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REDUCING URBAN NONPOINT SOURCE POLLUTION

Treating Runoff in Texas Cities Will Be Difficult, Expensive

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Nonpoint source pollutants - those contaminants that are swept away by heavy rains and cannot be traced to a specific source - create sizeable problems for urban areas in Texas and elsewhere. Because of the variety and scope of urban land uses, runoff pollutants originate from such diverse activities as chemical application to golf courses and residential and business landscapes, materials spilled on parking lots and highways, industrial wastes, soils disturbed by new construction, and others. This makes it hard to identify specific sources of pollution and develop plans to improve stormwater runoff quality.

The toxic nature of urban runoff pollutants constitutes another major problem. While many of the concerns about agricultural nonpoint source pollution dealt with increased levels of nitrogen and phosphorus, there is growing evidence that urban runoff may be comprised of higher amounts of toxic substances.

Dealing with nonpoint source pollution is being viewed by many cities as a significant challenge.

New EPA regulations are making cities in Texas test to determine the magnitude of urban nonpoint source pollution problems and to develop plans to capture and treat stormwater runoff to improve its quality. The rules dictate that nonpoint source pollutants become point sources of pollution when they enter storm sewers.

Permits will have to be obtained from EPA to limit runoff from landfills, vehicle maintenance areas, construction sites, and many other urban activities. It's likely that every Texas town will feel the brunt, and the expense, of complying with these rules.

Despite the complexity of the problem, there are some "common sense" solutions and best management practices (BMPs) that can be applied to lessen nonpoint source pollutants.

Detention basins can be built to capture stormwaters. Simply allowing eroded sediments to settle out will improve water quality. Lessening the amount of impervious cover (paved surfaces that water can't penetrate through) decreases the volume and speed of runoff and nonpoint source pollutants. Eliminating runofffrom sites with bare soils reduces the amount of sediments carried away by runoff. Carefully applying lawn chemicals will lessen pollution risks.

Some Texas cities are taking aggressive approaches to reduce their nonpoint source pollution problems.

Fort Worth utilizes a program of monitoring runoff waters for visible signs of pollution. Austin has adopted ordinances that require target levels of nonpoint source pollution be removed based on the amount of impervious cover. The Lower Colorado River Authority (LCRA) has developed flexible guidelines and specifications to reduce nonpoint source pollutants from the Highland Lakes. El Paso and other cities have proposed special financing districts to comply with the EPA regulations. Corpus Christi is studying if stormwater runoff can be managed by a district that includes areas outside the city limits.

Universities are working to identify nonpoint source pollution problems and to develop solutions. Projects include new methods to gather essential data, increased use of geographic information systems (GIS) to interpret pollution trends, and physical models of urban landscapes and drainage basins to measure the pollutants in runoff.

BASIC INFORMATION

Many factors make urban nonpoint source pollution difficult to deal with. Because of the variety of land uses and manufacturing and industrial processes in urban areas, there may be a greater array of toxic nonpoint source pollutants than there are in rural areas. Also, increased amounts of impervious surfaces in urban areas dramatically boost the amount and the speed of the runoff. More than 70% of rainfall that falls on asphalt and paved surfaces runs off, but only 29% runs off landscapes that are covered with 75% grasses. Because urban stormwater runoff occurs for relatively short time periods, pollutants are concentrated and may cause short-term problems. Finally, the use of grassy and vegetated areas and low-density developments to filter out nonpoint source pollutants may be limited because of the high costs of urban property.

Results of the EPA National Urban Runoff Program showed that metals including lead, zinc, and copper were detected in more than 75% of all samples, while chromium and arsenic were found in more than half of all runoff.

Toxic chemicals are routinely found in urban runoff, but using land use patterns to estimate toxic pollutants may not always be accurate. Field studies in Austin (1988) found that pollutant levels in large watersheds increase as impervious cover increases, but in smaller, suburban watersheds land use and maintenance practices can have a greater influence. One study found that residential rooftops, car service facilities and industrial areas, generated the most toxic runoff (Field and Pitt, 1990).

Nonpoint source pollution from golf courses and urban landscapes may be minimal (Cooper, 1990) if proper amounts of fertilizers and pesticides are applied. Turfgrasses intercept and reduce the amount of pesticides that pollute waters. A 150acre golf course can absorb 12 million gallons of water during a 3-inch rainstorm. Pesticides are less likely to cause pollution if used according to label directions.

