ARROYO

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Rainfall flowing over urban surfaces picks up various constituents and forms urban runoff nonpoint source pollution. (Photo from U.A. Graphics)

Nonpoint Source Pollution — Unfinished Business on the Water Quality Agenda

Although many and varied, all sources of water pollution are classified as either point or nonpoint. Pollution comes from a point source if its origins are distinct and identifiable; hence, point source is also called an end-of-the-pipe source. Pollution from point sources can usually be quantified, often by direct measurement. Point sources can often be regulated effectively with federal and state permits.

Nonpoint source (NPS) pollution is less readily identified with a particular source. Frequently associated with urban or agricultural runoff, NPS pollution develops from many human activities, usually related to the use of land. Relatively diffuse in its points of entry into the environment, NPS pollution can originate anywhere on the

land surface. NPS pollution might then flow with runoff to streams, rivers, lakes and aquifers.

The various sources of NPS pollution of concern to Arizona include:

Forestry Included within this category are such activities as forest harvesting, reforestation, residue management, forest management, and forest road construction and maintenance.

Construction Highway, road, and bridge construction, land development, especially in Arizona's rapidly expanding metropolitan areas, and military operations all contribute to NPS.

Resource extraction Extensive mining operations exist in Arizona, with copper, precious metals, uranium, industrial minerals, coal, and sand and gravel operations contributing to water quality problems in the state. These activities produce both point and NPS pollution.

Land disposal Although often contributing to point sources of pollution, sludge disposal, wastewater reuse, landfill, recharge, on-site wastewater systems, and hazardous waste disposal are also potential NPS pollutants.

Recreation Arizona's limited shoreline attracts concentrated use, with camping and fishing occurring as popular activites on water bodies and in riparian habitat areas. These activities can cause NPS pollution.

Urban NPS and agriculture These two significant NPS sources will be discussed in detail later.

Unknown Sources for several documented water quality violations in Arizona are unknown. They are therefore included within this category, until monitoring efforts identify specific NPS sources and their relative contribution to the total contamination in question.

Other NPS This category includes various subcategories: natural, waste storage and storage tank leaks, highway maintenance and runoff, spills, in-place contaminants, utility corridors and motor transportation.

Historically, efforts to control water pollution have focused primarily on point sources, with NPS pollution attracting attention only relatively recently. The 1987 amendments to the federal Clean Water Act, however, boosted efforts to confront NPS pollution problems. Included within the amendments was a provision requiring states to prepare an NPS water quality management program to be submitted for approval to EPA. Federal loan and grant funds were authorized to help states manage NPS pollution.

Arizona's 1986 Environmental Quality Act (EQA) assigned the Arizona Department of Environmental Quality (ADEQ) the task of developing the state's NPS water quality management program. The task consists of two components: an NPS pollution assessment report detailing the nature and extent of NPS pollution in Arizona and an NPS water quality management plan specifying the actions to be taken by the state to manage the identifed NPS problem.

NPS Pollution in the U.S. and Arizona

Substantial progress has been made in controlling point sources of pollution. Efforts are now being directed toward controlling NPS pollution. Describing the relative impact of the NPS pollution problem in U.S. impaired waters, a 1986 EPA report stated that nonpoint sources account for 45 percent of the pollution remaining in estuaries, 76 percent of the pollution in lakes and 65 percent of pollution now in rivers. Further, 165,000 miles of rivers and 8.1 million acres of lakes in the United States have been assessed to be impacted by various categories of NPS pollution.

Another study reports that even if all point sources were remedied, nonpoint sources would still produce 72,500 tons per day of suspended solids, 14,150 tons per day of nitrogen, 965 tons per day of phosphorus, and nearly all of the remaining fecal coliform pollution.

To determine Arizona's NPS pollution problem for the EPA-required assessment report, ADEQ reviewed surface water quality monitoring records and other information from reports, studies and land management plans from 1965 to 1987. Its evaluation of Arizona's surface water determined that over 90 percent was not meeting the protected uses or standards.

