The Other Water Pollution

BY KATHY BARTON

WHAT DO YOU THINK OF when you think of water pollution? Kepone in the James River? Sludge creeping up on New York harbor? Industrial chemicals and sewage—control these and you will control the problem, right?

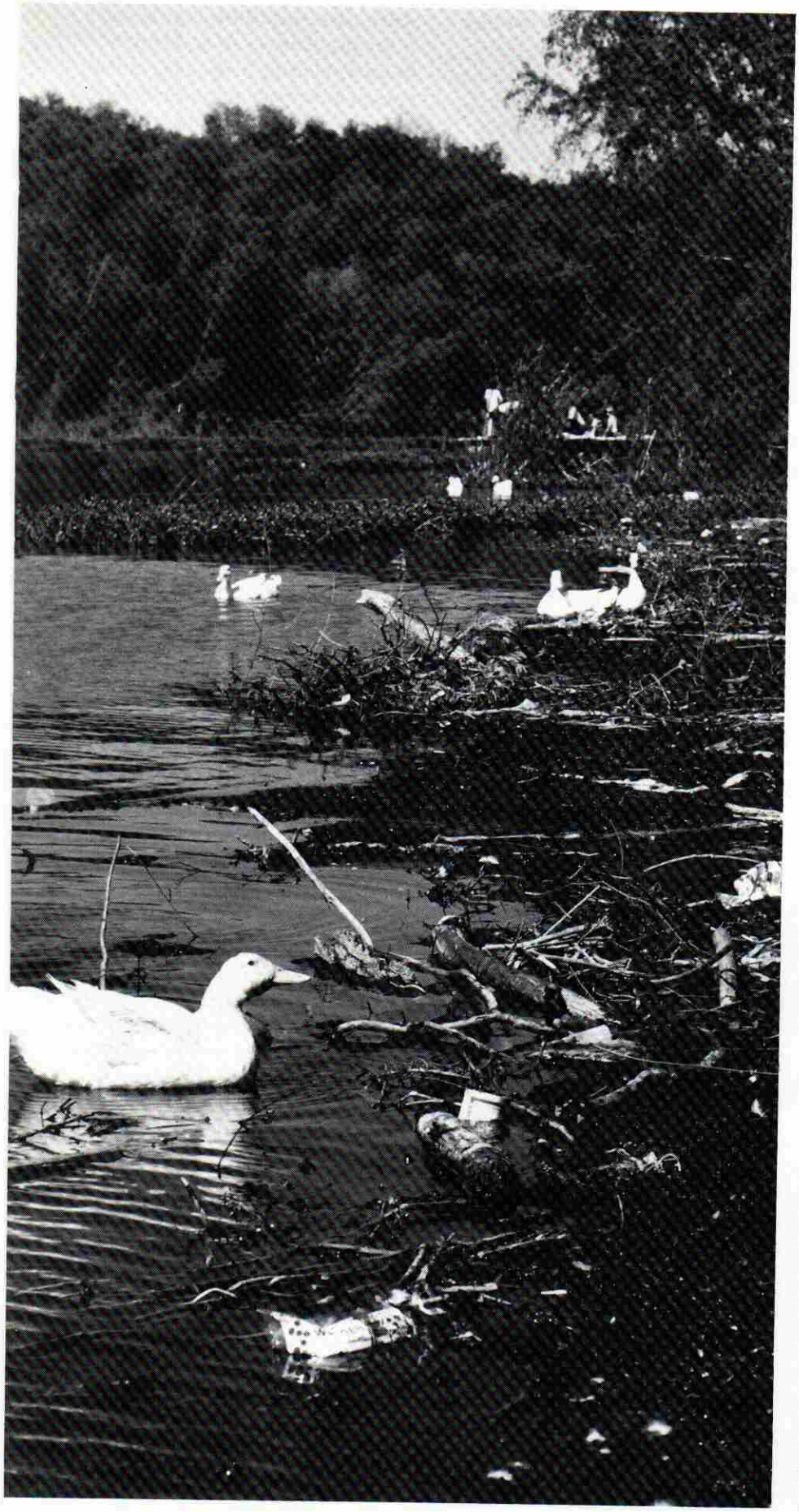
Think again. Follow the meanderings of a typical river in your mind's eye. What do you see? A clean, clear trickle from snow-capped mountains sliding by an abandoned mine leaching acid; now a not-so-clean stream, devoid of fish, flowing past a farm, picking up fertilizers, pesticides, and animal wastes; finally, a river unfit for human contact, collecting heavy metals, asbestos, litter, dust, oil, and air pollutants as the rain rolls off of city streets.

