempts to reduce pollutants not only in Virginia's waterways, but also in the nation's streams. Additionally, high levels of treatment result in disproportionate cost/benefit ratios. Data collection and research are needed for the state to present concrete figures to EPA. Failure to address the problem may result in a multiplicity of lawsuits, as well as excessive money being spent in an attempt to reach impossible standards.

18. *Submerged aquatic vegetation and some fin-and shellfish populations are declining in the estuarine environment*

Public concern has been growing in recent years over the disappearance of submerged aquatic vegetation-Bay grasses-and the changes in certain fish populations in Virginia's estuarine waters. The loss of

the grasses-which had buffered waves, reduced shoreline erosion, and trapped sediment-influences the productivity of the ecosystem and alters the feeding habits of waterfowl. Declining fish and shellfish populations can harm Virginia's multi-million-dollar commercial and recreational fishing industries. Such species as American shad, striped bass, and bay anchovy have been decreasing in number, while others-Atlantic menhaden, spot, and bluefish-have been increasing. Populations of the soft clam have been greatly reduced. Whether these changes are natural fluctuations or the results of degraded water quality or improper management is not presently known. Research is needed to establish the causes of fish and shellfish declines. Research on aquatic vegetation should concentrate on documenting (1) the physiological and ecological requirements for growth and survival of the Bay grasses and (2) the role of these grasses in the Chesapeake Bay ecosystem.

19. *Inadequate toxic waste treatment may cause water problems in the future.*

Most toxic wastes generated in Virginia are shipped to legal landfills in other states for storage. Storage, however, does not solve the toxic waste problem. The treatment and detoxification of toxic wastes is a promising alternative. Treatment would be economically advantageous as well as environmentally safe. Recent experiments have discovered a method to detoxify PCB's. However, research is still needed to discover detoxification methods for other dangerous wastes. Without the development of adequate treatment methods, the environment will continue to absorb toxic wastes, and the risk of human illness or death will increase.

20. *Insufficient information on relevant physical characteristics of Virginia's streams hampers efficient and equitable waste-load allocation.*

Virginia needs analytical methods for evaluating streams and more stream gaging stations and rainfall gages. Different streams, and even different segments within the same stream, have disparate physical characteristics. Therefore, waste-load allocation information collected on one stream or stream segment often cannot be applied elsewhere.

The State Water Control Board (SWCB) has primary responsibility for waste-load allocations in Virginia. Manpower and budgetary constraints, as well as the time-consuming nature of the research involved, have forced the SWCB to concentrate on critical areas and on those areas which qualify for federal funding. Much-needed research remains beyond the SWCB's time and budgetary capacities.

Important research topics include:

1. the development of models capable of determining how much waste a discharger should be allowed and the level of treatment the discharge requires,
2. the relative contribution of point and nonpoint sources of pollution,
3. the identification of naturally occurring levels of stream constituents (particularly nutrients),
4. analysis of stream hydrology, and
5. evaluation of the impact of any surrounding wetlands on water quality.

21. *The lack of criteria forestimating the frequency, intensity, and duration of storms makes it difficult to set an acceptable standard for nonpoint source loading on receiving waters.*

In Virginia the 7-day low flow which is likely to occur once in 10 years is used as the base condition to assess impacts of point source waste-load allocations on receiving streams. Similar predictive criteria need to be established to evaluate nonpoint source loads on receiving waters. For example, the effect of daily solid and BOD discharges from the proposed Coors brewery can be predicted, but the effect of runoff from the company's parking lot during storms is not known. Research is needed to identify those critical periods when nonpoint source overflow imposes maximum stress on receiving waters. Determinations must be made on frequency, intensity, and duration of storm events. Since nonpoint source loads depend on land use, soil type, topography, and meteorological factors, experimental studies are needed in critical sub-basins to determine the amount of pollutants resulting from a specific storm event. Otherwise, effects of nonpoint source pollution on the state's waterways cannot be predicted.

22. *Inadequate hazard evaluation of toxic chemicals threatens water quality.*

The development of new chemicals has increased the need to evaluate their toxicity and effect on the environment. In Virginia the Toxic Substances Information Act, adopted in 1976 and amended the following year, requires the reporting, with certain exceptions, of current and proposed chemical substances that are manufactured or used in manufacturing in the state, including the exact geographic location of each industry which produces or uses chemical substances. Thus, the state law differs from the federal Toxic Substances Control Act, which is designed to identify only larger manufacturers of chemical substances. Problems arise, however, in

determining what tests to use in assessing the toxicity of new chemical substances. Additionally, the laws may require certain tests which may not be adequate or necessary. Research opportunities remain in the areas of refining present tests and developing new ones that will provide quick, accurate, and predictive assessments of chemical toxicity.

