Storm Water Pollution Prevention - Source Controls

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This course was adapted from the EPA's Best Management Practice relating to the "Source Controls" section of the "Pollution Prevention/Good Housekeeping for Municipal Operations", which is in the public domain.

Pollution Prevention/Good Housekeeping for Municipal Operations

Regulatory Text

You must develop and implement an operation and maintenance program that includes a training component and has the ultimate goal of preventing or reducing pollutant runoff from municipal operations. Using training materials that are available from EPA, your State, Tribe, or other organizations, your program must include employee training to prevent and reduce storm water pollution from activities such as park and open space maintenance, fleet and building maintenance, new construction and land disturbances, and storm water system maintenance.

Guidance

EPA recommends that, at a minimum, you consider the following in developing your program: maintenance activities, maintenance schedules, and long-term inspection procedures for structural and nonstructural storm water controls to reduce floatables and other pollutants discharged from your separate storm sewers; controls for reducing or eliminating the discharge of pollutants from streets, roads, highways, municipal parking lots, maintenance and storage yards, fleet or maintenance shops with outdoor storage areas, salt/sand storage locations and snow disposal areas operated by you, and waste transfer stations; procedures for properly disposing of waste removed from the separate storm sewers and areas listed above (such as dredge spoil, accumulated sediments, floatables, and other debris); and ways to ensure that new flood management projects assess the impacts on water quality and examine existing projects for incorporating additional water quality protection devices or practices. Operation and maintenance should be an integral component of all storm water management programs. This measure is intended to improve the efficiency of these programs and require new programs where necessary. Properly developed and implemented operation and maintenance programs reduce the risk of water quality problems.

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Source controls

Pet Waste Collection

Pollution Prevention/Good Housekeeping for Municipal Operations

Description

Animal waste dispensers can increase waste collection by providing an convenient method for disposal

Pet waste collection as a source control involves using a combination of educational outreach and enforcement to encourage residents to clean up after their pets. The presence of pet waste in storm water runoff has a number of implications for urban stream water quality, with perhaps the greatest impact from fecal bacteria. According to recent research, nonhuman waste represents a significant source of bacterial contamination in urban watersheds. Genetic studies by Alderiso et al. (1996) and Trial et al. (1993) both concluded that 95 percent of fecal coliform found in urban storm water were of nonhuman origin. Bacterial source-tracking studies in a watershed in the Seattle, Washington, area also found that nearly 20 percent of the bacteria isolates that could be matched with host animals were matched with dogs. These bacteria can pose health risks to humans and other animals and result in the spread of disease. It has been estimated that for watersheds of up to 20 square miles draining to small coastal bays, 2 or 3 days of droppings from a population of about 100 dogs would contribute enough bacteria and nutrients to temporarily close a bay to swimming and shellfishing (USEPA, 1993).

Pet waste may also be a factor in the eutrophication of lakes. The release of nutrients from the decay of pet waste promotes weed and algae growth, limiting light penetration and the growth of aquatic vegetation. This situation, in turn, can reduce oxygen levels in the water, affecting fish and other aquatic organisms.

Pet waste collection programs use pet awareness and education, signs, and pet waste control ordinances to alert residents to the proper disposal techniques for pet droppings. In some parts of the country, the concept of parks or portions of parks established specifically for urban dog owners has gained in popularity. With provisions for proper disposal of dog feces and siting and design to address storm water runoff, these parks may represent another option for protecting local water quality.

Applicability

Pet ownership is not limited by factors such as region of the country, climate, or topography. For this reason, educational outreach regarding pet waste is appropriate throughout the country. In a survey of Chesapeake Bay residents, it was found that about 40 percent of households own a dog. Just about half of these dog owners actually walked their dog in public areas. Of the half that did walk their dog, about 60 percent claimed to pick up after their dog (Swann, 1999), which is generally consistent with other studies (Table 1). Men were found to be less prone to pick up after their dog than women were (Swann, 1999).

Residents seem to be of two minds when it comes to dog waste. While a strong majority agree that dog waste can be a water quality problem (Hardwick, 1997; Swann, 1999), they generally rank it as the least important local water quality problem (Syferd, 1995 and MSRC, 1997). This finding strongly suggests the need to dramatically improve watershed education efforts to increase public recognition about the water quality and health consequences of dog waste.

Table 1. A comparison of three resident surveys about cleaning up after dogs

Study	Survey Results
Maryland (HGIC, 1996)	• 62% always cleaned up after the dog, 23% sometimes, 15% never • Disposal method: trash can (66%), toilet (12%), other 22%
Washington (Hardwick, 1997)	• Pet ownership: 58% • 51% of dog owners do not walk dogs • 69% claimed that they cleaned up after the dog • 31% do not pick up • Disposal methods: trash can 54%, toilet 20%, compost pile 4% • 4% train pet to poop in own yard • 85% agreed that pet wastes contribute to water quality problems
Chesapeake Bay (Swann, 1999)	• Dog ownership: 41% • 44% of dog owners do not walk dogs • Dog walkers who clean up most/all of the time 59% • Dog walkers who never or rarely cleanup 41% • Of those who never or rarely clean up, 44% would not cleanup even with fine, complaints, or improved sanitary collection or disposal methods • 63% agreed that pet wastes contribute to water quality problems

Design Considerations

Programs to control pet waste typically use "pooper-scooper" ordinances to regulate pet waste cleanup. These ordinances require the removal and proper disposal of pet waste from public areas and other people's property before the dog owner leaves the immediate area. Often a fine is associated with failure to perform this act as a way to encourage compliance. Some ordinances also include a requirement that pet owners remove pet waste from their own property within a prescribed time frame.

Public education programs are another way to encourage pet waste removal. Often pet waste messages are incorporated into a larger non-point source message relaying the effects of pollution on local water quality. Brochures and public service announcements describe proper pet waste disposal techniques and try to create a storm drain-water quality link between pet waste and runoff. Signs in public parks and the provision of receptacles for pet waste will also encourage cleanup.

Another option for pet waste management could be the use of specially designated dog parks where pets are allowed off-leash. These parks typically include signs reminding pet owners to remove waste, as well as other disposal options for pet owners. The following management options have been used in Australian dog parks and could be incorporated for dog parks in the United States (Harlock Jackson et al., 1995):

- *Doggy loos*. These disposal units are installed in the ground and decomposition occurs within the unit. Minimal maintenance is required (no refuse collection).
- *Pooch patch*. A pole is placed in the park surrounded by a light scattering of sand. Owners are encouraged to introduce their dog to the pole on entry to the park. Dogs then return to the patch to defecate and special bins are provided in which owners then place the deposit.
- *The "Long Grass Principle."* Dogs are attracted to long grass for defecating and areas that are mowed less frequently can be provided for feces to disintegrate naturally. A height of around 10 cm (about 4 inches) is appropriate.

The design of these dog parks should be done to mitigate storm water impacts. The use of vegetated buffers, pooper-scooper stations, and the siting of parks out of drainageways, streams, and steep slopes will help control the impacts of dog waste on receiving waters.

Limitations

The reluctance of many residents to handle dog waste is the biggest limitation to controlling pet waste. According to a Chesapeake Bay survey, 44 percent of dog walkers who do not pick up indicated they would still refuse to pick up, even if confronted by complaints from neighbors, threatened with fines, or provided with more sanitary and convenient options for retrieving and disposing of dog waste. Table 2 provides factors that compel residents to pick up after their dog, along with some rationalizations for not doing so.

This strong resistance to handling dog wastes suggests that an alternative message may be necessary. One such example might be to encourage the practice of rudimentary manure management by training dogs to use areas that are not hydraulically connected to the stream or close to a buffer.

Table 2. Dog owners rationale for picking up or not picking up after their dog (Source: HGIC, 1996)

Reasons for not picking it up	Reasons for picking up
• because it eventually goes away • just because • too much work • on edge of my property • it's in my yard • it's in the woods • not prepared • no reason • small dog, small waste • use as fertilizer • sanitary reasons • own a cat or other kind of pet	• it's the law • environmental reasons • hygiene/health reasons • neighborhood courtesy • it should be done • keep the yard clean

Effectiveness

The pollutant removal abilities of pet waste collection programs has never been quantified. There is ample evidence that programs such as these are required in urban areas. For example, in the Four Mile Run watershed in Northern Virginia, a dog population of 11,400 is estimated to contribute about 5,000 pounds of solid waste every day and has been identified as a major contributor of bacteria to the stream. Approximately 500 fecal coliform samples have been taken from Four Mile Run and its tributaries since 1990, and about 50 percent of these samples have exceeded the Virginia State water quality standard for fecal coliform bacteria (NVRC, 2001). A project is currently underway to pinpoint the source of bacterial contamination through DNA fingerprinting.