TEXAS' NONPOINT SOURCE POLLUTION PROBLEM

Throughout Texas, the impacts of urban nonpoint source pollution are being felt. In some cases, the effects are pronounced. The LCRA projects that more than 90% of the pollution entering the Highland Lakes originates from nonpoint sources (Hartigan, 1990). Nonpoint source pollutants have degraded vulnerable waters such as Austin's Barton Springs where they have caused increased turbidity and algal growth. Nonpoint source pollution is suspected as a source of increased counts of fecal bacteria that are flowing into the Springs after storms. As a result, the Springs had to be closed to swimmers many times this year. Runoff into Austin's Town Lake has led to high levels of lead, fecal matter, phosphorus, nitrogen, and pesticides.

Many studies have examined nonpoint source pollution in the Dallas-Fort Worth area. The U.S. Army Corps of Engineers estimates that 17% to 50% of the pollution entering the UpperTrinity River comes from nonpoint sources (Atkinson, 1990). A U.S. Fish and Wildlife Service report (Irwin, 1988) suggests that areas with high levels of residential and industrial runoff negatively impact fish populations in the river. Studies by the Tarrant County Water Control and Improvement District estimate that nonpoint source pollution loadings (mainly from septic tanks) comprise 92% of the pollution flowing into Lake Weatherford and 84% of the pollutants entering Lake Benbrook.

Estimates of nonpoint sources of pollution flowing into the Houston Ship Channel show that 90% of total suspended solids and 80% of biochemical oxygen demands were generated by urban runoff (TWC, 1986). In coastal areas, EPAestimatesthat 10 times as many nutrients originate from upstream sources than from coastal wastewater treatment plants and industries.

UNIVERSITY RESEARCH

Many universities are investigating how and why nonpoint source pollution occurs and are developing technologies and management strategies to deal with the problem.

Phil Bedient and Hanadi Rifai of the Environmental Engineering Department at Rice University are using GIS techniques to assess nonpoint source pollutants entering Galveston Bay. The project involves identifying and mapping pollutant sources and ranking them in priority order. Pollutant loading rates will be calculated for different rainfall events, land uses and contaminants.

Studies sponsored by TWRI investigated nonpoint source pollution during rainfall events in the Dallas area (Collins and Dickey, 1989). Michael Collins, then with the Civil Engineering Department at Southern Methodist University (SMU), utilized field studies and computer simulations and developed an automated wet weather sampling station to provide continuous measurements of total suspended solids (TSS) and other parameters. Results from the study showed a wide variation in TSS loads. The mean annual TSS load was estimated at 340 Ibs. per acre.

Sam Atkinson of the Institute for Applied Science at the University of North Texas (UNT) is involved in projects that use GIS techniques to assess nonpoint source loadings. In one study, Atkinson used a GIS to assess sites that could be used for stormwater detention basins (Atkinson, 1990). The study was part of an Environmental Impact Statement done for the U.S. Army Corps of Engineers. Atkinson configured stormwater detention basins for each main stream flowing into the Upper Trinity River. Data on the shape of the river bed, flood plains, and flows were entered into a GIS and the sites were evaluated to see whether they met design criteria. The basins had to be located outside the standard flood plain and near the stream but could not include residential, transportation, parking or commercial areas. Results show that seven of the sites could be ideal sites for the treatment facilities. In another study, Atkinson and Ken Dickson (1989) used remotely sensed images to develop a GIS for the Cedar Creek watershed. The data were used to identify critical nonpoint source pollution areas based on land uses and the amount of impervious cover.

John Warwick of the Institute for Environmental Sciences at the University of Texas at Dallas is merging hydrologic models with GIS methods to assess watersheds that are vulnerable to nonpoint source pollutants. Warwick is also testing models to estimate stormwater runoff when actual data are limiting (Warwick and Wilson, 1990).

Scientists at Corpus Christi State University (CCSU) are also trying to learn more about nonpoint sources of pollution. Alan Berkebile of the Geology Department is working with the City of Corpus Christi to locate, map, and inventory all of the stormwater outlets and discharge points in the region. The project includes visually inspecting bays, creeks and rivers for noticeable signs of pollution, gathering data on land uses, and describing the condition of stormwater ouffalls. Once the initial mapping is completed, runoff sampling will be conducted during dry and wet weather periods. So far, more than 200 previously unmapped stormwater ouffalls have been located. The information CCSU develops will be used as the initial phase of a comprehensive study to identify sources of nonpoint source pollution and urban runoff. Results will be used to develop a stormwater quality and quantity management plan to help Corpus Christi comply with EPA regulations.