23. *No scientifically valid method exists to assess the value of any proposed alteration to a marine habitat*

Decisions to allow or forbid projects altering the state's marine environment are presently based on incomplete information because no valid method of scientific evaluation exists. This situation increases the chances of making ecologically unsound decisions. For example, dredge spoil is placed in sub-tidal areas, thereby filling these areas and changing them to marshland. At present it is not known which type of area is more important to the marine environment. Similarly, the construction of jetties destroys one type of marine environment and creates another whose value has not been ascertained. An important research task is the development of methods to measure these values.

Problems also arise in determining how those injured by marine alterations should be compensated. How much does the individual who deposits fill on sub tidal bottoms owe the state for the destruction of public shellfish beds and opportunities for fishing, crabbing, and recreation? No method exists to determine an equitable price. Thus, additional research on the values of habitats and the costs of alterations to the ecosystem would be beneficial.

24. *Virginia's present legal, institutional, and economic arrangements prevent flexible water allocation procedures, resulting in water supply problems which could be alleviated by interbasin transfer, regionalization, and state water management assistance to localities.*

Although Virginia possesses abundant water supplies, these supplies are not evenly distributed throughout the state. Further, uneven population growth patterns have complicated the state's water supply situation. Northern Virginia is the state's fastest growing region; Tidewater, which consists of 29 percent of the state's land area, has 60 percent of Virginia's population. The extensive development in these areas has resulted in increased water demands and chronic shortages. Problems arise because Virginia adheres to the riparian doctrine of water allocation; thus, water use is restricted to reasonable

use on riparian land. This doctrine precludes the use of those legal, economic, and organizational arrangements which would allow interbasin transfer or regional cooperation to solve water problems. Interbasin transfer, which is unlawful under common law in Virginia, would allow the transport of water from water-rich areas to those areas in need. Regional cooperation would allow the consolidation of existing water supply systems which are in close proximity, resulting in more efficient use. Such consolidation could bring competing localities together to solve water problems as a unit and could delay or delete the need for major investments. If a state agency were empowered to assist those localities which are competing for the same supply source, jurisdictional fighting could be minimized. Thus, a change in the state's water allocation doctrine could alleviate serious problems which result because the state's water supply is not distributed proportionately to its demands.

25. *Virginia law fails to recognize the interrelationship of ground and surface waters.*

All water is interrelated-surface water enters groundwater aquifers through natural recharge, and groundwater feeds surface streams. However, current Virginia law fails to recognize this interrelationship. The Commonwealth uses separate doctrines of groundwater law and surface water law. In addition, while the Groundwater Act of 1973 mandates special treatment for critical groundwater areas, no statutes pertain specifically to surface water. Any attempt to enact additional water allocation legislation in the state should recognize the interrelationship of these two sources and should not apply to one source independently of the other. If no new legislation is enacted, thought should be given to modifying the Groundwater Act so that adequate consideration can be given to the total water resource in its administration.

26. *Littering and vandalism by outdoor recreationists are reducing the public's access to water based recreational opportunities.*

Although interest in water-based recreational activities has expanded in recent years, littering and vandalism by outdoor recreationists have led many private landowners to post their property. During a 1977 survey conducted on selected stream segments across Virginia, the three problems with stream recreationists most often cited by landowners were (1) littering, 63 percent; (2) trespassing, 56 percent; and (3) vandalism, 43 percent. Litter also received the highest ratings when landowners were asked the magnitude of each problem. Littering not only has resulted in a degraded environment but also in higher

taxes to meet the costs of cleanup. For example, \$1.2 million was spent in 1979 to remove litter from Virginia's interstate and primary roads. Education in schools is recognized as a major step in fighting the problems of littering and vandalism.

27. *Inadequate statewide coordination of water supply information precludes the state from making accurate estimates of water needs for the future and the cost of meeting those needs.*

The riparian doctrine, which governs Virginia's surface water use, does not require the reporting of water usage to any state agency or authority. Although the State Department of Health has some data on municipal supplies and the State Water Control Board has information on some groundwater uses, no current figures on total water usage or availability exist. Without such data the state cannot make accurate estimates of future water needs, nor can it determine the costs and physical plant requirements for meeting those needs.