The Environmental Protection Agency (EPA)—the federal agency charged with taking the lead role in cleaning up the nation's waters—estimates that 50 percent of the nation's water pollution comes not from sources that can be controlled at the end of a pipe—"point" sources, such as factories and sewage treatment plants—but from a diverse array of hard-to-identify sources such as urban and agricultural runoff called, in the vernacular of water law, "nonpoint" sources.[1]

These hard-to-identify polluters are also hard to control. The Federal Water Pollution Control Act of 1972 (the Clean Water Act)[2] requires control of nonpoint as well as point sources of water pollution, but the program has so far failed dismally in the nonpoint area. While the federal government has spent billions of dollars during the past five years on the construction of municipal sewage treatment plants, nonpoint source pollution has been largely ignored. This is true despite a recent study by the General Accounting Office (GAO)[3] which concludes that even if all point-source discharges of pollutants were to be controlled, pollution from nonpoint sources would still prevent the achievement of the Clean Water Act's goal of fishable, swimmable waters by 1983.

What Are Nonpoint Sources?

"Nonpoint source pollution" is a catch-all for all water pollution that is not released at one specific identifiable point, a point at which the pollution can ordinarily be reduced by "end-of-pipe" controls. Nonpoint



source pollution consists primarily of runoff, and so it can include any pollutant that touches the ground. EPA groups the sources of nonpoint pollution into eight categories: (1) silviculture—the growing and harvesting of timber for lumber and paper production; (2) agriculture; (3) mining; (4) construction of roads and buildings; (5) saltwater intrusion into freshwater supplies; (6) subsurface excavations, including industrial injection wells, septic tanks, and landfills; (7) hydrologic modifications—pollution resulting from changes in the movement, flow, or circulation of surface groundwaters, including changes caused by dams, levees, channels, or flow diversions; and (8) urban runoff.

In terms of volume, the major pollutant from nonpoint sources is *sediment.* The principal contributor nationwide to sediment runoff is agriculture: 50 percent or more of the sediment deposited in lakes and streams comes from cropland.[4] As with all nonpoint-source pollutants, this proportion varies greatly from river basin to river basin. For example, clearcut timber harvesting and logging road construction in the Pacific northwest cause immense erosion rates and result in sediment loadings many times greater than normal [see *Environment,* January/February 1978, p. 16]. Construction and mining are also responsible for contributing large amounts of sediment.

Rivaling agriculture for first place as the worst nonpoint polluter is urban runoff. Pesticides and fertilizers on construction sites, lawns, and gardens, oily residue from automobiles, asbestos from brakes, clutches, and tires, street litter, dust, air pollution particulates, toxic heavy metals, and sewer overflows all contribute to the severe water pollution in urban areas. Because so much of the land in a city is topped by buildings, streets, parking lots, and other impervious cover, rainfall is prevented from soaking into the ground, thus aggravating the runoff problem. Heavy rains after a dry period may result in a "first flush" effect causing a sudden and very

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high concentration of pollutants to be washed into rivers and lakes early in a storm.

Urban stormwater runoff may, in fact, be a far more serious polluter than agriculture in many areas. The Washington, D.C. area's Occoquan watershed policy originally called for construction of an advanced wastewater treatment plant on the premise that such a plant would encourage conversion of agricultural lands to suburban development and reduce overall pollution by reducing agricultural runoff. A June 1977 study of the Occoquan area—hailed as one of the best such studies in the nation—revealed that pollutant loadings in runoff from the urbanized areas are considerably higher than those from agricultural lands. The study concluded that any improvement in water quality resulting from installation of the treatment plant would be more than offset by increases in nonpoint pollution created by the ensuing urbanization.[5]

Nonpoint sources other than agricultural and urban activities may account for only a small percentage of the total nonpoint pollution nationwide but they can pose almost insurmountable problems for the particular river basin where they are located. For instance, Pennsylvania has already spent more than $40 million to control acid mine drainage and has succeeded in completely cleaning up an estimated 48 miles of stream and in reducing pollution in 140 more miles. But officials estimate that 2,021 miles of major streams will not meet the 1983 water quality goals because of acid mine drainage and that it would take $3 billion to make these streams pollution free.[6]