There is plenty of evidence that pets and urban wildlife can be significant bacterial sources. According to van der Wel (1995) a single gram of dog feces can contain 23 million fecal coliform bacteria. Dogs can also be significant hosts of both *Giardia* and *Salmonella* (Pitt, 1998). A 1982 study of Baltimore, Maryland, catchments reported that dog feces were the single greatest contributor of fecal coliform and fecal strep bacteria (Lim and Olivieri, 1982). This evidence points to a need for enforcement and education to raise resident awareness regarding the water quality impacts of this urban pollutant source.

Cost Considerations

The cost of pet waste collection programs will vary depending on the intensity of the effort and the paths chosen to control pet waste. The most popular way is through an ordinance, but managers must consider the cost of enforcement, including staff and equipment requirements. Public education program costs are determined by the type of materials produced and the method of distribution selected. Signs in parks may initially have a higher cost than printed materials, but can last for many years. Signs may also be more effective because they act as on-site reminders to dog owners to clean up in parks.

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Automobile Maintenance

Pollution Prevention/Good Housekeeping for Municipal Operations

Description

This pollution prevention measure involves creating a program of targeted outreach and training for businesses and municipal fleets (public works, school buses, fire, police, and parks) involved in automobile maintenance about practices that control pollutants and reduce storm water impacts. Automotive maintenance facilities are considered to be storm water "hot spots" where significant loads of hydrocarbons, trace metals, and other pollutants can be produced that can affect the quality of storm water runoff. Some of the waste types generated at automobile maintenance facilities and at homes of residents performing their own car maintenance include the following:

Improper disposal of pollutants from automobile maintenance can be prevented by taking used antifreeze to designated waste collection facilities

- Solvents (paints and paint thinners)
- Antifreeze
- Brake fluid and brake lining
- Batteries
- Motor oils
- Fuels (gasoline, diesel, kerosene)
- Lubricating grease.

Estimates show that each year over 180 million gallons of used oil is disposed of improperly (Alameda CCWP, 1992) and that a single quart of motor oil can pollute 250,000 gallons of drinking water (DNREC, 1994). For this reason, automotive maintenance facilities' discharges to storm and sanitary sewer systems are highly regulated. Fluid spills and improper disposal of materials result in pollutants, heavy metals, and toxic materials entering ground and surface water supplies, creating public health and environmental risks. Alteration of practices involving the cleanup and storage of automotive fluids and cleaning of vehicle parts can help reduce the influence of automotive maintenance practices on storm water runoff and local water supplies.

Applicability

The automotive repair industry is the leader in number of generators and amount of total waste produced for small quantity generators of hazardous waste in the United States (USEPA, 1985). Common activities at maintenance shops that generate this waste include the cleaning of parts, changing of vehicle fluids, and replacement and repair of equipment. These activities are also performed by residents at home in their driveway in the course of normal vehicle care. Since the use of automobiles is not limited by geographic or climatic conditions, maintenance facilities are present nationwide and the concerns involving waste created during vehicle repair are similar across the country. In ultra-urban areas, the impacts of automotive maintenance practices are more pronounced due to the greater concentrations of vehicles and higher levels of impervious surface.

Design Considerations

The most effective way to minimize the impacts of automotive maintenance generated waste is by preventing its production. Pollution prevention programs seeking to reduce liquid discharges to sewer and storm drains from automotive maintenance should stress techniques that allow facilities to run a dry shop. Among the suggestions for creating a dry operation are the following:

- Spills should be cleaned up immediately, and water should not be used for clean up whenever possible.
- Floor drains that are connected to the sanitary sewer should be sealed off.
- A solvent service might be hired to supply parts and cleaning materials, and to collect the spent solvent.

Those facilities that are not able to eliminate discharges to the sanitary sewer system may be required to treat their wastewater prior to release from the site. There are several methods for preventing untreated wastewater from entering storm water runoff. Some municipalities require the use of structural treatment devices to pretreat wastes before they are discharged for treatment at sewage treatment plants. These devices prevent oils and grease from entering the sewer system, often by separating the oil and solids from the water through settling or filtration.

Other methods are also available to help prevent or reduce the discharge of pollutants from vehicle maintenance. Table 1 lists some of the common suggestions found regarding practices that can reduce vehicle maintenance and repair impacts. Many of these practices apply both to business owners and to residents who maintain their own vehicles. Additionally, these practices also apply to maintaining municipal fleets, including school buses, public works, fire, police, parks, and other types of municipal fleets. This list is not comprehensive, and many other suggestions for reducing impacts are available to those responsible for managing storm water runoff from maintenance facilities.

Table 1. Recommendations for reducing the storm water impacts of automotive maintenance

Pollution Prevention Method	Suggested Activities
Waste Reduction	• The number of solvents used should be kept to a minimum to make recycling easier and to reduce hazardous waste management cost. • Do all liquid cleaning at a centralized station to ensure that solvents and residues stay in one area. • Locate drip pans and draining boards to direct solvents back into solvent sink or holding tank for reuse.
Using Safer Alternatives	• Use non-hazardous cleaners when possible. • Replace chlorinated organic solvents with nonchlorinated ones like kerosene or mineral spirits. • Recycled products such as engines, oil, transmission fluid, antifreeze, and hydraulic fluid can be purchased to support the market of recycled products.
Spill Clean Up	• Use as little water as possible to clean spills leaks, and drips. • Rags should be used to clean small spills, dry absorbent material for larger spills, and a mop for general cleanup. Mop water can be disposed of via the sink or toilet to the sanitary sewer.
Good Housekeeping	• Employee training and public outreach are necessary to reinforce proper disposal practices. • Conduct maintenance work such as fluid changes indoors. • Update facility schematics to accurately reflect all plumbing connections. • Parked vehicles should be monitored closely for leaks and pans placed under any leaks to collect the fluids for proper disposal or recycling. • Promptly transfer used fluids to recycling drums or hazardous waste containers. • Do not pour liquid waste down floor drains, sinks, or outdoor storm drain inlets. • Obtain and use drain mats to cover drains in the event of a spill. • Store cracked batteries in leakproof secondary containers.
Parts Cleaning	• Use detergent-based or water-based cleaning systems instead of organic solvent degreasers. • Steam cleaning and pressure washing may be used instead of solvent parts cleaning. The wastewater generated from steam cleaning can be discharged to the on-site oil/water separator.

Limitations

There are a number of limitations to implementing recommendations for automotive maintenance facilities. Space and time constraints may make performing work indoors unfeasible. Containment of spills from vehicles brought on-site after working hours may not be possible. Proper disposal education for employees must continually be updated. Installation of structural BMPs for pretreatment of wastewater discharges can be expensive. Prices for recycled materials and fluids may be higher than those of non-recycled materials. Some facilities can be limited by a lack of providers of recycled materials and by the absence of businesses to provide services such as hazardous waste removal, structural BMP maintenance, or solvent recycling equipment.

Maintenance Considerations

For facilities responsible for pretreating their wastewater prior to discharging, the proper functioning of structural BMPs is an important maintenance consideration. Routine cleanout of oil and grease is required for the devices to maintain their effectiveness, usually at least once a month. During periods of heavy rainfall, cleanout is required more often to ensure that pollutants are not washed through the trap. Sediment removal is also required on a regular basis to keep the device working efficiently.

Effectiveness

The effectiveness of automotive maintenance best management practices at removing pollutants is difficult to quantify. However, there are studies that demonstrate the effect pollution prevention practices can have in reducing impacts from automotive fluids. A 1994 study of auto recycling facilities demonstrates the effect that using best management practices can have on reducing storm water toxicity and pollutant loads. Through the use of structural and nonstructural BMPs, the study facility was able to reduce concentrations of lead, oil, and grease to levels approaching USEPA benchmarks.