28. *The state presently does not have a procedure for determining an efficient and equitable assignment of the costs and benefits of nonpoint pollution control.*

Nonpoint pollution control in Virginia is based on a voluntary compliance program of Best Management Practices. These BMP's, described in a series of handbooks, are practices or combinations of practices which have been determined by the state to be the most effective and practicable means of preventing or reducing nonpoint sources of pollution in order to accomplish water quality goals. The major constraint on their implementation is that many of the benefits of nonpoint control accrue to off-site locations; i.e., the people who benefit from the control mechanisms do not pay for them.

Several possible solutions are available. For instance, the state could require upstream dischargers to pay the damage costs of pollution to other users. Another potential solution envisions a more even distribution of costs among all who benefit from pollution control. However, more knowledge of the impact of these procedures is needed. Changes in financial and other institutional arrangements may be necessary before the problem can be solved.

29. *The effects of strip mining on water resources and water quality need to be evaluated.*

Nonpoint water pollution results when dissolved, suspended, or other mineral wastes and debris from mining activities enter receiving streams or groundwater. Water quality also is affected by alterations in

natural drainage patterns for surface and subsurface waters. Processes involved in locating seams or deposits cause surface denudation and erosion, mineralized groundwater discharge, leaching of exposed minerals, and chemical seepage or release. Although strip mining is known to affect stream quality, many effects are not yet known, especially where ground water is involved. More research is needed to ascertain the extent to which strip mining is affecting water quality and to identify all pollutants caused by this activity. Such research should help the adoption of enforceable regulations and the consideration of the most serious water quality problems caused by strip mining.

30. *A state-regulated waste disposal and recycling plant for waste oil, chlorinated and fluorinated hydrocarbons, and similar wastes is needed to prevent contamination of surface and ground waters.*

Virginia's industries presently must ship their wastes to disposal sites in other states because no facilities for such waste disposal exist within the Commonwealth. Even wastes which can be recycled must be shipped out of state because Virginia has no recycling facilities. Due to high shipping costs, some industries have found it more economical to buy new products—such as oil—even though they could reuse material after it has been recycled. For example, a Lynchburg industry generates 5,000 gallons of waste oil per week. With some degree of cleaning, this oil could be used again by the same industry. However, the company has found it to be cheaper to buy new oil than to ship the waste oil to another state to be cleaned and shipped back to Lynchburg for reuse. As regulations on waste disposal and interstate waste transportation become stricter, some disposal sites will close and industries will be tempted to utilize disposal methods that are potentially harmful to water quality.

Needed is information as to (1) who is producing what wastes and in what amounts, (2) which industries could reuse the waste products of other industries, and (3) which industries could reuse their own waste products. State regulations could then be formulated and a control program set up in conjunction with the three regulatory agencies in this area the State Department of Health, the State Water Control Board, and the Air Pollution Control Board. Without such research Virginia's industries may lose a valuable opportunity to develop a safe and efficient means of disposing of waste products.

31. *The unavailability of information in an affordable form on the risk of flood hazard and methods of loss reduction precludes comprehensive planning to mitigate flood damage.*

Many communities in Virginia—especially the smaller ones—cannot afford the cost of studies to map the floodplain or to provide information on integrated land use and hydrologic impacts. Such information is of paramount importance in developing comprehensive plans to cope with flooding. Otherwise, existing and potential problems cannot be identified, nor can the best approaches for reducing flood hazard conditions be determined. Flood data within a watershed change as land use activities and the number of structures increase, but costs involved in studying such changed conditions prohibit localities from giving these conditions adequate consideration. In order to make necessary data available where needed, the functions of the State Office of Emergency and Energy Services could be expanded to provide technical assistance and funding aid in developing flood criteria for Virginia localities. Priorities could be assigned based on frequency of flooding. Until this problem is solved, communities will not be able to formulate adequate plans to deal with floods.

32. *Industrial site locations intensify water resource problems when suitable water supply, the wastewater assimilative capacity of receiving streams, land-use classifications, and the agricultural history of surrounding areas are not adequately considered.*

In locating sites for industrial use, adequate studies are needed to help prevent the problems which can occur from improper sitings. For example, the Jackson River is not capable of assimilating the treated waste from Westvaco in Covington, and the location might have been changed if information about the site had been scrutinized by modern techniques. Determinations on sitings require a joint state and local effort, with the state making technological information available to the localities. Without proper determinations on industrial sitings, water quality and quantity may suffer irreparable harm.