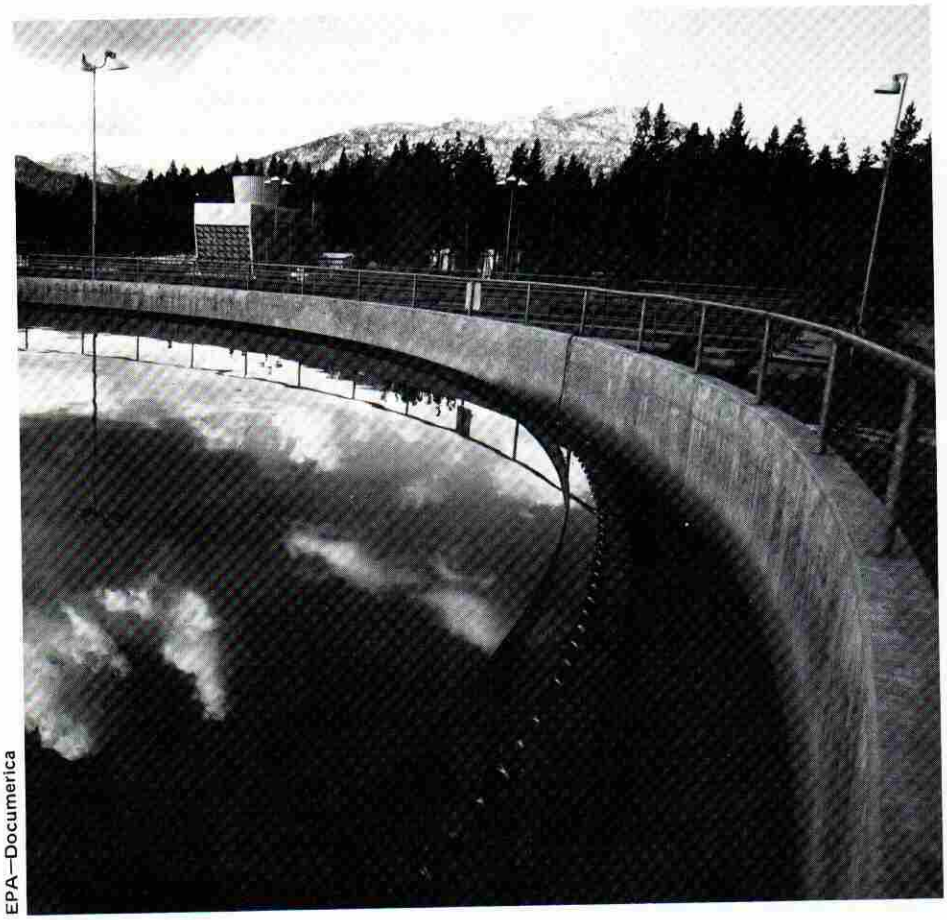
Even activities that do not cause pollutants to enter water can contribute to nonpoint pollution. Reduced stream flow created by dams, water removal, or channelization results in an increased concentration of pollutants; this can magnify the effect of these pollutants. It is for this reason that EPA lists hydrologic modifications as one of the sources of nonpoint pollution.

The diversity of types of nonpoint pollution sources and the variability with which they discharge pollutants into the water makes them difficult to evaluate either quantitatively or qualitatively. Because ordinarily nonpoint contributions to water pollution are intermittent and enter all along the water's edge, they are much more difficult to measure than point-source pollutants, which are discharged at predictable times from a distinct, identifiable source.

However, studies that relate types of land use to the amount of nonpoint pollution provide estimates of the magnitude of this source of pollution and indicate that, in terms just of the *amount* of pollutants entering the waters nationwide, nonpoint sources are extremely significant. For example, a study by the Midwest Research Institute[7] estimates that the amount of suspended solids (sediment) from nonpoint pollution is approximately 360 times that from municipal and industrial point sources. The total biological oxygen demand (BOD) and nutrient loadings from seven categories of nonpoint pollution identified in that study are about five to six times those from the identified point sources (see Table 1). Limited studies show that toxic metals from road runoff greatly exceed those from point sources.

The *effects* of nonpoint source pollutants are also usually difficult to evaluate because the pollutants tend to be less concentrated and conspicuous than those from point sources. This does not mean, however, that their effects are any less significant.