A program that has had great success in controlling contaminated flows from vehicle maintenance facilities is the Clean Bay Business Program in Palo Alto, California. In exchange for allowing inspectors to visit a facility once a year and implementing recommended management practices, the facility is designated as a Clean Bay Business. This entitles the facility to promotional tools like listings twice a year in full-page newspaper ads, decals for shop windows, and other Clean Bay Business materials. Other promotions involving prize drawings and discount coupon giveaways help generate business for the facilities in the program. The effectiveness of the program at creating behavioral changes is evident in the increase in the number of facilities that have received the Clean Bay Business designation. In 1992 when the program began, only 4 percent of businesses used all of the recommended management practices. By 1998, 94 percent of businesses had instituted the practices suggested (NRDC, 1999).

The effectiveness of those programs aimed at altering behaviors detrimental to storm water is impressive. After participation in the program, the changes facilities made had the following impacts:

- 78 direct discharges to storm drains were eliminated by ceasing or modifying the practices used for activities such as parking lot cleaning, vehicle washing, and wet sanding.
- Violations of storm drain protection requirements fell by 90 percent from 1992 through 1995.
- The number of shops conducting outdoor removal of vehicle fluids without secondary containment fell from 43 to 4.

Cost Considerations

The initial per-facility cost for the program was approximately $300, with a cost of $150 for each subsequent year. This cost includes inspector visits and follow-up work, outreach materials, mailing lists, and database management. The program has been expanded to include auto parts stores and outreach to local high schools and adult education repair classes.

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Vehicle Washing

Pollution Prevention/Good Housekeeping for Municipal Operations

Description

Using commercial car wash facilities can reduce storm water impacts caused by car washing because such facilities must treat their wash water discharges before release

This management measure involves educating the general public, businesses, and municipal fleets (public works, school buses, fire, police, and parks) on the water quality impacts of the outdoor washing of automobiles and how to avoid allowing polluted runoff to enter the storm drain system. Outdoor car washing has the potential to result in a high loads of nutrients, metals, and hydrocarbons during dry weather conditions in many watersheds, as the detergent-rich water used to wash the grime off our cars flows down the street and into the storm drain. Commercial car wash facilities often recycle their water or are required to treat their wash water discharge prior to release to the sanitary sewer system, so most storm water impacts from car washing are from residents, businesses, and charity car wash fundraisers that discharge polluted wash water to the storm drain system. According to the surveys, 55 to 70 percent of households wash their own cars, with the remainder going to a commercial car wash. Sixty percent of residents could be classified as "chronic car-washers" who wash their cars at least once a month (Smith, 1996, and Hardwick, 1997). Between 70 and 90 percent of residents reported that their car wash water drained directly to the street and, presumably, to the nearest stream. It has been estimated that 25 percent of the population of the United States may be classified as chronic car washers, which translates into about 27 million potential residential car wash polluters (Center for Watershed Protection, 1999).

Applicability

Car washing is a common routine for residents and a popular way for organizations such as scout troops, schools, and sports teams to raise funds. This activity is not limited by geographic region, but its impact on water quality is greatest in more urbanized areas with higher concentrations of automobiles. Currently, only a few pollution prevention programs incorporate proper car washing practices as part of an overall message to residents on ways to reduce nonpoint source pollution. Other programs have extended this message to include charity car washes and provide these charity groups with equipment and training to alleviate the problems associated with polluted wash water entering the storm drain system.

Implementation

The development of a prevention program to reduce the impact of car wash runoff includes outreach on management practices to reduce discharges to storm drains. Some of these management practices include the following:

- Using a commercial car wash.
- Washing cars on gravel, grass, or other permeable surfaces.
- Blocking off the storm drain during charity carwash events or using a insert to catch wash water.
- Pumping soapy water from car washes into a sanitary sewer drain.
- If pumping into a drain is not feasible, pumping car wash water onto grass or landscaping to provide filtration.
- Using hoses with nozzles that automatically turn off when left unattended.
- Using only biodegradable soaps.

Storm drain stenciling programs (see the Storm Drain Stenciling fact sheet) emphasizing the connection between the storm drain system and runoff can also help reinforce the idea that car washing activities can affect local water quality.

In the Pacific Northwest, outreach programs provide materials to charity carwash organizers to prevent car wash water from entering storm drains. These "water friendly "carwash kits are provided free of charge to charity organizers, along with training and educational videos on planning an environmentally friendly carwash. Two types of equipment are available for charity organizations to borrow: a catch-basin insert with a sump pump, or a vacuum/boom device known as a Bubble Buster (Kitsap County, 1999). Both devices capture wash water runoff, allowing it to be pumped to either a sanitary sewer or a vegetated area for treatment.

For businesses, good housekeeping practices can minimize the risk of contamination from wash water discharges. The following are some general best management practices that those businesses with their own vehicle washing facilities can incorporate to control the water quality impacts of wash water discharges:

- All vehicle washing should be done in areas designed to collect and hold the wash and rinse water or effluent generated. Wash water effluent should be recycled, collected, or treated prior to discharge to the sanitary sewer system.
- Pressure cleaning and steam cleaning should be done off-site to avoid generating runoff with high pollutant concentrations. If done on-site, no pressure cleaning and steam cleaning should be done in areas designated as wellhead protection areas for public water supply.
- On-site storm drain locations should be mapped to avoid discharges to the storm drain system.
- Spills should be immediately contained and treated.

Limitations

The biggest limitation to implementing residential car wash best management practices may be the lack of knowledge regarding the impacts of polluted runoff. Many people do not associate the effects of their vehicle washing activities with local water quality and may be unaware that the discharges that enter storm drains are not treated at plants before being discharged into local waters. Surveys indicate that the average citizen does not fully understand the hydrologic connection between their yard, the street, the storm sewer, and the streams. For example, a recent Roper survey found that just 22 percent of Americans know that storm water runoff is the most common source of pollution of streams, rivers, and oceans (NEETF, 1999).

Most car washing best management practices are inexpensive and rely more on good housekeeping practices than on expensive technology. However, the construction of a specialized area for vehicle washing can be expensive for businesses. Also, for facilities that cannot recycle their wash water, the cost of pretreating wash water, through either structural practices or planning for collection and hauling of contaminated water to sewage treatment plants, can represent a cost limitation.

Effectiveness

The effectiveness of car washing management practices at reducing nonpoint source pollutant loads has yet to be measured accurately. Due to the diffuse nature of nonpoint source pollution, it is often difficult to determine the exact impact of a particular pollution prevention measure at reducing pollutant loading. While not much is known about the water quality of car wash water, it is clear that car washing is a common watershed behavior. Three recent surveys have asked residents where and how frequently they wash their cars (Table 2).

Table 2. A comparison of three surveys about car washing.

Study	Car Washing Behavior
Smith, 1996 Maryland	60% washed car more than once a month
Pellegrin, 1998 California	73% washed their own cars 73% report that wash-water drains to pavement
Hardwick, 1997 Washington	56% washed their own cars 44% used a commercial car wash 91% report that wash-water drains to pavement 56% washed car more than once a month 50% would shift if given discounts or free commercial car washes

Residents are typically not aware of the water quality consequences of car washing and do not understand the chemical content of the soaps and detergents they use. Car washing is a very difficult watershed behavior to change since it is often hard to define a better alternative. However, as with all pollution prevention measures, the reduction of pollutant loads from outdoor car washing activities are bound to have a positive effect on storm water quality.

Cost Considerations

Staffing and materials represent the largest expenditure for local governments seeking to administer a nonpoint source education program. Car wash outreach programs are relatively inexpensive to staff and often require only a limited outlay for materials (brochures, training videos, etc.), and staff time devoted specifically to car wash education can be less than 5 percent of an employee's time. For Kitsap County, Washington, the Sound Car Wash program requires roughly 10 to 15 hours a week of staff time over a 25-week period from April to September. Cost for materials and equipment replacement is estimated to be between $1,500 and $3,000 for the same 25-week period (Kitsap County, 1999). The Clean Bay Car Wash kits program in Tacoma, Washington, uses only the catch basin insert option and estimates that it spends no more than $2,000 per year and less than 2 weeks of staff time per year to handle requests for its program (Tacoma Stormwater Utility, 1999).

The purchase of wash water containment equipment is often a one-time expense, and this equipment is often used for a number of years. Two pieces of equipment used in car wash programs developed in the Pacific Northwest provide an example of the potential equipment cost. For the catch-basin insert, the approximate cost of installation is $65. In some cases, locations where charity car washes are frequently held have constructed their own catch basin inserts using plywood. For the Bubble Buster, the cost ranges from $2,000 to $2,500.