33. *The damage from flooding continues to rise because elected officials, administrators, and the general public lack knowledge about the nature and extent of the flood problem and the means to cope with it.*

New floodproofing technology can result in less damage to structures, and information is available on other methods which can reduce the impact of flooding. However, many local governmental officials and the general public are not aware of the existence of this information. The situation is complicated by failure to look at flooding as a long-term problem since many citizens view flooding as a natural disaster about which nothing can be done. Officials as well as the general public need to be made aware of

the existence of flood data, the sources of technical and planning assistance, implementation procedures for floodplain management programs and regulations, benefits and requirements of the National Flood Insurance Program, and the techniques of floodproofing. Local workshops can be a major step in educating officials and the public on the nature and extent of the flood problem. Damage from flooding could be minimized if localities would adopt and/or enforce flood management ordinances. Until more positive measures—such as floodproof structures—are taken, damage from floods will continue to mount.

34. *Increased competition for water supplies will result in shortages in some areas if conservation and reuse measures are not adopted.*

Uncontrolled use of Virginia's water supply cannot continue indefinitely. Population growth, industrial expansion, and urban concentration place heavy demands on the state's water resources. By the year 2000, public water supply requirements are expected to more than triple, and industrial water needs are predicted to double from 1975 levels. In order to meet increasing energy demands, greater quantities of water will be needed for electric generating plants. This stiffening competition for available water supplies increases the need for strategies to promote the wisest use of water. Education of the public in conservation measures will be a necessary step.

35. *The extent to which air pollution, especially acid rain, affects water quality is not known.*

Air pollution can have a detrimental effect on water quality. Much emphasis in recent years has been placed on the problem of acid rain. Although acid rain has resulted in alterations of fish populations in other areas of the United States, its magnitude, pattern, and effect in the Commonwealth are not known. Research efforts should center on whether acid rain is causing a significant deterioration of water quality in Virginia.

36. *Current stream monitoring practices are expensive and inconsistent.*

Standardized methods of data collection are needed, and more effective means of handling and analyzing data are required in order to make the most effective and economical use of available data. Different types of instrumentation and methods of using instrumentation and techniques of analyses have caused a great deal of confusion in attempting to compare data from various sources. In order to alleviate these difficulties, standardized methods for data collection need to be determined and an agency designated a clearinghouse for data storage. Better instruments

for monitoring water quality need to be developed. Emphasis should be placed on reducing the amount of labor as well as the cost of routine chemical analyses. A technique of statistical analysis should be developed for use by all agencies in the state. Otherwise, money will continue to be spent not only on duplications of effort, but also on data which cannot be compared.

37. *Many Virginia communities do not have plans to meet water crises arising from drought, contamination, or mechanical failures.*

Backup plans to guide communities through the loss of water supplies are not common in Virginia. Water companies and other utilities lack an established set of procedures or standards to guide them through such emergency periods. Furthermore, no state agency has been assigned to assist communities in formulating those plans. The State Office of Emergency and Energy Services can offer short-term assistance in a crisis context. To alleviate such potential problems, the state, in conjunction with the localities, should study community water supply systems and develop alternative supplies for emergency use. The increasing potential for loss of water supply through groundwater pollution and toxic spills necessitates adequate planning for such emergencies.

38. *The dredging required to maintain navigable waters can result in immediate harm to the marine ecosystem and in long-term environmental degradation.*

Both short- and long-term deleterious effects to the environment can result from the dredging required to maintain Virginia's navigable waterways. Short term effects include harm to the marine ecosystem as a result of the disruption of bottom fauna, including the destruction of oyster beds.

The disposal of dredged material poses long-term ecological problems. In many situations, off-shore disposal may be impractical either for economic reasons or because the material is too polluted. In such cases, an upland disposal site is required. Since a disposal site near the dredging operation is desirable, the tendency in the past has been to utilize coastal marshes and wetlands. Over the years this procedure has removed many acres of habitat for waterfowl. Bulkheaded or confined disposal sites have been used for polluted dredge spoil. However, in most instances no monitoring program has been mounted to determine what leachate may be entering the marine environment or the groundwater

supply. In considering any dredging operation, the economic benefits from the increased channel depth or new channel must be balanced against the environmental costs.

39. *Money and energy resources are being wasted on inefficient wastewater treatment systems.*

As treatment costs have risen and energy supplies dwindled, the need for communities to utilize the most cost-effective and energy-efficient wastewater treatment systems has increased. Information detailing the strengths and weaknesses of existing systems, including their monetary and energy costs, should be made available to waste system engineers.