The effectiveness of vegetative buffer strips on reducing nonpoint source pollution is being evaluated in a project carried out by scientists at Texas A&M University. The study is sponsored by TWRI and the City of Austin. Tom Thurow of the Range Science Department and Mary Leigh Wolfe and Roger Glick of the Agricultural Engineering Department are evaluating oak, bunch and sod grasses on slopes ranging from 5% to 25% in field plots in Austin. Preliminary results suggest that runoff water at the site is relatively free of nonpoint source pollutants and thus little pollutant removal is occurring (Glick, et al, 1991).

Researchers with the Texas Agricultural Experiment Station at Dallas are investigating the impact of lawn care and landscape chemicals on nonpoint source pollution. Billy Hipp constructed 20 "micro-watersheds" that simulate typical urban landscapes. Each plot is comprised of 67% turfgrasses and 33% shrubs and is instrumented to measure runoff and changes in groundwater quality from irrigation and rainfall events (Hipp, et al, 1990).

IMPROVING WATER QUALITY

State and local government agencies are working with cities to reduce nonpoint source pollution in many parts of Texas.

The Texas Water Commission (TWC) is implementing the Clean Lakes Program to evaluate nonpoint sources of pollution at Lake Houston and Lake Worth. The projects identify nonpoint source pollution problems as well as BMPs that improve water quality. BMPs are implemented on a pilot scale basis and results are monitored. The TWC was concerned about turbidity and high nutrients caused by runoff from landscapes and septic systems in urbanized areas around the lakes. An information campaign is now being carried out to educate citizens and lower pollutant loadings. Eventually, pollution prevention measures including plans to manage fertilizers and nutrients could be implemented.

The TWC is also assessing nonpoint source pollution problems throughout Texas and has identified specific measures that can improve water quality (TWC, 1990). A program to encourage citizens to monitor streams for pollution is also being formed.

In the Dallas area, the North Central Texas Council of Governments (NCTCOG) is helping cities search for illegal connections, developing a GIS to help locate stormwater outfalls and industries, characterizing stormwater runoff quality, and working with developers to slow runoff from construction sites. Six sites will be monitored before, during, and after construction activities in three watersheds to quantify the amount of soil losses and pollution. That data will be used to estimate reductions in erosion that can take place if BMPs are adopted. NCTCOG is also working with the U.S. Army Corps of Engineers to study the use of wetlands to improve water quality.

Nonpoint source pollution risks can also be lessened in developing areas. For example, the Rowlett Creek watershed runs through many cities in the north Dallas area. Local cities worked with NCTCOG to preserve the natural stream corridor, create vegetative buffer zones, lessen extreme stream velocities, and create uniform guidelines for runoff detention basins.

The City of Fort Worth uses a program that monitors storm drain discharges and stream quality each month for the presence of sewage bacteria, changes in water color, fish kills, turbidity, oil and grease, and other factors. The monitoring is used as a screening tool to determine if more studies are needed. Those involve entering storm drains with video cameras to document where the problems exist (Rattan, 1990). Since the program began in 1985, the number of undesirable features detected has dropped from 60 to less than 10.

In the Highland Lakes, LCRA developed ordinances to control sedimentation, eutrophication, and oil and grease in runoff waters. LCRA established technology based standards to treat runoff. Eventually, these may be linked with stream water quality standards. Goals are to lessen erosion from construction sites by requiring temporary controls, reducing streambank erosion by using permanent BMPs to control stormwater flows, and removing pollutants by treating runoff (LCRA, 1991). LCRA requires that a one-year frequency storm be detained for at least 24 hours to control streambank erosion.

LCRA's nonpoint source ordinances for Lake Travis illustrate how water quality can be improved. First, indicator pollutants (total suspended solids, total phosphorus, and oil and grease) are selected based on runoff characteristics. Then, polIutant loads are estimated based on the size of the site, average rainfall and runoff, and pollutant concentrations. Finally, BMPs are selected that might work best in a given situation and are applied to development sites. The water quality of the runoff is compared before and after the BMPs were used. LCRA developed a sliding scale that shows the amounts of different pollutants in runoff that must be removed, depending on the location and slope of the property (Table 2). Sites with more than 20% impervious cover usually require structural BMPs.

The City of Austin (1989) uses a comprehensive watersheds ordinance to reduce nonpoint source pollutants. The ordinance has historically only covered outlying areas that could be developed but pollution controls for developed, downtown areas have recently been proposed.