The assessment indicated the seriousness of the problem by listing how many miles of Arizona streams are affected by each category of NPS pollution: unknown, 3,675; rangeland, 3,540; hydrologic/habitat modification, 860; resource extraction, 717; recreation, 590; other (including natural), 574; irrigated agriculture, 514; land disposal, 465; urban runoff, 256; construction, 229; and silviculture, 159.

Because runoff, often carrying NPS pollutants from various sources, usually drains into bodies of water, riparian areas are especially vulnerable to NPS pollution. The situation becomes particularly critical in Arizona where, because of semiarid conditions, riparian ecosystems are especially few and fragile. Ninety percent of Arizona's riparian areas have been altered or destroyed.

The ADEQ assessment also addresses groundwater quality. A database made up of long-term groundwater sampling from 1979 to 1987 was used to plan sampling and monitoring strategies. Groundwater sampling results summarized from the groundwater database indicated that more than 350 wells have been documented as being contaminated in the state.

Arizona's NPS Water Quality Management Plan

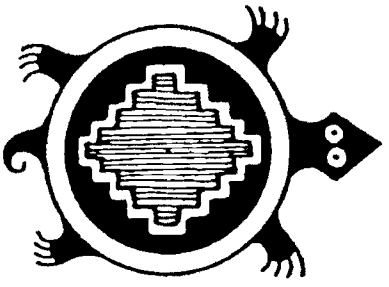
As mentioned, the Clean Water Act (CWA) requires that states develop an NPS water quality management program, a complex task ADEQ is now coordinating. Concerned with 11 NPS categories and involving various agencies and programs from three levels of government, Arizona's NPS management program, made up of planning, implementing and compliance activities, defies simple description.

Contributing to the complexity of the state program is the number of agencies participating in the effort. In developing and implementing the plan, ADEQ involves, whenever possible, federal, state, and local agencies presently concerned with water quality. In other words, rather than initiating a program at ground level, ADEQ is instead working with established agencies and programs, each with some power to control NPS, to organize a collective effort to manage NPS pollution in the state. To provide one example among many: the planning phase to control forestry NPS pollution involves the participation of the U.S. National Park Service, U.S. Forest Service, Bureau of Land Management, Arizona State Land Department and Arizona State Parks, with ADEQ coordinating the effort.

Although ensuring broad involvement in the NPS management program, this extensive coordinating effort, which is the basis of the state program, is viewed with concern by some critics. They believe that by mainly relying on existing water quality programs to form its NPS management package, ADEQ is not providing the innovative leadership needed to confront the NPS problem. Such critics believe new approaches are needed to ensure a change in the status quo.

Possibly the state plan could best be understood if considered not as a single program but a cluster of programs, with one devoted to each type of NPS pollution – e.g., construction, resource extraction, etc. – and with the entire operation coordinated by ADEQ. Such an approach would best describe ADEQ's efforts to develop individual plans to manage each category of NPS pollution depending upon the distinctive features and characteristics of each.

That the NPS pollution issue is made up of various subissues, each representing a unique NPS category with special characteristics and concerns, presents difficulties to those seeking a comprehensive understanding of the problem. NPS often attracts a fragmentation of interests, as attention is often focused on specific categories, with less emphasis on the interconnections among them to define the overall problem. As a result, NPS is a difficult concept for many to grasp, especially for the nonprofessional.



Mimbres pottery design of turtle.

Identifying best management practices (BMPs) is the central task when developing an NPS water quality program under the 1987 CWA amendments. Statements of the most effective and practical means of preventing or abating NPS pollution, BMPs, which are prepared for each NPS category and subcategory, are the master plans or blueprints for the state's NPS program. The selection of BMPs involves assessment of NPS problems, examination of alternatives, and public participation, including the assistance of advisory groups made up of members representing public and private interests.