40. *The scenic beauty of the Commonwealth's riverscapes is being lost to urban, industrial, forestal, and agricultural development.*

Aesthetics are an important aspect of the use of Virginia's rivers by recreationists and are influenced not only by the quality of the stream but also by the use which is made of the adjacent land. Thus, the state's waterways are affected by the location of industries, houses, airports, and highways, as well as by forestal and agricultural practices along the streambanks. Clear-cutting of timber adjacent to rivers encourages erosion and nonpoint pollution, while industrial sitings near streams destroy the scenic beauty. Land use controls need to be enacted and enforced which will preserve the scenic beauty of the Commonwealth's rivers.

41. *Less-than-full enforcement of existing environmental laws contributes to pollution and sedimentation of the Chesapeake Bay and has a harmful effect on the marine environment.*

Although Virginia has laws controlling pollution in the Bay, as well as agencies with authority to enforce these statutes, some violations still occur. For example, municipal sewage treatment plants may discharge higher BOD levels than allowable during certain periods. Additionally, industrial emissions in violation of air quality guidelines occasionally occur, and appropriate measures are not always taken to fulfill the requirements of erosion and sediment control laws. One potential solution involves studying enforcement records to determine the effectiveness of permit programs. Laws which are not effectively enforced should be identified, and agencies with regulatory mandates should be forced to act.

42. *Some localities are risking human lives and property damage by not enforcing floodplain management plans.*

Many localities in Virginia do not enforce the floodplain ordinances, and some enact them only in order to qualify for federal flood insurance. Such localities often are unaware of the human and financial costs caused by flood damage. A comprehensive, accurate flood education program for both citizens and public officials would increase awareness of the risks involved and encourage enforcement of floodplain ordinances.

43. *Public water supplies are endangered because of the inability to predict when accidental spills of contaminants in surface streams will reach intake structures.*

The March 1980 rupture at two locations of a pipeline running through Virginia emphasized the need for time-of-travel information on the state's streams. The potential for water-polluting accidents involving trucks or trains also points to the need for developing a family of curves on time-of-travel for major waterways and those streams used for water supply.

44. *The quality of public water supplies in Virginia is deteriorating because of the unexpected side effects of modern technology and the aging of pipelines and storage facilities.*

Many of Virginia's water quality problems are attributable to the unexpected side effects of modern technology and to the aging of older pipelines and storage facilities. Plastic pipes, which are less expensive materials, are sometimes more prone to breakage and are difficult to repair. The health effects of plastic compounds leaching from this type of pipe are not known. In addition, extremely low levels of potentially lethal contaminants, such as asbestos and lead, have been detected in some older water supply systems. Taste and odor problems with reservoir stored water are increasing because eutrophication or-as in the case of Ragged Mountain Reservoir excessive leaf litter. Research is needed to develop effective treatment control measures, and in reservoir improvements such as dredging, aeration, and retrofitting should be studied.

45. *Changes in water or land use can affect an entire watershed and can result in storm runoff problems not previously encountered.*

Jurisdictions with storm water retention-detention policies do not always have the necessary information to establish design standards or to evaluate the cumulative effects of the policy. For example, the construction of a shopping center in Rockingham

County has caused storm drainage problems which need to be solved. County officials recognize the situation but lack technical information and methods to finance any structural solutions to the problem. In regions with both upland and lowland development, the lowland areas are prone to flooding problems—such as in Chesterfield County. Research is needed to determine upland impacts and methods of effective storm water runoff control.

46. *The lack of information about location, quality, and availability of groundwater for irrigation may be inhibiting the growth of agriculture in Virginia.*

Irrigation could ease the effects of droughts which occur in some region of the state every three to five years. Before this agricultural tool is used, however, research is needed to determine the extent to which groundwater could be used. In the Piedmont area of the state, groundwater availability for irrigation is very limited. East of the Piedmont, where groundwater is known to be plentiful, the effects of chemicals in the water—such as chlorides—on crops cause problems. In the Tidewater region, saltwater intrusion can be a factor, and the effects on crops of high pH and high levels of sodium bicarbonates found in deep artesian waters need to be determined.

47. *Recreational opportunities in the state are being harmed by poor water quality.*

The use of Virginia's streams for recreational purposes is being hampered by both point and nonpoint source pollution. Such pollution is resulting in colored and/or foamy water and in declining or inedible fish populations. Abnormally colored and foamy water destroys the aesthetic value of a stream for the recreationist, and heavily polluted streams are unfishable.