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Illegal Dumping Control

Pollution Prevention/Good Housekeeping for Municipal Operations

Description

Illegal dumping control as a management practice involves using public education to familiarize residents and businesses with how illegal dumping can affect storm water. By locating and correcting illegal dumping practices through education and enforcement measures, the many risks to public safety and water quality associated with illegal disposal actions can be prevented. For storm water managers, illegal dumping control is important to preventing contaminated runoff from entering wells and surface water, as well as averting flooding due to blockages of drainage channels for runoff.

Signs can be used to discourage dumping in sensitive areas (Source: NCDENR, 2000)

Several types of illegal dumping can occur. The first is the illegal dumping (also known as "open dumping," "fly dumping," or "midnight dumping") of litter that occurs at abandoned industrial, commercial, or residential buildings, vacant lots, and poorly lit areas such as rural roads and railway lines. This dumping primarily happens to avoid disposal fees or the time and effort required for proper disposal at landfills or recycling facilities. A second type of illegal dumping involves disposal of water that has been exposed to industrial activities and then released to the storm drainage system, introducing pollutants into storm water runoff.

Applicability

Illegal dumping can occur in both urban and rural settings and can happen in all geographic regions. The effects of illegal dumping may be more pronounced in areas with heavier rainfall, due to the greater volume of runoff. In more urbanized areas, illegal dumping may occur due to inaccessibility of recycling or solid waste disposal centers, which are often located on the suburban-rural fringe.

Design Considerations

Illegal dumping control programs focus on community involvement and targeted enforcement to eliminate or reduce illegal dumping practices. The key to successfully using this BMP is increasing public awareness of the problem and its implications. Illegal dumping control programs use a combination of public education, citizen participation, site maintenance, and authorized enforcement measures to address illegal waste disposal. Some of the issues that need to be examined when creating a program include the following:

- The locations of persistent illegal dumping activity
- Types of waste dumped and the profile of dumpers
- Possible driving forces behind illegal dumping, such as excessive user fees, restrictive curbside trash pickup, or ineffective recycling programs

- Previous education and cleanup efforts
- Current control programs and local laws or ordinances addressing the problem
- Sources of funding and additional resources that may be required.

Effective illegal dumping control programs use practices that educate and involve the community, local industries, and elected officials in an effort to eliminate the illegal discarding of wastes. An EPA toolkit for preventing illegal dumping focuses on four programmatic areas (USEPA 1998):

1. <u>Cleanup efforts</u>

Cleanup projects will require a coordinated planning effort to ensure that adequate resources and funding are available. Once a site has been cleaned, signs, lighting, or barriers may be required to discourage future dumping. Signs should indicate the fines and penalties for illegal dumping, and a phone number for reporting incidents. Landscaping and beautification efforts might also discourage future dumping, as well as providing open space and increasing property values.

2. <u>Community Outreach and Involvement</u>

This might be the most important tool in ensuring that this best management practice is effective. The organization of special cleanup events where communities are provided with the resources to properly dispose of illegally dumped materials increases the understanding among residents of illegal dumping impacts and supplies opportunities to correctly dispose of materials which may otherwise be illegally dumped. Integration of illegal dumping prevention into community policing programs or use of programs such as Crimestoppers may also be an effective way to increase enforcement opportunities without the additional cost of hiring new staff. Producing simple messages relating the cost of illegal dumping on local taxes, and directions to proper disposal sites will aid in eliminating the problem. Having a hotline where citizens can report illegal activities and educating the public on the connection between the storm drain and water quality will decrease disposal of waste into storm drain inlets.

3. <u>Targeted Enforcement</u>

This tool involves the use of ordinances to regulate waste management and eliminate illegal dumping through methods such as fines, cost recovery penalties for cleanup, and permit requirements for waste management activities. These fines and penalties can be used to help fund the prevention program or to provide rewards to citizens who report illegal dumping activities. Other recommendations for this tool include training of staff from all municipal departments in recognizing and reporting illegal dumping incidents, and dedicating staff who have the authority to conduct surveillance and inspections and write citations for those caught illegally dumping.

4. <u>Tracking and Evaluation</u>

This tool measures the impact of prevention efforts and determines if goals are being met. Using mapping techniques and computer databases allows officials to identify areas where dumping most often occurs, record patterns of dumping occurrence (time of day, day of week, etc.), and calculate the number of citations issued to the responsible parties. This allows for better allocation of resources and more specific targeting of outreach and education efforts for offenders.

Limitations

Illegal dumping is often spurred by cost and convenience considerations, and a number of factors encourage this practice. The cost of fees for dumping at a proper waste disposal facility are often more than the fine for an illegal dumping offense, thereby discouraging people from complying with the law. The absence of routine or affordable pickup service for trash and recyclables in some communities also encourages illegal dumping. A lack of understanding regarding applicable laws or the inadequacy of existing laws may also contribute to the problem.

Municipalities can coordinate with state and federal agencies to help enforce illegal dumping control measures when resources such as funding and staff for enforcement activities are scarse.

Effectiveness

While the effectiveness of illegal dumping control measures at removing pollutant loads to local waters is hard to quantify, there are numbers to demonstrate the preventative effects these programs have in keeping waste from illegal dump sites and ultimately from storm water runoff. Some examples follow:

- The City/County of Spokane, Washington, Litter Control program is responsible for removing indiscriminate dumping on publicly owned properties and road right-of-ways. The program is estimated to remove 350 tons of illegally dumped material each year.
- Project HALT in Phoenix, Arizona, cleaned up a reported 15,000 tons of waste in 1996 and 1997 and issued more than 165 citations.
- The "Tire Roundup" program sponsored by the Southwest Detroit Environmental Visions community organization pays local residents to bring in illegally dumped tires. In 1995, residents were paid 25 cents per tire, and more than 8,000 tires were collected.

Illegal dumping of household and commercial waste has a variety of impacts on water quality. Hazardous chemicals generated from household, commercial, and industrial sources can contaminate ground and surface water supplies, affecting drinking water and public health as well as aquatic habitat. Reduced drainage of runoff due to blockage of streams, culverts and drainage basins can result in flooding and channel modification. Open burning associated with some illegal sites can cause forest fires that create severe erosion and cause sediment loading in streams. Economically, property values decrease as a result of illegal dumping and affect the local tax base and the ability to maintain pollution prevention programs.

Cost Considerations

The cost of illegal dumping control program activities can vary due to economic and social factors, but with creative thinking potential costs may be reduced. Possible sources of labor for dumping site cleanups can include community and youth groups, county or state corrections programs, or corporations. Equipment for cleanup may be available through either public works or transportation agencies or through donations by private companies. Training municipal staff to report incidents of illegal dumping witnessed during the performance of other duties reduces the need for full-time staff for the program.

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Landscaping and Lawn Care

Pollution Prevention/Good Housekeeping for Municipal Operations

Description

Applying too much lawn fertilizer can significantly contribute to water quality problems

This management measure seeks to control the storm water impacts of landscaping and lawn care practices through education and outreach on methods that reduce nutrient loadings and the amount of storm water runoff generated from lawns. Research has indicated that nutrient runoff from lawns has the potential to cause eutrophication in streams, lakes, and estuaries (CWP, 1999a, and Schueler, 1995a). Nutrient loads generated by suburban lawns as well as municipal properties can be significant, and recent research has shown that lawns produce more surface runoff than previously thought (CWP, 1999b). Pesticide runoff (see Pest Control fact sheet) can contribute pollutants that contaminate drinking water supplies and are toxic to both humans and aquatic organisms.

Landscaping, lawn care, and grounds maintenance are a big business in the United States. It has been estimated that there are 25 to 30 million acres of turf and lawn in the United States (Robert and Roberts, 1989, Lawn and Landscape Institute, 1999). If lawns were classified as a crop, they would rank as the fifth largest in the country on the basis of area, after corn, soybeans, wheat, and hay (USDA, 1992). In terms of fertilizer inputs, nutrients are applied to lawns at about the same application rates as those used for row crops (Barth, 1995a). The urban lawn is also estimated to receive an annual input of 5 to 7 pounds of pesticides per acre (Schueler, 1995b).