The cost of implementing BMPs is a concern to many water managers, with some viewing the commitment as a cost with no returns. Some researchers emphasize, however, that BMPs in some areas can result in positive economic returns. For example, the U.S. Forest Service developed analysis procedures for estimating the economic benefits of improved soil and water resource management. The identified benefits include increments of increased timber, forage and other resources. More research is needed to quantify the economic value of reduced NPS pollution. Understanding the economic value of lessened NPS pollution damage is essential to developing efficient NPS control programs.

Federally funded demonstration projects are also part of the state's NPS program. Intending to provide measurable improvements in water quality, the demonstration projects focus on management priorities of specific categories of NPS pollution. The projects are also expected to provide basic information about effective methods to control NPS problems. Of 55 projects proposed, ADEQ selected eight to receive technical and financial support. Additional demonstration projects will be solicited and funded in future years.

The cost of mitigating NPS pollution will be high. With traditional point sources, the federal government assumed the bulk of the financial responsibility for clean-up. A different scenario exists today, with Congress reluctant to allocate substantial funding to control NPS pollution. Meanwhile, state and local governments also lack the financial resources to support extensive new operations. Further, they want to avoid new and increased taxes.

Despite the uncertain financial picture, policy researches have considered funding possibilities for controlling NPS pollution. Generally they have identified two sources of funding for policymakers to consider: NPS polluters (polluter pays principle) and/or those who benefit from the improvement of water quality. Under the polluter pays principle, such funding possiblities exist as erosion taxes, fertilizer and pesticide taxes, and special purpose district property taxes. Beneficiaries of improved water quality would pay through such funding sources as a potable water volume use tax, general interest potable water surcharge, special property assessments, and recreation license fees.

Having briefly described some general features of the state plan, discussion will now focus mainly on efforts to manage two types of NPS pollution – agriculture and urban runoff. By concentrating on these two NPS categories, *Arroyo* can provide more detail about the process and dynamics involved in managing NPS pollution in the state than would be possible with a general discussion of all NPS categories. Agriculture and urban runoff were selected for review because they represent diverse activities and therefore provide a broad perspective on NPS management planning and coverage in the state.

Agriculture Nonpoint Source Pollution

A major source of NPS pollution in Arizona, agriculture includes activities relating to irrigated cropland, animal feeding, grazing, and aquaculture. As a result of these activites, sediment, pesticides, nitrate, animal wastes, and total dissolved solids enter the state's water supplies.

Nitrate contamination is a significant NPS problem resulting in part from agricultural activities. Its effects are evident in the state's aquifers. More than 150 water supply systems regulated by ADEQ were identified as having groundwater supplies with potentially high nitrate levels. EPA standards are exceeded in historically irrigated areas of the Phoenix metropolitan area.

Arizona's EQA states that a program made up of BMPs be adopted by rule to control the discharges of NPS pollutants from certain agricultural operations. These designated operations include the application of nitrogen fertilizers and concentrated animal feeding operations. In other words, these operations are to be regulated agricultural activities, with specific BMPs defining required practices. ADEQ and its advisory committees decided, however, that to adopt by rule specifically directive BMPs for agriculture would not be appropriate.

Agriculture is viewed as a very complex activity, not readily regulated by specifically defined rules. Such regulations were seen to inhibit the flexibility needed when working with diverse crops, cropping patterns, soils, and irrigation technologies. A dilemma existed since BMPs were required by law, but, if implemented, were seen to be unduly restrictive to agricultural production.

The dilemma was resolved by redefining BMPs as general goal statements. This strategy would establish generalized BMPs to provide the needed direction and purpose for managing NPS pollution, but at the same time allow flexibility to agricultural operations. For example, a proposed agriculture BMP broadly states that an application of nitrogen fertilizer shall be limited to the amount necessary to meet projected crop plant needs.

Not mentioned in the BMPs are the specifics of how these goals are to be achieved. For example, the BMPs do not indicate how much fertilizer is to be used with various types of crops and soil types, nor how much water is to be used with each application. To assist the regulated community in complying with the law, ADEQ developed a handbook of specific guidance practices. This document describes methods useful to an operator for implementing the general BMPs. Not incoroprated into rule, the guidance practices can be readily modified to reflect changes in technology.