Sediment, the major nonpoint polluter, destroys habitat by covering feeding and spawning areas on stream bottoms and raises stream beds, which aggravates flooding problems. Sediment also transports other pollutants such as pesticides, herbicides, excess nutrients from fertilizers, and pathogens. In addition, particulate-bound pollutants such as toxics and nutrients usually have extended effects due to their release into the aquatic system or their interactions with pollutants from other sources.



EPA—Documerica

Building new sewage treatment plants may not be the most efficient or economical way to control water pollution. Studies indicate that improvements in water quality resulting from the installation of treatment plants can be more than offset by increases in nonpoint pollution created by ensuing urbanization.

Table 1.—Estimated Pollutant Contributions to Surface Waters from Sources in the Contiguous 48 States[1]
Average Pollution Loads in Thousand Tons Per Day

NPS Category	Sediment	BOD	Nitrogen	Phosphorus	Acid Drainage[2]	Salinity
Cropland	5200	24.1	12	4.35	---	143[3]
Pasture and Range	3400	13.7	6.85	2.0	---	---
Forest	720	2.25	1.1	0.25	---	---
Construction	540	---	---	---	---	---
Mining	170	---	---	---	8.85	---
Urban Runoff	57	1.25	0.4	0.055	---	---
Rural Roadways	5	0.0116	0.00125	0.00315	---	---
Deicing Salts	---	---	---	---	---	19
Small Feedlots	5	1.35	0.455	0.09	---	---
Land Fills	---	0.93	0.07	---	---	---
Subtotal	10097	57.6	20.9	6.75	8.85	162
"Natural Background"	3500	14	7	3	---	---
Total	13597	71.6	27.9	9.75	8.85	162
(Municipal Point Sources after treatment, 1975)	(5.8)[4]	(5.3)	(4.0)[5]			
(Industrial Point Sources after Treatment, 1975)	(22.1)[4]	(6.0)	(0.3)[5]		0.7	35

[1] 207 million acres in public lands (14% of contiguous U.S.), mostly in Rocky Mountain region, were excluded due to inadequacy of information

[2] As $CaCO_3$ [3] From irrigation return flow [4] Suspended solids [5] Nitrogen plus phosphorus

Sources: **National Assessment of Water Pollution from Nonpoint Sources** (Draft of Final Report), Midwest Research Institute, November 1975. **Cost of Air and Water Pollution Control 1976-1985,** Section Three, Agency Draft, February 1976.

Reprinted from U.S. Environmental Protection Agency, **Interim report of the Nonpoint Source Water Pollution Working Group,** November 8, 1976.

Isolated examples of specific effects of nonpoint source pollution show that they can be quite serious. GAO cites, for example: (1) a 20-mile segment of stream in Colorado which contained no aquatic life due to acid mine drainage; (2) commercial fishing prohibitions due to dangerous DDE, DDT, and dieldrin levels resulting from agricultural pesticide runoff; and (3) the discovery of the suspected carcinogen chloroform in the drinking water of Fairfax, Virginia, resulting from the chemical interaction of organics from nonpoint sources and the chlorine used to disinfect drinking water.

Best Management Practices

Methods for controlling nonpoint source pollution are as varied as the sources. They range from reducing application of pollutants and using conservation techniques that reduce erosion, to zoning in order to control growth and the amount of impervious cover. EPA terms methods for reducing nonpoint pollution "best management practices" (BMPs).

Each nonpoint pollution category consists of a variety of activities and may require a variety of controls. For example, the major problems associated with agriculture are sedimentation, pesticides, fertilizers, and animal feedlot wastes. Sedimentation can be controlled through appropriate conservation methods such as contour plowing, terracing, no-till farming, stripcropping, grassed waterways, crop rotations, and proper drainage. Pollution due to nutrients from fertilizers can be controlled by determining the proper amount, time, and method of plant nutrient applications for insuring efficient use by plants and by reducing runoff. Integrated pest management (IPM)—which includes the use of biological pest controls, crop rotation, bug traps, and more efficient use of pesticides—can considerably reduce pesticide pollution. Wastes from animal feedlots can be contained or removed from the area and eventually used as fertilizer.

Urban nonpoint source pollution—much of it caused by construction of roads and highways—can be controlled by reducing pollutants at the source, reducing erosion, and managing runoff. Source management includes sewer flushing and waste pick-up; erosion management techniques involve sodding, use of diversion berms and hay bales, revegetation, and sedimentation basins;

runoff management includes use of detention basins for storm water, porous pavements, recreation lakes, and in-line storage.