Not many residents understand that lawn fertilizer can cause water quality problems overall, less than one-fourth of residents rated it as a water quality concern (Syferd, 1995 and Assing, 1994), although ratings were as high as 60 percent for residents who lived adjacent to lakes (Morris and Traxler, 1996, and MCSR, 1997). Interestingly, in one Minnesota survey, only 21 percent of homeowners felt their own lawn contributed to water quality problems, while over twice as many felt that their neighbors' lawns did (MCSR, 1997). Unlike farmers, suburban and rural landowners are often ignorant of the actual nutrient needs of their lawns. According to surveys, only 10 to 20 percent of lawn owners take the trouble to take soil tests to determine whether fertilization is even needed (CWP, 1999). The majority of lawn owners are not aware of the phosphorus or nitrogen content of the fertilizer they apply (Morris and Traxler, 1996) or that mulching grass clippings into lawns can reduce or eliminate the need to fertilize. Informing residents, municipalities, and lawn care professionals on methods to reduce fertilizer and pesticide application, limit water use, and avoid land disturbance can help alleviate the potential impacts of a major contributor of nonpoint source pollution in residential communities.

Applicability

Lawn care, landscaping, and grounds maintenance are done in all parts of the country, in all types of climates, and in every type of community from rural to urban. Lawn fertilization is one of the most widespread watershed practices conducted by homeowners. In a survey of resident attitudes in the Chesapeake Bay, 89 percent of residents owned a yard, and of these, about 50 percent applied fertilizer every year (Swann, 1999). The average rate of fertilization in 10 other resident surveys was even higher, at 78 percent, although this could reflect the fact that these surveys were biased toward predominantly suburban neighborhoods, or excluded non-lawn owners. Because lawn care, landscaping, and grounds maintenance are such common practices, education programs for both residents, municipalities, and lawn care professionals on reducing the storm water impacts of these practices are an excellent way to improve local water quality.

Design Considerations

Designers of education programs that seek to change the impacts of fertilizer, pesticide, and herbicide use on receiving water quality should first consider creating training programs for those involved in the lawn care industry. Nationally, lawn care companies are used by 7 to 50 percent of consumers, depending on household income and lot size. Lawn care companies can exercise considerable authority over which practices are applied to the lawns they tend, as long as they still produce an attractive lawn. For example, 94 percent of lawn care companies reported that they had authority to change practices, and that about 60 percent of their customers were "somewhat receptive to new ideas", according to a Florida study (Israel et al., 1995). De Young (1997) also found that suburban Michigan residents expressed a high level of trust in their lawn care company.

Local governments that want to influence lawn care companies must have an active program that supports those companies that employ techniques to limit fertilizer and pesticide use to the minimum necessary to maintain a green lawn. One way to do this is through providing promotional opportunities. One example is the state of Virginia Water Quality Improvement program that includes the chance for lawn care professionals to enter into an agreement to use more environmentally friendly lawn care practices. In exchange, the lawn care company can use their participation in the program as a promotional tool (VA DCR, 1999). Providing certification for representatives from lawn care companies for attending training workshops put on by cooperative extension offices can also be an effective promotional tool.

Training for employees of lawn and garden centers is another important tool in spreading the message regarding lawn care and pollution control. Many studies indicate that product labels and store attendants are the primary and almost exclusive source of lawn care information for the average consumer who takes care of their own lawn. The Florida Yards and Neighbors program has worked with 19 stores of a large national hardware and garden chain to educate store employees and incorporate messages regarding fertilizer use and pesticide reduction (NRDC, 1999). Often the key strategy to implementing a program like this is to substitute watershed-friendly products for those that are not, and to offer training for the store attendants at the point of sale on how to use and, perhaps more importantly, how not to abuse or overuse such products.

A recent Center for Watershed Protection (CWP) survey of 50 nutrient education programs provides a number of tips to program managers on making outreach programs more effective. The results of the study showed that there were a number of important considerations for increasing the recall and implementation of pollution prevention messages. Table 1 provides some tips that appear to work the best at relaying pollution prevention messages and changing pollution-producing behaviors.

Table 1. Tips for creating more effective resident lawn care outreach programs

Tip 1: *Develop a stronger connection between the yard, the street, the storm, and the stream*.	Outreach techniques should continually stress the link between lawn care and the undesirable water quality it helps to create (e.g., algae blooms and sedimentation).
Tip 2: *Form regional media campaigns*.	Since most communities operate on small budgets, they should consider pooling their resources to develop regional media campaigns that can use the outreach techniques that are proven to reach and influence residents. In particular, regional campaigns allow communities to hire the professionals needed to create and deliver a strong message through the media. Also, the campaign approach allows a community to employ a combination of media, such as radio, television, and print, to reach a wider segment of the population. It is important to keep in mind that since no single outreach technique will be recalled by more than 30 percent of the population at large, several different outreach techniques will be needed in an effective media campaign.
Tip 3: *Use television wisely*.	Television is the most influential medium for influencing the public, but careful choices need to be made on the form of television that is used. The CWP survey found that community cable access channels are much less effective than commercial or public television channels. Program managers should consider using cable network channels targeted for specific audiences, and develop thematic shows that capture interest of the home, garden and lawn crowd (e.g., shows along the lines of "Gardening by the Yard"). Well-produced public service announcements on commercial television are also a sensible investment.

Table 1. Tips for creating more effective resident lawn care outreach programs (Continued)

Tip 4: *Keep messages simple and funny*.	Watershed education should not be preachy, complex, or depressing. Indeed, the most effective outreach techniques combine a simple and direct message with a dash of humor.
Tip 5: *Make information packets small, slick, and durable*.	Educators continually struggle about how to impart the detailed information to residents on how to really practice good lawn care behaviors, without losing their interest. One should avoid creating a ponderous and boring handbook. One solution is to create small, colorful and durable packets that contain the key essentials about lawn care behaviors, and direct contact information to get better advice. These packets can be stuck on the refrigerator, the kitchen drawer or the workbench for handy reference when the impulse for better lawn care behavior strikes.
Tip 6: *Understand the demographics of your watershed*.	Knowing the unique demographics of a watershed allows a program manager to determine what outreach techniques are likely to work for that particular area. For example, if some residents speak English as a second language, a certain percentage of outreach materials should be produced in their native language. Similarly, watershed managers should consider more direct channels to send watershed messages to reach particular groups, such as through church leaders or ethnic-specific newspapers and television channels.

Pollution prevention programs may also wish to incorporate a much stronger message that promotes a low- or zero-input lawn. Watershed education programs might strongly advocate no chemical fertilization, reduced turf area, and the use of native plants adapted to the ecoregion (Barth, 1995b). This message provides a balance to the pro-fertilization message that is marketed by the lawn care industry.

Program managers need to incorporate some method for evaluating the effectiveness of their programs at reaching residents. Many programs use "before and after" market surveys to provide information on the level of understanding of residents and the percentage of residents that implement good lawn care practices. These surveys provide insights on what outreach techniques work best for a community and the level of behavior change that can be expected.

Alternative landscaping techniques such as naturescaping and xeriscaping can also be used. *Xeriscaping* is considered to be a viable alternative to the high water requirements of typical landscaping. It is a form of landscaping that conserves water and protects the environment. Xeriscaping does not result in landscaping with cactus and rock gardens. Rather, cool, green landscapes can be used when they are maintained with water-efficient practices. The main benefit of xeriscaping is that it reduces water use (TAMU, 1996). Xeriscaping incorporates seven basic principles that reduce water use (NYDEP, 1997):

- *Planning and design*. Consider drainage, light, and soil conditions; desired maintenance level; which existing plants will remain; plant and color preferences; and budget.

- *Soil improvement*. Mix peat moss or compost into soil before planting to help the soil retain water. Use terraces and retaining walls to reduce water run-off from sloped yards.
- *Appropriate plant selection*. Choose low-water-using flowers, trees, shrubs, and groundcovers. Many of these plants need watering only in the first year.
- *Practical lawns.* Limit the amount of grass area. Plant groundcovers or add hard surface areas like decks, patios, or walkways. If replanting lawns, use drought-tolerant grass seed mixes.
- *Efficient irrigation*. Install drip or trickle irrigation systems, as they use water efficiently.
- *Effective use of mulches*. Use a 3-inch deep layer of mulches such as pine needles or shredded leaves or bark. This keeps soil moist, prevents erosion, and smothers weeds.
- *Appropriate maintenance*. Properly timed fertilizing, weeding, pest control, and pruning will preserve the beauty of the landscape and its water efficiency.