Much of the ordinance focuses on limiting impervious cover. Data from Austin field studies show levels of many pollutants increase dramatically as the amount of paved surfaces increase (see Figure 1). For example, when impervious cover jumps from 60% to 90% nitrogen loadings triple and phosphate loads increase by 250%.

The regulations also include require structural controls for higher amounts of impervious cover, limits on the amount of impervious cover, creation of water quality buffer zones, protection of critical environmental features, erosion control practices, and the use of filtration basins.

Different levels of pollutant control are required for projects inside and outside the recharge zone. The ordinance reduces the amount of development over the recharge zone.

Vegetated buffers can be required near creeks, springs, and caves. Sedimentation and filtration ponds can be required near high intensity developments. In environmentally sensitive watersheds, limits are being proposed on the amount of land that can be developed. The ordinances are controversial because they allow only 30% of tracts to be covered with paved surfaces in sensitive areas. Developers claim that at least 40% of commercial developments must be covered with buildings, streets and parking lots to be economically feasible.

Austin is now considering strengthening its ordinances for watersheds that flow into Barton Springs and the Edwards Aquifer. Nonpoint source pollution above background levels would not be allowed, the amount of paved surfaces would be limited, and key problem areas could be retrofitted with stormwater controls.

The City of Houston, the Harris County Flood Control District and the Houston-Galveston Area Council are
cooperating to help area cities obtain EPA permits.

Current efforts involve water quality sampling in urbanized areas and mapping stormwater outfalls into rivers and creeks. Erosion and sediment control measures including temporary silt traps, diversion structures, hay bales, seeding and sodding, and others are required at construction sites.

Houston may banefit from already having a number of stormwater detention basins in place for flood control. Some of those may be modified by installing outlet structures to improve water quality. Another option being considered to cope with the heavy rains is the use of major downstream detention facilities. A unique problem Houston faces is that many Superfund sites in the area are near major streams and may introduce toxic pollutants into waters.

NEW EPA REGULATIONS

The EPA is requiring all cities with more than 100,000 people to obtain permits to discharge stormwater runoff to streams and lakes. Dallas, Fort Worth, Austin, Houston, El Paso, Lubbock and San Antonio are among some of the cities impacted by the rules along with many smaller cities. Towns with storm sewers that interconnect with systems in major cities and areas judged by the EPA to contribute to water quality problems may also be subject to the new rules.

Municipalities will first have to submit "Part One" applications to the EPA (large cities have until November 1991 while medium sized cities have a May 1992 deadline). The process involves management strategies such as developing wet weather monitoring programs to quantify sources of pollution during storm events, and generating site maps that can be used to locate illegal connections to storm sewers and stormwater outfalls, assessing current conditions. Historical data on leaks and spills also needs to be summarized.

Within a year following the completion of the "Part One" activities, cities will have to submit "Part Two" applications to EPA. The major aspects of this process are to assess pollutant loadings through wet weather sampling and computer modeling. The amount of storm water sampling required to meet the regulations will be considerable. In the Dallas-Fort Worth area, 30 sites could have to be monitored for seven storm events (depending on climate conditions). Strategies will have to be developed to manage runoff from residential and commercial areas, landfills and key industries, and construction sites, illegal discharges into storm sewers. Runoff pollutants must be removed to the "maximum extent practicable (MEP)" although EPA has not defined what this means. Cities will also have to commit to implement management controls for a wide range of pollution sources. EPA could then issue permits that specify conditions that have to be met. Violating terms of the permit could lead to fines and court actions.

Cities (regardless of size) and other local government entities that carry out "industrial activities" including landfills, wastewater treatment plants, vehicle care and maintenance, and airports must also obtain EPA permits under the program. Many industries will also be impacted. For example, any new construction of more than 5 acres will require an EPA permit.

Many types of industries including energy, chemical, and metal production and processing operations; hazardous waste treatment, storage and disposal sites; lumber and paper manufacturers; ship building, and facilities that leave materials exposed to stormwater will also have to obtain EPA permits to treat runoff.