The examples could go on and on. EPA has published several general BMP booklets for different nonpoint categories. But these rarely provide practical guidance to individuals or local areas seeking solutions to particular problems. The variety of soils, climates, topographies, crops, and economic factors across the nation means that the appropriate BMPs must vary also. Controls must be tailored specifically to the individual locality.

Many states currently have laws that require some type of regulation–best management practices–for controlling nonpoint pollution from certain activities. For example, the state of Washington in 1974 passed the Forest Practice Act to insure that logging operations comply with state water quality standards. The Act regulates logging road construction and maintenance, timber harvesting, reforestation, chemical use, and slash disposal. The state of Maryland has a sedimentation law that requires development of sediment control plans for most types of construction.

The Economic Side

Best management practices are not only "best" for preventing water pollution, but can also be the best road to economic efficiency. No-till farming–a method of planting without first removing the existing plant cover and previous crop residues–is a prime example of a technique that plays this dual role. Water quality planners applaud no-till farming because it reduces soil erosion by 95 percent. Farmers say they use it for a number of reasons: it yields more income; it makes farming easier; in hot dry summers no-till corn does better than conventional corn with the same rainfall; and it requires fewer trips over the field thus reducing fuel costs.[8]

It is generally far cheaper, in both dollars and energy, to prevent water pollution through BMPs than to clean it up afterwards. For example, the sediment from construction runoff costs about $8 per cubic yard to remove from city streets, $68 from sewers, and $77 from basements (and it has to be done repeatedly). The further down the line one waits to control the problem, the more it seems to cost. More than $125 million is spent each year to dredge sediment from harbors and riverways and an additional $100 million is lost each year in hydroelectric capacity, flood control, and recreation due to sediment in reservoirs. USDA estimates total annual cost of sediment damages and dredging to be about $500 million.[9]

Through planning which takes into account nonpoint sources of pollution, significant amounts of money can be saved on sewage treatment plant construction or advanced treatment techniques. The General Accounting Office cites the example of the Willamette River in Oregon, where augmenting the flow of water in the river from reservoirs (dams are a nonpoint source of pollution) in combination with controlling the discharge from one industrial polluter would just as effectively reduce the pollution problem as advanced treatment facilities, and at a much lower cost.[10]

The Law: In Theory . . .

The Clean Water Act attempted to address exactly this kind of issue by setting up a comprehensive planning process to determine the most effective and most efficient ways of reducing water pollution. The 1972 Act instructed

One of the worst nonpoint polluters is urban runoff. Pesticides from lawns and gardens, oil from automobiles, asbestos from brakes and tires, street litter, air pollution, and sewer overflows all contribute to water pollution. Because so much of the land in a city is topped by buildings, streets, parking lots, and other impervious cover, rainfall is prevented from soaking into the ground, thus aggravating the runoff problem.

U.S. Department of Agriculture

FROM TOP TO BOTTOM: A badly eroded cornfield which had been cultivated in straight rows on a slope. "No till" planting through the stubble of the previous season's wheat crop, which serves as a moisture-holding mulch. Contour plowing which holds the melting snow in the furrows until it can soak into the ground.

USDA Soil Conservation Service

states to set water quality goals to achieve fishable, swimmable waters by 1983 and to develop plans to attain these goals under Section 208. Section 208 is the only authority under federal law for a comprehensive program for handling nonpoint source pollution of all kinds. This section directs the states to develop "areawide waste treatment plans" to deal with both point pollution, through sewage treatment, and nonpoint pollution, through application of best management practices. Under the law, areas with severe pollution problems–generally urban-industrial areas–are designated as planning units. Thus, the plans are, for the most part, developed locally, with the state assuming planning responsibility for the remaining, primarily rural, undesignated areas. EPA terms this planning process the "water quality management" program.

Theoretically, Section 208 provides for a rational, comprehensive, integrated planning process enabling local areas to develop methods to control water pollution. Under the 208 process areas were supposed to estimate growth and identify needs for municipal sewage treatment for a 20-year period; to inventory point pollution; to identify nonpoint pollution sources and develop regulations and land use measures (BMPs) to control them; to estimate the economic, social, and environmental impact of the plan; and to designate appropriate agencies to implement it. The plan was then to be submitted for approval to EPA, with implementation following plan approval.