48. *The growth, reproduction, and survival of commercially fished species in the Chesapeake Bay are being harmed by chlorine compounds.*

Chlorine compounds are believed to be toxic to commercially fished species in the Chesapeake Bay. They could ultimately reduce the viability of this industry in the Commonwealth. Research is needed to determine the effects of these compounds on survival rates of eggs, larvae, and young-of-the-year. The transport and fate of the chlorine compounds need to be examined in the Bay and its tributaries, and an assessment should be made of the role of these compounds in causing the effects observed in the laboratory.

49. *Many communities have incurred property damage from floods because they cannot afford to draw up master drainage plans.*

The serious lack of master drainage plans for urbanized areas is due, in part, to little or no financial assistance. Many communities, especially those with below-average per capita incomes, cannot afford the initial studies to develop these plans. For example, Buena Vista has been seeking financial assistance to make such a study for a year and a half. The community cannot afford the study. Because the town's flooding is in the residential district, the federal Economic Development Administration will not pay for it. The Department of Housing and Urban Development is willing to fund the actual implementation of devices, but not the study. Farmers Home Administration will lend Buena Vista money but will not give the town a grant. Virginia's State Division of Planning and Community Affairs has no funds available. Thus, localities such as Buena Vista need a combined federal-state program which will make funds available to communities with average or below average per capita incomes.

50. *Public lands for recreation are overcrowded and overused, and demands on them are expected to increase.*

More than 75 percent of the statewide demand for recreational facilities is generated east of the Blue Ridge, especially in the urban corridor; yet 48 percent of all outdoor recreation land acreage in Virginia—administered by the U.S. Forest Service as National Forests—lies west of the Blue Ridge in an area which contains only 31 percent of the population. These lands are only of limited recreational benefit to the majority of the state's population, especially since over 45 percent of current recreational demands are for close-to-home facilities. Massive shortages of park acreage exist in the more heavily populated regions of the state. In order to meet these growing needs, the state needs greater investments of private capital in the outdoor recreation industry; more acquisition and development by local, regional, and state governmental units and agencies; and the development of more recreational opportunities on private lands.

51. *Property losses caused by floods amount to millions of dollars annually because of indiscriminate building on the floodplain.*

In the past decade, federal aid to flood disaster areas in Virginia has totaled more than \$70 million. Controlling land use in the floodplain is one way to reduce losses caused by floods. Although builders may decide that the odds are in their favor following a 100-year flood, this is not so. It is possible for two or more 100-year floods to occur within the same year. Floodplains not yet developed should be zoned as parks and open spaces, and counties need to adopt and enforce flood management ordinances.

Additionally, the public needs to be educated on the dangers of floodplain construction.

52. There is a lack of governmental concern for river-based recreational activities.

Examples of the lack of official concern for river based recreational activities range from deteriorating conditions in city riverside parks to the inability to achieve the goals of the Scenic Rivers Act. Regardless of the political problems related to scenic river selection, there are actions which could be taken by the Commonwealth to promote river-based recreation. For example, Virginia could advertise canoe trips on some of its major rivers or identify streams suitable for extended canoe trips. Educating the public as well as governmental officials to recognize the potential of river-based recreation in Virginia is seen as the initial step in solving this problem.

53. Local governments and small industries do not have the resources to keep abreast of waste treatment regulations and legislation.

An information program on the proper treatment and disposal of waste would benefit many groups within the state. One suggestion is to empower the State Water Control Board, which evaluates the impact of federal regulations on the state, to mail its analysis to relevant user groups. If such information is not readily available, localities will continue inadvertently to violate laws, to lose time and money remedying errors, and to threaten the state's water and related land resources.

54. Conflicts are arising from competing uses for Virginia's rivers.

Virginia possesses little information either on the actual uses of the state's rivers or on the impacts of those uses. This absence of information prohibits effective planning. A monitoring program which documents numbers of users and examines user characteristics over a period of several years could provide a sound basis for use projections. With this information, planning could be undertaken to minimize the conflict among competing uses for Virginia's rivers.

55. Wastewater treatment plant operations are adversely affecting air quality and nearby land uses.

Certain wastewater treatment operations can result in odor problems which affect nearby land uses. These problems occur throughout the state even though methods of preventing air quality degeneration exist. Virginia needs to educate local governments on the

availability of this type of assistance to prevent the necessity of costly redesigns, relocations, or equipment purchases.