Naturescaping is a way of putting native plants and beneficial wildlife habitat back into your yard or community. It is also a beautiful way to conserve water and energy, reduce pollution of water and soil, and create habitat for wildlife. Native plants are the foundation of naturescaping. The plants that evolved in your region are well adapted to our climate and naturally resistant to local pests and diseases. Once established, natives can often survive on rainwater alone. Naturescaping areas can include replacing some lawn area with a wildflower meadow; hummingbird and butterfly garden, plants and trees selected for seeds, fruit, and nectar; and nesting boxes.

When creating a naturescape, it is important to include four elements: food, water, shelter, and adequate space. When creating a naturescape in your yard or community, keep in mind these steps:

- Visit "wild" places and naturescaped sites and imagine how these landscapes would fit in your yard or community.
- Educate yourself and your community. Learn about native plants and basic design and care concepts. You can attend workshops and read plant and design books.
- When you are ready to develop a site plan, choose a small viewable site. When planning, consider maintenance water, gardening, access to feeders. Know the existing conditions of the area shade/sun, wet/dry, wind patterns, drainage, existing plants and critters. Once you develop a plan and you have gotten any necessary permits, you are ready to gather your material and begin.

A local government can meet with local neighborhood and creek groups to promote community naturescaping, host naturescaping workshops, and establish naturescaping demonstration sites in neighborhoods, and can offer naturescaping assistance to many residential, business, and public projects.

Integrated Pest Management (IPM) is an effective and environmentally sensitive approach to pest management that relies on a combination of common-sense practices. IPM programs use current, comprehensive information on the life cycles of pests and their interaction with the environment. This information, in combination with available pest control methods, is used to manage pest damage by the most economical means, and with the least possible hazard to people, property, and the environment.

The IPM approach can be applied to both agricultural and nonagricultural settings, such as the home, garden, and workplace. IPM takes advantage of all appropriate pest management options, including -- but not limited to -- the judicious use of pesticides. In contrast, *organic* food production applies many of the same concepts as IPM but limits the use of pesticides to those that are produced from natural sources, as opposed to synthetic chemicals.

IPM is not a single pest control method but, rather, a series of pest management evaluations, decisions, and controls. Integrated pest management is a sustainable approach to managing pests by combining biological, cultural, physical, and chemical tools. Municipalities can encourage homeowners to practice IPM and train/encourage municipal maintenance crews to use these techniques for managing public green areas. There are many methods and types of integrated pest management, including the following:

- Mulching can be used to prevent weeds where turf is absent, fencing installed to keep rodents out, and netting used to keep birds and insects away from leaves and fruit.
- Visible insects can be removed by hand (with gloves or tweezers) and placed in soapy water or vegetable oil. Alternatively, insects can be sprayed off the plant with water or in some cases vacuumed off of larger plants.
- Store-bought traps, such as species-specific, pheromone-based traps or colored sticky cards, can be used.
- Sprinkling the ground surface with abrasive diatomaceous earth can prevent infestations by soft-bodied insects and slugs. Slugs also can be trapped in small cups filled with beer that are set in the ground so the slugs can get in easily.
- In cases where microscopic parasites, such as bacteria and fungi, are causing damage to plants, the affected plant material can be removed and disposed of. (Pruning equipment should be disinfected with bleach to prevent spreading the disease organism.)
- Small mammals and birds can be excluded using fences, netting, tree trunk guards.
- Beneficial organisms, such as bats, birds, green lacewings, ladybugs, praying mantis, ground beetles, parasitic nematodes, trichogramma wasps, seedhead weevils, and spiders that prey on detrimental pest species can be promoted.

Limitations

The overriding public desire for green lawns is probably the biggest impediment to limiting pollution from this source. For example, when residents were asked their opinions on more than 30 statements about lawns in a Michigan survey, the most favorable overall response was to the statement "a green, attractive lawn is an important asset in a neighborhood" (De Young, 1997). Nationally, homeowners spend about $27 billion each year to maintain their own yard or to pay someone else to do it (PLCAA, 1999). In terms of labor, a majority of homeowners spend more than an hour a week taking care of the lawn (Aveni, 1994, De Young, 1997). Convincing residents that a nice, green lawn can be achieved without using large amounts of chemicals and fertilizers is difficult when conventional lawn care techniques are often seen as more effective, less time-consuming, and more convenient.

Effectiveness

The effectiveness of pollution prevention programs designed to educate residents on lawn care and landscaping practices has not been well documented to date. However, the need for such programs is evident. Source area monitoring in Marquette, Michigan, found that nitrogen and phosphorus concentrations in residential lawn runoff were 5 to 10 times higher than from any other source area (CWP, 1999). This report confirms earlier Wisconsin research findings that residential lawns yielded the highest phosphorus concentrations of 12 urban pollutant sources examined (Bannerman et al, 1993).

A critical step in crafting an education program is to select the right outreach techniques to send the lawn care message. From the results of a number of market surveys, two outreach techniques have shown some promise in actually changing behavior -- media campaigns and intensive training. Media campaigns typically use a mix of radio, TV, direct mail, and signs to broadcast a general watershed message to a large audience. Intensive training uses workshops, consultation, and guidebooks to send a much more complex message to a smaller and more interested audience. Intensive training requires a more substantial time commitment, ranging from several hours to a few days.

From evaluations of several market surveys, it appears that media campaigns and intensive training can each produce up to a 10- to 20-percent improvement in selected watershed behaviors among their respective target populations. A combination of both outreach techniques is probably needed in most watersheds, as each complements the other. For example, media campaigns cost just a few cents per watershed resident reached, while intensive training can cost several dollars for each resident that is actually influenced. Media campaigns are generally better at increasing awareness and sending messages about negative watershed behaviors. Intensive training, on the other hand, is superior at changing individual practices in the home, lawn, and garden.

Cost Considerations

The cost of creating and maintaining a program that addresses lawn care and landscaping practices and water quality varies depending on the intensity of the effort and what outreach techniques are selected. Media campaigns often require a greater amount of money to create, but are also most likely to reach the largest proportion of the community. Intensive training campaigns may not require as large a creation cost, but often require more staff time. Production costs for materials such as flyers and brochures is often inexpensive ($0.10 to $0.50 per brochure), and soil kits and testing may be provided through a local university to reduce expense. Many cooperative extension offices have already produced materials on lawn care and landscaping techniques to protect water quality, and program managers may save money by utilizing these available resources.

An example of a program that educates residents on better lawn care practices is The Water-Wise Gardener Program of the Prince William County, Virginia, Cooperative Extension service. Through the changes in behavior of more than 700 participants, an estimated aggregate reduction in fertilizer application of 20 tons has been realized in the county in 5 years. The program operates on an average annual budget of approximately $30,000 and requires the yearly time of 1.5 staff persons. Expense is deferred by the use of master gardener volunteers, who act as consultants for volunteer lawns where lawn care practices have been implemented. The program has recently been developed into a regional model that has been applied in several other Virginia counties.

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Pest Control

Pollution Prevention/Good Housekeeping for Municipal Operations

Description

The use of pesticides, such as those pictured here, should be limited to avoid runoff contamination

This management measure involves limiting the impact of pesticides on water quality by educating residents and businesses on alternatives to pesticide use and proper storage and on application techniques. The presence of pesticides in storm water runoff has a direct impact on the health of aquatic organisms and can present a threat to humans through contamination of drinking water supplies. The pesticides of greatest concern are insecticides, such as diazinon and chloropyrifos (CWP, 1999 and Schueler, 1995), which even at very low levels can be harmful to aquatic life. A recent study of urban streams by the U.S. Geological Survey found that some of the more commonly used household and garden insecticides occurred at higher frequencies and concentrations in urban streams than in agricultural streams (USGS, 1999). The study also found that these insecticide concentrations were frequently in excess of USEPA guidelines for protection of aquatic life.

The major source of pesticides to urban streams is home application of products designed to kill insects and weeds in the lawn and garden. It has been estimated that an average acre of a well-maintained urban lawn receives an annual input of 5 to 7 pounds of pesticides (Schueler, 1995). Pesticide pollution prevention programs try to limit adverse impacts of insecticides and herbicides by providing information on alternative pest control techniques other than chemicals or explaining how to determine the correct dosages needed to manage pests. Lawn care and landscaping management programs often include pesticide use management as part of their outreach message.