Critics are doubtful that the above arrangements will, in fact, effectively control agriculture NPS. They criticize the BMPs as being too broad, general, and even vague and, as a result, practically unenforceable. The guidance document is seen as basically advice, to be ignored or accepted. As a result, critics believe that the enforcement of practices and standards to control agriculture NPS is decidedly lacking and that compliance is more or less voluntary.

Some economic analysts more broadly question the efficacy of agricultural BMPs to control NPS pollution. They believe that farmers extensively use chemical fertilizers because of socioeconomic forces, with the agricultural chemistry industry and federal research and commodity programs mutually reinforcing farmers' dependence on chemical input. These researchers stress that any efforts to curb the use of chemical fertilizers must confront such structural forces, a goal not achieved by BMPs.

Presently Arizona's Attorney General's office is reviewing the state's agriculture BMPs for certification. If they are rejected, the agricultural component of the NPS managment program would have to be reworked and redesigned.

Another important agriculturally related NPS problem concerns rangeland, the specific NPS category of greatest impact in Arizona. Resulting from both natural causes and grazing, range land NPS, which mainly consists of silt and sediment, is identified as having an adverse effect on the state's riparian areas. Poor watershed

quality has been correlated to both historic and current rangeland management practices.

It is generally acknowledged that to effectively control rangeland NPS, both natural causes (i.e., those that relate to such variables as weather patterns and soil types), as well as grazing, the rangeland NPS most conducive to management, must be studied. At issue, however, is the extent to which grazing is responsible for rangeland NPS problems.

Some people believe that grazing, which occurs on private, state, and federal rangeland, is the prime cause of NPS pollution and that broad regulations are in order. Others, however, argue that factors besides grazing contribute to the silt or sediment of rangeland NPS, and it is sometimes difficult to determine what derives from natural causes and what from improper grazing. To better understand the role of grazing in rangeland NPS, they say specific sites must be examined to evaluate such variables as particular soil types and precipitation zones, with regulations drawn up accordingly. These different positions raise basic questions that affect what BMPs are eventually adopted.

The state's Environmental Quality Act does not work out as specifically the procedure to control NPS grazing activities as it does irrigated agriculture and concentrated feeding operations. For example, BMPs for grazing activities do not have to be in rule.

ADEQ is intending to manage grazing NPS by developing a program that will involve private, state and federal land managers. BMPs are being developed with government land management agencies that will complement the rules the agencies presently have. Through memoranda of understanding these agencies will also have responsibilities to enforce water quality standards.

Urban Runoff Nonpoint Source Pollution

Urban runoff, although not as serious an NPS problem in Arizona as it is in more urbanized states, is still a concern and will become more so as urban areas in the state expand. Rainfall flowing over urban surfaces – streets, parking lots, landscaped areas, industrial sites – picks up constituents such as

Mimbres pottery design of frog.

sediments and debris from worn and weathered pavements and buildings; heavy metals and inorganic chemicals from transportation activities and building materials; and nutrients from fertilizers used on lawns and landscape vegetation.

Urban runoff tends to be more toxic than other forms of NPS pollution. That Arizona's NPS toxicity level, in general, tends to be lower than in some other states indicates that urban runoff is not currently a predominant form of pollution in the state. The urban runoff that does occur is mostly lost to infiltration and evaporation before reaching the state's few surface water bodies. Although urban runoff contributes to Arizona's NPS problems, much of state's NPS pollution is caused by land disturbances that generate sediment and erosion.

As is true of most forms of NPS pollution, geographical variables affect urban runoff. For example, since Arizona has infrequent rains, urban runoff in the state could contain a higher concentration of pollutants than is found in states with more frequent rains. This is because the constituents that make up NPS pollution in the urban areas of Arizona may accumulate for a month or more before being washed by rains. The effects of urban runoff in the state may therefore be more pronounced.