. . . and in Practice

In practice, this is not what happened at all. Section 208 planning got off to a slow and faulty start, with EPA issuing billions of dollars of sewage treatment construction grants before planning under 208 had even begun. Although the law stipulates that EPA

can only give sewage-treatment construction grants for projects that conform to the 208 plan, it does not say that such grants cannot be awarded prior to the plan's completion. Congress, in fact, authorized $18 billion in federal grants for municipal sewage treatment plant construction for the years 1973 through 1975. Considerable political pressure was brought to bear to get the grants out fast and to build sewage plants as a quick and easy way to show some tangible results from the pollution control program.

At the same time, 208 planning was getting off to a slow start. EPA was developing its plan criteria at the same time that the states were trying to develop the initial stages of the plan, causing uncertainty and confusion. Approval of any grant funding for planning was largely delayed until June 1975. Moreover, only $300 million in federal planning grants was authorized for the first three years and not even all of this funding was spent.

Thus, without the existence of the plans prescribed by 208 as a basis for establishing growth projections and methods for controlling growth where needed to control pollution, treatment plants were built which often had unnecessarily large capacities, thereby encouraging growth and increasing rather than decreasing pollution problems. And without data on nonpoint source contributions to pollution, expensive sewage treatment facilities were constructed that sometimes proved a costly and ineffective method of controlling an area's water pollution problems. EPA placed major emphasis on point-source control and the states followed suit, glad to follow the relatively noncontroversial road to water clean-up provided by the technological quick-fix of sewage treatment rather than hazard the politically dangerous route of imposing land use controls, permit requirements, and zoning, which would have been necessary for controlling nonpoint pollution.

Within the past few years, however, it has become obvious that, although more and better sewage treatment is still needed in some areas and although the problem of industrial pollution is far from solved, at least half of the nation's water pollution now comes from nonpoint sources[11] and it is this nonpoint pollution that will prevent attainment of the 1983 water quality goals in many of America's river basins.

Improving the Nonpoint Program

In December 1977 the General Accounting Office completed a study of the nonpoint-source pollution control program and found the major problems to be a lack of data on sources of nonpoint pollution and on methods of control and a lack of EPA emphasis, both in terms of funding and visibility, on the nonpoint program.

GAO was particularly concerned about the lack of data on the volume and effects of nonpoint sources and on the relative effectiveness of costs of different types of controls and pinpointed this lack of information as the most significant contributor to inaction in controlling nonpoint source pollution nationwide. The GAO study noted, "We emphasize the need for an adequate data collection program because our work at planning agencies suggests that progress will be limited without it." GAO asserted that research was essential if the best use was to be made of the Act's limited funding: "The most obvious nonpoint sources may not be the most serious, and cost-effective solutions are not always obvious." Perhaps, most importantly, data is needed to demonstrate to the people who will be required to implement, comply with, and pay for the control measures that the controls are not arbitrary but are, in fact, badly needed.

The low level of funding for nonpoint pollution control, for both research and planning, has been another cause of the minimal efforts that have been put into the nonpoint program. In general, 208 funds as a whole have been inadequate and unpredictable. For example, EPA approved a $284,000 work program for Virginia's statewide plan, a drastic cut from the $1.2 million originally requested, and these grant funds were held up in EPA processing, delaying action by the state. Moreover, only a small portion of 208 funds have gone

SOME NONPOINT SOURCES OF POLLUTION ARE:
Debris from construction sites . . .

USDA photos

erosion due to strip mining . . .

Section 208 planning has turned out to be a difficult political process requiring coordination, cooperation, and agreement between elected officials, the public, and local, state, and federal levels of government.

into the nonpoint control portion of the planning effort.[12]

These are serious stumbling-blocks, but the nonpoint-source control program is an integral part of, and thus shares the problems inherent in, the politically complex 208 program. Infusions of funding into research and planning, or encouraging words to local agencies about the importance of nonpoint pollution control, will not be sufficient to turn the program around. Research is often offered as a panacea (or perhaps placebo) for difficult government program problems and, in this case, lack of research is a poor excuse for delay and inaction on many obvious nonpoint pollution problems. In addition, no matter how much EPA emphasizes the nonpoint problem—whether through funding, guidance, or providing technical expertise—the emphasis will have little meaning without an accompanying program that has some teeth.