Applicability

EPA estimates that nearly 70 million pounds of active pesticide ingredients are applied to urban lawns each year. Table 1 compares surveys on residential pesticide use in eleven different areas of the country, broken down by insecticides and herbicides use. It appears that pesticide application rates vary greatly, ranging from a low of 17 percent to a high of 87 percent, but climate is an important factor in determining insecticide and herbicide use.

Table 1. A comparison of eleven surveys of residential insecticide and weedkiller use

Study	Number of Respondents	% Using Insecticides	% Using Herbicides
Chesapeake Bay Swann, 1999	656	21%	–
Maryland, Kroll and Murphy,1994	403	42%	32%
Virginia, Aveni, 1998	100	66%	–
Maryland, Smith, 1994	100	23%	n/a
Minnesota, Morris and Traxler, 1997	981	–	75%
Michigan, De Young, 1997	432	40%	59%
Minnesota, Dindorf, 1992	136	–	76%
Wisconsin, Kroupa, 1995	204	17%	24% **
Florida, Knox et al, 1995	659	83%	–
Texas, NSR, 1998	350	87%	–
California, Scanlin and Cooper, 1997	600	50%	–

Notes: (**) note difference in self-reported herbicide use and those that use a weed and feed product (herbicide combined with fertilizer)

Insecticides appear to be applied more widely in warm weather climates where insect control is a year-round problem (such as Texas, California, and Florida). Anywhere from 50 to 90 percent of residents reported that they had applied insecticides in the last year in warm-weather areas. This can be compared to 20 to 50 percent levels of insecticide use reported in colder regions, where hard winters can help keep insects in check. By contrast, herbicide application rates tend to be higher in cold weather climates to kill the weeds that arrive with the onset of spring (60 to 75 percent in the Michigan, Wisconsin, and Minnesota surveys).

Design Considerations

The use of integrated pest management (IPM) is a popular way for program managers to educate residents and businesses on alternatives to chemical pesticides. IPM reflects a holistic approach to pest control that examines the interrelationship between soil, water, air, nutrients, insects, diseases, landscape design, weeds, animals, weather, and cultural practices to select an appropriate pest management plan. The goal of an IPM program is not to eliminate pests but to manage them to an acceptable level while avoiding disruptions to the environment. An IPM program incorporates preventative practices in combination with nonchemical and chemical pest controls to minimize the use of pesticides and promote natural control of pest species. Three different nonchemical pest control practices biological (good bugs that eat pests), cultural (handpicking of pests, removal of diseased plants, etc.), and mechanical (zappers, paper collars, etc) are used to limit the need for chemicals. In those instances when pesticides are required, programs seek to have users try less toxic products such as insecticidal soaps. The development of higher tolerance levels among residents for certain weed species is a central concept of IPM programs for reducing herbicide use.

Education on the proper use of pesticides is often included in many lawn care and landscaping management programs. Most often this is in the form of informational brochures or fact sheets on pesticide use around the home or garden. These information packets include tips on identifying pest problems and selecting treatment approaches that reduce environmental impacts; less-toxic pest control products if chemical control is necessary; and the proper mixing, application rates, and cleanup procedures for pesticide use. Program managers can consult cooperative extension programs and university agricultural programs for more information regarding pest control techniques that are more water quality friendly.

Limitations

The public perception that no alternative to pesticide use exists is probably the greatest limitation that program managers will face. Surveys tell us that the public has a reasonably good understanding about the potential environmental dangers of pesticides. Several surveys indicate that residents do understand environmental concerns about pesticides, and consistently rank them as the leading cause of pollution in the neighborhood (Elgin DDB, 1996). Even so, pesticide use still remains high in many urban areas (see Table 1). The time required for homeowners to learn more about alternative pest control techniques may also limit program effectiveness. Many residents prefer the ease of spraying a chemical on their lawns to other pest control techniques they perceive as more time intensive and less reliable. Managers should recognize that IPM programs have their own limitations, including questions about the effectiveness of alternative pest control techniques.

Effectiveness

A national study of the effectiveness of alternative pest control programs at reducing pesticide use and protecting water quality has not yet been performed. Cooperative extension and university agriculture programs across the country have performed studies of the ability of distinct alternative pest control techniques at limiting pesticide use, but a synthesis of these individual studies into a national report has not been performed. However, the need for pesticide control programs is evident from recent studies on the presence of insecticides in storm water. Results of recent sampling of urban streams caused the USGS to conclude that the presence of insecticides in urban streams may be a significant obstacle to restoring urban streams. (USGS, 1999). Table 2 examines eight studies on storm water runoff and insecticide concentrations and provides an example of how insecticides persist even after their use is discontinued.

Additional research done in the San Francisco Bay Region regarding diazinon use further illustrates the need for pest control programs. Results of the study show that harmful diazinon levels can be produced in urban streams from use at only a handful of individual homes in a given watershed (CWP, 1999). Due to the solubility of diazinon, current storm water and wastewater treatment technologies cannot significantly reduce diazinon levels. The best tool for controlling diazinon in urban watersheds is through source control by educating residents and businesses on pesticide alternatives and safe application.

An example of successful use of IPM is the Grounds Maintenance Program for the City of Eugene, Oregon. This program was started in the early 1980's and includes all the city public parks and recreation areas. The city uses a variety of IPM methods, including water blasting to remove aphids, insecticidal soaps, and limited use of pesticides. The city has also adopted higher tolerance levels for certain weed and pest species that reduces the need to apply pesticides and herbicides. Since the program's inception, pesticide usage by the City of Eugene has dropped bay more than 75 percent (Lehner et. al., 1999). Although no exact cost savings have been calculated from the use of the IPM program, the city turf and grounds supervisor believes the program saves money and has little citizen opposition.

Table 2: Banned or restricted insecticides found in storm water runoff concentrations in µg/l (ppb) (Source: Schueler, 1995)

Study	Chlordane	Lindane	Dieldrin	Other
Baltimore Kroll/Murphy	0.52	0.18	2.44	–
Rhode Island Cohen	Detected	NA	NA	NA
Atlanta Hippe	NA	0.01 (0.048)	NA	–
Atlanta Thomas	Detected	NX	NX	heptachlor
Milwaukee Bannerman	Detected	Detected	Detected	DDT, DDE
Washington MWCOG	0.2	0.2	0.2	Heptachlor
Northern Virginia Dewberry and Davis	ND	Trace	ND	Endrin
Toronto D'Andrea	NA	0.5 to 2	0.1 to 2	–
Toronto D'Andrea	NA	0.5 to 2	0.1 to 2	–
ND=Not Detected, NA=Not Analyzed, NX= Detection reported only if they exceeded water quality standards.				

Cost Considerations

The cost of educating residents on proper pesticide use varies greatly depending on the intensity of the effort. Some cities have begun partnerships that include training of retail employees on IPM techniques, similar to lawn care and landscaping programs. In addition, promotional materials and displays on safer pesticide alternatives are set up. The cost of staff time for training and production of materials must be included in any cost estimate. Since there are currently a number of good fact sheets on IPM and pesticide use available through cooperative extension programs, managers should consider using this source instead of creating a new one. Another way to save cost would be to utilize master gardener volunteers to help with training, for both residents and store employees.

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Parking Lot and Street Cleaning

Pollution Prevention/Good Housekeeping for Municipal Operations

Description

A street sweeper cleans up pollutants and sediments on the street to reduce the amount of pollutants entering receiving waters

This management measure involves employing pavement cleaning practices such as street sweeping on a regular basis to minimize pollutant export to receiving waters. These cleaning practices are designed to remove from road and parking lot surfaces sediment debris and other pollutants that are a potential source of pollution impacting urban waterways (Bannerman, 1999). Although performance monitoring for the Nationwide Urban Runoff Program (NURP) indicted that street sweeping was not very effective in reducing pollutant loads (USEPA, 1983), recent improvements in street sweeper technology have enhanced the ability of present day machines to pick up the fine grained sediment particles that carry a substantial portion of the storm water pollutant load. Many of today's sweepers can now significantly reduce the amount of street dirt entering streams and rivers, some by significant amounts (Runoff Report, 1998). A debate as to whether this ability to pick up finer particles will improve the overall pollutant removal effectiveness of street sweepers is ongoing, and further research is required to establish the optimal sweeping frequency for pollutant removal and what streets are most appropriate for a sweeping program.