Federal, state and local agencies are involved in controlling urban runoff NPS. Collectively and individually, these concerned government agencies are contributing to the state's NPS management program.

At the federal level the EPA has proposed rules and regulations for stormwater discharge. The proposed EPA regulations would require cities with a population of 250,000 or more to obtain a National Pollutant Discharge Elimination System (NPDES) permit for stormwater discharge by 1991; cities with populations between 100,000 and 250,000 would have until 1993 to obtain a NPDES permit. Originally used to control point discharges into bodies of water, a designation that includes lakes, streams, dry riverbeds, washes and playas, the NPDES permit would be the prime tool to enforce water quality in urban runoff.

To receive EPA's stormwater discharge permit a city or county would need to inventory their land uses to determine the quantity and quality of discharged water. These activities are being proposed by EPA since information about urban runoff is often lacking. Even such basic information as the kinds of constituents that are in urban runoff is not readily available. The lack of this information in Arizona has been partly the result of the limited number of sampling points within the state's urban centers.

Also, the EPA stormwater discharge permit would require an applicant to develop a management plan

for stormwater runoff. This plan involves identifying problem areas and working out strategies and practices to reduce the flow of NPS pollutants into bodies of water.

As part of its efforts to develop a state NPS management program, ADEQ has been working with an Urban Runoff Technical Advisory Committee to develop a BMP handbook for urban runoff. The committee includes representatives from Phoenix, Tucson, Mesa, Chandler, the Pima Association of Governments and the Arizona Department of Transportation.

A draft of the handbook was generated in January, with a final version expected this summer for public review and comment. When completed, the document will serve several purposes. Along with assisting applicants to develop BMPs for the EPA, the handbook will also contribute to statewide uniformity in controlling urban runoff and stormwater discharges and assist communities that lack resources to develop efficient practices to reduce pollutants from urban runoff.

The draft handbook stresses the essential role that local governments have in controlling NPS pollution in urban runoff. With the authority to control land use, cities and counties have the power to enforce ordinances that, for example, control dust and erosion from construction sites or require revegetation. Drainage and flood control policies can also be developed at the local level, and zoning regulations established. All these practices can help reduce the NPS pollution in urban runoff.

Used extensively in Arizona for on-site disposal of storm water, drywells are another issue related to urban runoff. The EQA identified drywells for management under a regulatory program and driller licensing. Some officials are concerned that with strict water quality standards for stormwater runoff, drywells will be increasingly used and could affect groundwater quality.

The drywell issue demonstrates that care needs to be taken that activities meant to control NPS pollution do not adversely affect other resources such as groundwater. Although NPS control is mainly concerned with surface water, the interrelationship between surface water and groundwater needs to be considered.

With the distinct possibility of having a major role in NPS urban runoff control, some county and city officials are questioning the applicability of the EPA stormwater program for Arizona cities. These officials believe the program is more appropriate to cities that drain stormwater into large bodies of water, thereby threatening aquatic life. Urban runoff, they believe, is not as great a danger when it drains into dry river beds and washes.

Also of concern to some officials are the water quality standards that will eventually be set for stormwater runoff. The state is presently revising its surface water quality standards and, because of the EQA, proposed standards tend to be more stringent than those required by the federal government. Concern is expressed that if such state standards prevail for stormwater runoff, cities and counties may have to treat stormwater, a costly operation that some believe the federal government never intended.

Nonpoint Source and Management Concerns

With the above discussions of agricultural and urban runoff provided as case studies, certain characteristics of the NPS problem can now be identified. For example, the discussions should indicate that to effectively manage NPS pollution is a complicated task. The fact that its sources are diffuse and difficult to trace demonstrates that NPS pollution is not easily isolated, controlled, and regulated. Urban runoff is the result of many and varied activities occurring at sites that include individual households. Agriculture NPS comes from many different farms, with various types of operations and conditions. As a result, to clearly delineate NPS sources is a complex chore.