Section 208 planning has turned out to be a difficult political process requiring coordination, cooperation, and agreement between elected officials, the public, and local, state, and federal levels of government. Agencies planning for designated areas and those preparing statewide plans have been uncertain about each other's areas of responsibility. Guidance from EPA has not always been clear either to the planning agencies or to the EPA Regional Administrators who must approve the plans. Planning agencies traditionally associated with water quality problems must be joined by agencies responsible for such areas as agriculture, silviculture, and construction, which are not oriented to water quality problems. Public awareness of and involvement in the planning process is crucial for enactment of necessary laws and for compliance with the plan—an idea generally resisted by planners and decision-makers.

Areawide plans—originally due two years after initiation of the planning process—have received an extended due date in the 1977 Clean Water Amendments and, for the most part, should be going to EPA for approval this year. State plans for the undesignated areas are due beginning in November. But EPA predicts that these plans will often be late, incomplete, and inadequate, particularly with respect to nonpoint pollution problems. In order to get the acceptable portions of the plans implemented as soon as possible and to avoid complete disapproval of an area's efforts, EPA has decided to give plans "conditional" approval, allowing disapproved or incomplete portions of plans to be submitted later. EPA neither expects nor requires complete plans to be submitted on time; portions of plans are expected to continue to trickle in for approval, perhaps until planning funding is discontinued in 1983.

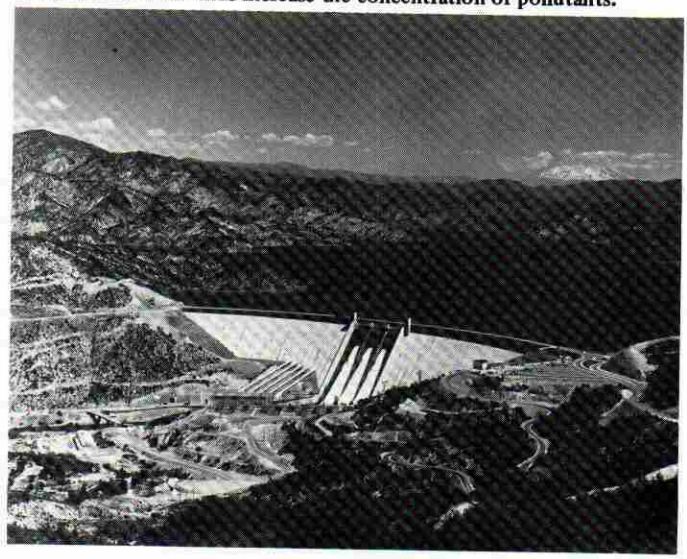
Even when 208 water quality management plans are approved, only the first step will have been taken toward comprehensive water pollution control. The implementation and enforcement of the 208 plans create additional practical and political difficulties.

Again, one difficulty may be convincing agencies not oriented toward water pollution control to enforce faithfully the required regulations, review carefully the necessary permits, and stand firm on zoning requirements. EPA has neither the funds nor the staff to monitor plan implementation directly, although plans can be monitored indirectly through water quality monitoring. EPA has no authority to *force* implementation of a plan anyway. And perhaps most important, with the exception of agricultural activities, no funding is available to local areas for implementing the plans and very little is available to states.

Thus, in addition to research into nonpoint pollution and increased planning funds, EPA must find ways to

spraying with pesticides and herbicides.

Even dams are considered a source of nonpoint pollution since they lower the level and thus increase the concentration of pollutants.



ensure that plans are completed, that states and areas know what is supposed to be in their plans, that the plans are carefully reviewed before approval, and that means are found to insure compliance with the plans. Easily monitored regulatory controls for nonpoint source pollution, such as permits and licenses, must be required and other ways must be found to ensure that plans are implemented. Also, the public must be guaranteed a meaningful role in plan development and implementation.

A New Direction

In response to a directive from President Carter to federal agencies to consolidate and simplify their planning programs and a directive from the Office of Management and Budget to EPA to improve the 208 planning program, EPA has developed a "Program Strategy for Water Quality Management, FY 1979-83," issued last March. This document pinpoints many of the causes of 208's past inadequacies and sets forth a significantly strengthened and more focused program for the next five years, with increased emphasis on nonpoint source pollution. In this document EPA concludes that the uncertainty of federal funding has been a major problem that EPA must articulate expectations for state programs and help set out the relationships between state and area-wide plans, and that EPA must provide more effective guidance and must spell out sanctions and incentives for planning and plan implementation.