56. Sedimentation, channel degradation, and channel modification of stream flow caused by erosion is intensifying the flood problem in Virginia

Nature normally protects slopes with vegetation, thereby keeping erosion to a minimum. When this protective layer is stripped off by such activities as construction, mining, agriculture, and silviculture, the potential for erosion is greatly increased. During rainfall, sediment is carried from these areas into streams. When large amounts of sediment enter a stream, the material may clog the channel, changing the flow characteristics and reducing stream capacity. Thus, the possibility of flooding during times of heavy runoff is increased. More research is needed on the effects of sedimentation, channel degradation, and channel modification on streamflow in order to determine actual cause/effect relationships between erosion and flooding.

57. Inadequate domestic animal waste management in confined areas is degrading water quality.

The organic waste generated by animals confined for food production is a source of biological pollutants which can enter ground and surface waters through seepage and runoff. Thus, as the use of this production method has increased, so too have concerns about water pollution and environmental degradation. Since the volume and high concentrations of wastes from confined animals would require costly treatment systems, the need exists for alter native disposal methods. Research is needed to evaluate land application practices and their impact on receiving waters. Work also is needed in the area of converting animal wastes to methane gas or other energy sources.

58. Public use of Virginia's canoeable and floatable streams is limited by the lack of access.

Although Virginia contains thousands of miles of rivers and streams suitable for canoeing, most of the land bordering these resources is in private ownership, thus limiting public access and use. Research is needed on ways to provide incentives to private landowners to allow the public access.

59. There are conflicts between recreationists and riparian landowners because some streambeds are in private ownership

With the increasing public demand for water-related recreational activities on Virginia streams has come conflict between recreationists and riparian landowners. Although definitive legislation on recreational rights is lacking, it generally appears that streams which have been used at sometime for commercial navigation are open to public use. Problems arise because official navigability determinations have not been made on many streams in the state leaving uncertainty as to public use in the wake.

60. *Additional marinas in tidal waters will lead to the closing of shellfish beds.*

The popularity of boating has increased and caused a shortage of marinas in tidal waters. The construction of additional slips hurts shellfish interests because the State Department of Health automatically condemns shellfish beds adjacent to marinas. The problem is further complicated by the fact that there is no policy with respect to what the state wants-shellfish or boaters.

APPENDIX A: PROBLEM IDENTIFICATION AND RANKING

Water Resources Classification

To maintain continuity with its last five-year plan, the Center used the same eight classifications for water resources: water supply, outdoor recreation, nonpoint sources of pollution, marine environment, inventory and monitoring, flood damage abatement, resource management, and waste treatment. An ad hoc committee was formed for each area. A committee was asked to identify the most important water problems in its area.

Participant Selection

To secure wide representation within the state's water resources community, the Center turned for assistance to its Statewide Advisory Committee, a group which is itself varied in expertise and affiliation. Advisory Committee members recommended persons to serve on the ad hoc committees. The committees averaged 16 members each, with representation usually from state agencies, universities, private industries, local governments, and citizens' groups.

Problem Identification by the Committees

Each ad hoc committee met once independently of the other committees. Before meeting, each committee member submitted a list of problems within the committee's topical area which he or she perceived to be urgent. The Center compiled these problems into a single list and mailed a copy to each

member of the committee. Participants were asked to rank the problems on the list in order of importance before the committee meeting.

The Delphi method, a way to organize communication among individuals that enables the group as a whole to provide information about a complex problem, was used to conduct the meetings. The process involved individual value assignments (problem ranking, in this case), statistical analysis of the individual value assignments to yield a group average, group discussion of rankings, and opportunity for group members to revise their ranking based on the discussion. The process was repeated twice during the meeting. The intention was to identify the top seven to nine problems in each topical area.

Since each group was encouraged to identify all significant problems in its topical area, some aspects of certain problems were recognized by more than one committee. For example, elements of the nonpoint source pollution problem were on the priority lists of both the nonpoint pollution and marine environment committees.

Comprehensive Evaluation of Problems

There were 69 problems on the eight lists. The problems were randomly listed in a workbook for a final ranking at a three day conference at Virginia Tech. Conference participants included two representatives from (1) each of the eight ad hoc committees, (2) the Center's Technical Advisory Committee, and (3) the Statewide Advisory Committee, along with persons from such other areas as coal mining, urban planning, and agriculture. In all, 25 persons participated in the conference.