A strategy that many Texas cities may want to consider to help offset the costs of complying with the EPA rules is establishing a storm water utility district. Some estimates place the cost of implementing the regulations at $500,000 annually for a city of 250,000 residents. El Paso budgeted slightly over $1 million to create a storm water utility, while Fort Worth estimates that urban nonpoint source control will cost $800,000 to $1.1 million. The districts usually charge a small rate (Arlington charges roughly $1 a month for residences, $.50 per month for apartments, and $10 a month for commercial and industrial establishments) based on the amount of paved surfaces in each lot. Funds are dedicated to stormwater programs (Ewen, 1991). Initial reaction to the districts has been mixed. Arlington officials say only 3% of city residents contacted them with comments about the new district and its fees. Conversely, a proposal to create a similar district in El Paso was so unpopular some analysts say it led to the defeat of the mayor in a recent election.

A problem many cities face is identifying areas that need rapid attention. EPA has developed a method that incorporates the importance of the waters, the type of use, water quality status, and pollutant loads to prioritize waters that most need nonpoint source pollution controls (EPA, 1990).

ALTERNATIVES AND SOLUTIONS

A number of things can be done to reduce urban nonpoint source pollution.

Strategies to reduce nonpoint source pollution are grouped into structural and nonstructural measures. Structural controls include protective coverings of crushed stone, gravel, interlocking plastic meshes, and other measures.

Nonstructural measures include vegetative filter strips and trees that remove pollutants by reducing runoff volumes, filtering out contaminants, biological uptake of pollutants, and lessening erosion by holding the soil in place. Mulches can help stabilize bare soils and can reduce erosion by 70% to 90% in most cases. They are most effective where slopes are less than 10%. One solution that's been proposed for the Upper Trinity River is utilizing natural and man-made wetlands to treat nonpoint source pollutants found in urban runoff (Lee, 1990). Engineered wetlands can remove nearly 80% of suspended solids and lead and more than half of the total phosphorus found in typical urban runoff. Wetlands also provide the added benefits of decreasing flood flows and increasing wildlife habitat.

Low-maintenance landscapes or "xeriscapes" utilize native and adapted plant species and improved management practices to save water. Xeriscapes lower runoff by lessening the amount of water that's applied. Fewer chemicals are applied, so risks of pesticide runoff are minimized.

Porous pavements, which can be used for streets and parking lots, remove soluble and fine particle pollutants while increasing groundwater recharge. If properly designed, most of the runoff can be stored and will infiltrate into the ground where it can be used by trees and other vegetation.

Structural measures store runoff and keep pollutants from entering surface waters. Stormwater detention basins temporarily store runoff before releasing it, can reduce peak flows by 90%, and improve water quality by settling out pollutants. Extended detention ponds capture runoff and drain it 24 to 40 hours after being collected. These ponds often use wetlands planted with vegetation that can survive flooding and droughts. Sand filtration can be added to detention basins to increase the pollutant removal capacity. Retention ponds capture runoff but do not discharge it to surface waters. Instead, waters are allowed to infiltrate into soils. Results of a City of Austin (1990) study show that sand filtration basins and wet ponds are effective at removing pollutants.

Construction of a major freeway interchange in Austin generated fears that pollutants associated with construction and motor vehicles could enter the Barton Springs-Edwards Aquifer recharge zone. To treat the pollutants, the TWC requested catch basins be used to trap runoff and slowly filter it through sands and vegetative buffer strips to help pollutants settle out before they reach the recharge zone.

Erosion and sedimentation controls consist of maintaining vegetated areas, limiting the amount of bare soils, diverting peak flows around sensitive areas, slowing the speed of runoff, and spreading flows to lessen their depth and concentration.

SUMMARY

Urban areas face significant nonpoint source pollution problems. Because many surfaces are paved, the volume and speed of runoff increases dramatically. In many areas, industries, transportation, and other activities utilize hazardous and toxic substances that end up as stormwater runoff. Commercial and residential urban landscapes may make the problem worse by adding pesticides to rivers and streams. The final result may be that water quality is becoming worse, in spite of massive investments in improved treatment plants.

The new EPA regulations make stormwater runoff an economic as well as a water quality issue. Cities and industries argue the new rules will be very expensive and hard to implement. We have already seen opposition when new fees are proposed to improve runoff quality.

It is also obvious that there are many common sense things individuals, local governments, and corporations can do to improve water quality. Volunteer groups can be formed to monitor streams for visible signs of pollution. Individuals can use fewer chemicals and safely dispose of them.

Research needs to be conducted in many areas. The amount, variety, and level of nonpoint source pollutants generated during storm events need to be measured. The use of urban wetlands to improve water quality needs to be evaluated.

The economics of the new EPA rules should be evaluated to determine if they present undue hardships to cities, towns, and industries. If hardships do exist, lower cost alternatives need to be explored.

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