New EPA "management strategies" for strengthening the 208 program include:

- Placing primary importance on promoting public participation;
- Encouraging local or state planning agencies to develop plans by denying or delaying construction grant funds to areas without plans and denying implementation money to states with insufficient state plans;
- Making the 208 plan the decision-making process for the state construction grant program;
- Cutting off planning funds to areas and states that do not have partial implementation of a plan by 1980.
- Assuming responsibility for implementation of parts of the plan if necessary.

EPA's new program includes particularly good news for nonpoint pollution control. EPA identified nonpoint source pollution generally and urban stormwater runoff specifically as two of four priority areas for funding. A special research and testing program to find nonstructural ways to control urban stormwater runoff is proposed as a way of reducing the need for costly structural controls. And the nonpoint source program generally is scheduled to be heavily funded throughout the six-year period of fiscal years 1978-1983. The revised regulations are expected to be issued in July.

Help in the form of funding for plan implementation is included in the 1977 amendments to the Clean Water Act (now the Federal Water Pollution Control Act of 1977, PL 95-217), which contain a new agricultural cost-sharing provision. The federal government may make partial grants to farmers in identified priority areas for implementation of best management practices required by an approved state 208 plan. In addition to providing funding for implementation, the cost-sharing provides EPA with an additional lever to encourage plan completion.

But how these changes at the federal level, even if faithfully executed, will affect actions at the local level remains to be seen. A new commitment by EPA does not necessarily translate into a new commitment by those who are actually preparing and implementing the plan.

At the local and state level, 208 planning and implementation—particularly nonpoint pollution control—will still meet resistance by planners and politicians who prefer the seemingly simple and federally fundable sewage treatment route to pollution control. For example, the recently completed draft 208 plan for the Metropolitan Washington area endorses a controversial advanced waste treatment plant and a pumpdown facility, both of which have previously been denied funding by EPA. The plan inadequately addresses the problems of growth, nonpoint source pollution, and urban stormwater. The citizen's advisory committee which participated in the plan's development insists that the plan needs to be extensively revised, despite the fact that $3.5 million has been spent on the plan so far.[13]

It is clear that EPA can only make its seemingly more aggressive stance credible (1) if it approves only acceptable plans or portions of plans, (2) if it requires plans to include regulatory, monitorable, enforceable best management practices for nonpoint source pollution control, and (3) if it uses every means available to insure that plans are completed and implemented. But it will take action by many others besides EPA if 208 is going to do the job it was designed to do. It will take an awareness and acceptance of the fact that truly comprehensive planning is the only route to pollution control, and it will take the involvement of every citizen concerned with the quality of our water if we are ever to achieve sensible, efficient, and effective programs of water pollution control.

NOTES

1. U.S. Environmental Protection Agency, **Interim Report of the Nonpoint Source Water Pollution Working Group**, November 8, 1976.

2. P.L. 92-500.

3. Comptroller General of the United States, **National Water Quality Goals Cannot Be Attained without More Attention to Pollution from Diffused or "Nonpoint" Sources**, Report to the Congress, CED-78-6, December 20, 1977.

4. Ibid.

5. Northern Virginia Planning District Commission and Department of Civil Engineering, Virginia Polytechnic Institute and State University, **Interim Report: Occoquan/Four Mile Run Nonpoint Source Correlation Study**, prepared for Metropolitan Washington Water Resources Planning Board, June 1977.

6. Comptroller General.

7. Midwest Research Institute, **National Assessment of Water Pollution from Nonpoint Sources** (Draft of Final Report), November 1975, cited in U.S. EPA **Interim Report**, p. 1.

8. U.S. Environmental Protection Agency, "No-Till Farming," **EPA Journal: Soil and Pollution**, 3 (April 1977).

9. U.S. Environmental Protection Agency, "Non-Point Pollution," **EPA Journal: Soil and Pollution**, 3 (April 1977).

10. "GAO Study Questions High Costs, Effectiveness of Advanced Treatment," **Environment Reporter** 7 (January 7, 1977), p. 1276.

11. Comptroller General.

12. Virginia Division, Izaak Walton League of America, **'Swimming Clean' Waters for Virginia by 1983: A Planning Role for the Public**, November 1977.

13. Citizen Advisory Committee of the Water Resources Planning Board, "Summary of Comments on Draft 208 Plan," March 1978.