Also that NPS pollution discharges occur largely during storm events and are therefore intermittent further complicates the management of NPS pollution. Even obtaining a good sampling of urban runoff NPS becomes difficult when rains are irregular and, as is true of most of Arizona, infrequent.

Also, institutional factors must be considered. When NPS pollution is managed and contolled, responsibilities are shared differently among the various levels of government – federal, state and local – than when point source pollution is at issue. Point sources of pollution are traditionally regulated from "top-down," i.e., federal and state governments enforce specific requirements on water users. With NPS pollution new institutional arrangements must be considered, with roles and responsibilities worked out among the different levels of government. (In fact, the state's NPS management program can be viewed as an exercise in mapping new institutional arrangements, as responsibilities are coordinated among many different government agencies.)

Local governments tend to be increasingly involved in NPS pollution problems. This was especially evident in the discussion of urban runoff NPS, which, as is true of other forms of NPS pollution, is often the result of past and present land use practices. Along with urban runoff the NPS sources that can be managed entirely or in part by local governments include construction, landfills, on-site disposal systems, and wastewater treatment plant sludge disposal.

Federal concern with land use is mostly limited to wilderness and wild and scenic river designations, as well as land set aside for national parks and forests or for grazing. With such limited federal involvement in land use decisions, local level involvement increases. In short, NPS pollution control tends to be more "bottom up" than control of point sources.

Also brought out by the discussions of agricultural and urban runoff is the variability that exist among programs set up to control the different categories of NPS pollution. Even in such a basic area as enforcement, differences exists. For example, the federal NPDES permit will ensure the enforcement of water quality standards in urban runoff. Agriculture faces a different situation. Not bound by NPDES regulations, which do not apply to agricultural runoff, agriculture is mainly regulated by its BMPs which, as mentioned, are general statements designed to allow flexibility of actions.

Also a review of the agriculture and urban situations raises a question about the degree to which NPS regulations should be site-specific or local. This seems to be an area of some controversy. A local focus is appropriate in many situations since some NPS problems arise from site-specific conditions and, as a result, need local management and control. This situation was brought out in the discussion of urban runoff. Some critics are concerned, however, that agricultural interests are claiming the need of site-specific rules to avoid a more fitting, comprehensive and forceful regulation of their activities. Clearly, the appropriateness of general and site-specific categories is an issue to resolve.

Control of NPS pollution must also involve consensus-building, as an informed and concerned public must participate in solving NPS problems. More than is true with point sources of pollution, personal and household practices and habits contribute to the NPS problem. Gasoline and oil for cars, boats, or lawnmowers; herbicides, pesticides, and fertilizers applied on lawns; and cleansers and solvents used in household tasks all add to urban runoff NPS. Education and involvement of the public are major concerns in the management of various forms of NPS pollution.

Conclusion

Identified relatively recently as a significant problem, NPS is perceived by many to be the unfinished business on the water quality agenda. More than just the recent notice of NPS, however, is responsible for its incomplete control and management. That NPS pollution is difficult to describe and measure adds to the situation.

Even characterizing the effects of NPS pollution has caused problems. Its impacts are diverse, and they are evident in different ways and over different time periods. Nor are the impacts fully known. More manageable are the obvious impacts of NPS pollution: impairment of water use and associated water and land resources; dangers to public health; and risks to aquatic life.

How NPS is evaluated will determine the most effective institutional strategies for its control. With NPS evaluation still incomplete, few definitive institutional strategies for its management are established. Instead, strategies are being tried and tested throughout the country, including Arizona.

ADEQ is coordinating the development of Arizona's NPS water quality management program. The project is in progress, with components being developed for each category of NPS pollution. The state program is intended to be flexible to accommodate new information about NPS pollution. Public participation is encouraged.

Although its eventual success remains to be seen, Arizona's NPS management program recently received national recognition. The EPA has commended the state's program as an exemplary effort and awarded an extra $100,000 to Arizona. Only seven states received that recognition.

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