The Delphi method was used again, this time to rank the 69 problems in the workbook. Every participant rated each problem on a scale from lowest value (1) to highest value (9) for each of three problem characteristics:

Magnitude-The difference between the desired state for a given situation and the actual one.

Scope-The number of people or the amount of area in Virginia affected by the problem.

Urgency-The immediacy with which the problem should be addressed.

The final rank of each problem was determined by the sum total of points assigned by conference participants to all three aspects of a problem

(highest possible points = 675; lowest possible = 75). The ranking-discussion process was repeated twice during the conference.

Because of similarities in some of the problem statements, the Center combined several problems into broader statements following the conference. For example, priority problem 4 reflects such a combination. The original statements were:

Virginia lacks an ongoing, routine monitoring program necessary to establish a data base, identify current water quality standards, and note changes or trends in the quality of receiving water.

Data elements for assessing water quality need to be identified and a consistent level of reliability in data collection needs to be attained.

Each of the committees evaluated between 30 and 40 problems before selecting the seven to nine problems of highest priority. Thus, the 60 water resources problems selected as being of highest priority evolved from a list of nearly 300 problems.

Some Weaknesses

Weaknesses exist in any approach to problem identification. All strategies admit the possibility of some inequity, particularly when diverse interests seek to reach a consensus. Some conference participants felt that the importance of their causes may have been underestimated by participants representing other areas of interest. Quite possibly, not all members of the evaluating group perceived problems outside their area of interest to be as severe as may have been objectively warranted. Similarly, it is possible that proponents of specific problems may not have been able to view their causes in the total context of Virginia's water problems.

In spite of these weaknesses, the Center selected this approach to consensus building because it believed that problems whose solutions would impart the greatest benefit to Virginia's water resources could be identified. It was these problems on which the Center wished to build its next five year plan.

APPENDIX B: ANALYSIS OF THE PRIORITY PROBLEMS

From the proceedings of the ad hoc committee meetings and the conference, as well as from subsequent discussions with participants and other

water resources practitioners, the staff of the Center has concluded that the following conditions prevail in Virginia:

1. Water resources are neither sufficiently planned nor well managed. Seven of the top 10 problems listed the need for a comprehensive water resources plan, prudent land management measures, official state policy for sludge disposal, policy on the use of Chesapeake Bay, adequate forecasting of water needs, policy measures for protecting potential water supplies, and a sound groundwater management program.
2. Nonpoint source pollution is a critical problem. Important aspects include identifying where such problems exist, developing techniques to measure natural background levels of stream pollutants, developing techniques to measure transport of pollutants from land to water, and measuring the effectiveness of the state's voluntary Best Management Practices program in combating nonpoint pollution.
3. Methods for inventorying and monitoring Virginia's surface waters are inadequate. Among the problems are redundancy in data collection efforts, difficulties in retrieving data, nonstandardization of reporting formats, measurement problems that render parameters unmeasured or measured at an insufficient number of sites, and weaknesses in instrumentation. These inadequacies have increased the manpower necessary to collect data, although the data remain insufficient and imprecise.
4. Availability of high-quality water is not guaranteed for all areas. Since many water supply problems are related to great population expansion in relatively small areas of the state, legal issues involving interbasin transfer and state control of water rights are important to those individuals responsible for large municipal water systems. Groundwater issues are important to cities and industries and, to a lesser extent, to agriculture, which may need to turn to groundwater in the future for irrigation.
5. Marine resources are threatened in several ways. The lack of a comprehensive management strategy hinders planning decisions. Upstream pollution and the dredging required to maintain navigable waters endanger marine life. Laws to protect marine waters are not adequately enforced.

6. Waste treatment, including sludge disposal and toxic wastes handling, is a problem. As water purification techniques increase in efficiency, the amount of sludge increases, but the state has no policy with regard to the land application of sludge. Policies and methods for handling and disposing of toxic wastes are in a state of flux amid changing federal directives. There are indications that the regulatory agencies responsible for toxic wastes may lack the manpower to safeguard the citizenry.
7. The state suffers from sporadic but often severe flood damage, primarily because of extensive floodplain development. Flooding problems are magnified by the failure to build floodproof structures, the inability of small communities to afford flood hazard and loss reduction information, and the lack of information on the cause-effect relationship between erosion and flooding.
8. Water-related outdoor recreation problems include littering and vandalism by recreationists, too few public access points to rivers and streams, improper land use along stream banks, and sluggish state action on scenic river designations.

**APPENDIX C:
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