Applicability

Street sweeping is practiced in most urban areas, often as an aesthetic practice to remove sediment buildup and large debris from curb gutters. In colder climates, street sweeping is used during the spring snowmelt to reduce pollutant loads from road salt and to reduce sand export to receiving waters. Seventy percent of cold climate storm water experts recommend street sweeping during the spring snowmelt as a pollution prevention measure (CWP, 1997). The frequency and intensity of rainfall for a region are also key variables in determining how streets need to be swept to obtain a desired removal efficiency. Other factors that affect a street sweeper's ability to reduce nonpoint pollution include the condition of the street, its geographical location, the operator's skill, the presence of parked cars, and the amount of impervious area devoted to rooftop.

Design Considerations

One factor considered most essential to the success of street sweeping as a pollutant removal practice is use of the most sophisticated sweepers available. Innovations in sweeper technology have improved the performance of these machines at removing finer sediment particles, especially for machines that use vacuum-assisted dry sweeping to remove particulate matter. By using the most sophisticated sweepers in areas with the highest pollutant loads, greater reductions in sediment and accompanied pollutants can be realized.

Another important aspect of street sweeping programs is the ability to regulate parking. The ability to impose parking regulations in densely populated areas and on heavily traveled roads is essential.

The frequency and location of street sweeping is another consideration for any program. How often and what roads to sweep are determined by the program budget and the level of pollutant removal the program wishes to achieve. Computer modeling of pollutant removal in the Pacific Northwest suggests that the optimum sweeping frequency appears to be once every week or two (CWP, 1999). More frequent sweeping operations yielded only a small increment in additional removal. The model also suggests that somewhat higher removal could be obtained on residential streets as opposed to more heavily traveled arterial roads.

Sweeping of parking lots is also employed as a nonstructural management practice for industrial sites. This sweeping involves using brooms to remove small quantities of dry chemicals and solids from areas that are exposed to rainfall or storm water runoff. While the effectiveness of this practice at pollutant removal is unknown, the sweeping and proper disposal of materials is a reasonably inexpensive method of pollution prevention that requires no special training or equipment.

Limitations

For street sweeping, the high cost of current sweeper technologies is a large limitation to using this management practice. With costs approaching $200,000 for some of the newer sweeper technologies, storm water managers with limited budgets must consider the high equipment cost together with the uncertainty about pollutant removal efficiency to decide whether a sweeping program is an attractive management option. The potential inability to restrict parking in urban areas may present another limitation. Other possible limitations include the need for sweeper operator training, the inability of current sweeper technology to remove oil and grease, and the lack of solid evidence regarding the expected levels of pollutant removal. Proper disposal of swept materials might also be a limitation.

Maintenance Considerations

Street cleaning programs require a significant investment of capital and a yearly operation and maintenance budget. Sweepers have a useful life of about four years, and proper maintenance can greatly improve sweeping efficiency. Arrangements for disposal of the swept material collected must also be made, as well as accurate tracking of the streets swept and the frequency of sweeping. The operation and maintenance costs for two types of sweepers are included in Table 1.

Effectiveness

Street sweeping programs had largely fallen out of favor as a pollutant removal practice following the 1983 NURP report, but improvements in sweeper technology have caused a recent reevaluation of their effectiveness. New studies show that conventional mechanical broom and vacuum-assisted wet sweepers reduce nonpoint pollution by 5 to 30 percent and nutrient content by 0 to 15 percent. However, newer dry vacuum sweepers can reduce nonpoint pollution by 35 to 80 percent and nutrients by 15 to 40 percent for those areas that can be swept (Runoff Report, 1998).

While actual reductions in storm water pollutants have not yet been established, information on the reductions in finer sediment particles that carry a significant portion of the storm water pollutant load is available. Recent estimates are that the new vacuum assisted dry sweeper might achieve a 50–88 percent overall reduction in the annual sediment loading for a residential street, depending on sweeping frequency (Bannerman, 1999).

A benefit of high-efficiency street sweeping is that by capturing pollutants before they are made soluble by rainwater, the need for structural storm water control measures might be reduced. Structural controls often require costly added measures, such as adding filters to remove some of these pollutants and requiring regular manpower to change-out filters. Street sweepers that can show a significant level of sediment removal efficiency may prove to be more cost-effective than certain structural controls, especially in more urbanized areas with greater areas of pavement.

Cost Considerations

The largest expenditures for street sweeping programs are in staffing and equipment. The capital cost for a conventional street sweeper is between $60,000 and $120,000. Newer technologies might have prices approaching $180,000. The average useful life of a conventional sweeper is about four years, and programs must budget for equipment replacement. Sweeping frequencies will determine equipment life, so programs that sweep more often should expect to have a higher cost of replacement.

If investing in newer technologies, training for operators must be included in operation and maintenance budgets. Costs for public education are small, and mostly deal with the need to obey parking restrictions and litter control. Parking tickets are an effective reminder to obey parking rules, as well as being a source of revenue.

Table 1 gives sweeper cost data for two types of sweepers: mechanical and vacuum-assisted. The table shows that while the purchase price of vacuum-assisted sweepers is significantly higher, the operation and maintenance costs are lower.

Table 1. Estimated costs for two types of street sweepers

Sweeper Type	Life (Years)	Purchase Price ($)	O&M Cost ($/curb mile)	Sources
Mechanical	5	75,000	30	Finley, 1996 SWRPC, 1991
Vacuum-assisted	8	150,000	15	Finley, 1996 Satterfield, 1991

Cost data for two cities in Michigan provide some guidance on the overall cost of a street cleaning program. Table 2 contains a review of the labor, equipment, and material costs for street cleaning for the year 1995 (Ferguson et al., 1997). The average cost for street cleaning was $68/curb mile and approximately 11 curb miles/day were swept.

Table 2. The cost of street cleaning for two cities in Michigan

City	Labor	Equipment	Material and Services	Total
Livonia	$23,840	$85,630	$5,210	$114,680
Plymouth Township	$18,050	$14,550	$280	$32,880

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Roadway and Bridge Maintenance

Pollution Prevention/Good Housekeeping for Municipal Operations

Description

This practice involves pollution prevention techniques that reduce or eliminate pollutant loadings from existing road surfaces as part of an operation and maintenance program. Substantial amounts of sediment and pollutants are generated during daily roadway and bridge use and scheduled repair operations, and these pollutant loadings can threaten local water quality by contributing heavy metals, hydrocarbons, sediment, and debris to storm water runoff. Table 1 shows some of the constituents that can be present in highway runoff and their primary sources.

Pollutants generated from road and bridge maintenance can be minimized with good housekeeping practices (Source: VDOT, 2000)

As Table 1 demonstrates, numerous pathways for pollutant deposition on roadways and bridges influence the water quality of storm water runoff. Routine performance of general maintenance activities such as sweeping, vegetation maintenance, and cleaning of runoff control structures can help alleviate the impacts of these pollutants. Modifications in roadway resurfacing practices and application techniques for salt and other deicers can also help reduce pollutant loads to storm water runoff and protect the quality of receiving waters.

Table 1. Highway runoff constituents and their primary sources (Source: USEPA, 1993)

Constituent	Primary Sources
Particulates	Pavement wear, vehicles, atmosphere
Nitrogen, Phosphorus	Atmosphere, roadside fertilizer application
Lead	Tire wear, auto exhaust
Zinc	Tire wear, motor oil, grease
Iron	Auto body rust, steel highway structures, moving engine parts
Copper	Metal plating, brake lining wear, moving engine parts, bearing and bushing wear, fungicides and insecticides
Cadmium	Tire Wear, insecticides

Table 1. Highway runoff constituents and their primary sources
(Source: USEPA, 1993) (Continued)

Chromium	Metal plating, moving engine parts, brake lining wear
Nickel	Diesel fuel and gasoline, lubricating oil, metal plating, brake lining wear, asphalt paving
Manganese	Moving engine parts
Cyanide	Anticake compound used to keep deicing salt granular
Sodium, Calcium, Chloride	Deicing salts
Sulphate	Roadway beds, fuel, deicing salts
Petroleum	Spills, leaks or blow-by of motor lubricants, antifreeze and hydraulic fluids, asphalt surface leachate

Applicability

Roadway systems are a large part of the infrastructure of urban areas across the country, and require regular repairs and maintenance due to traffic use and climatic conditions. The level of pollutants found in road and bridge runoff is variable and is determined by a number of factors in addition to traffic volume and climate. Other factors affecting pollutant levels include surrounding land use, the design of the bridge or roadway, the presence of roadside vegetation, the use of insecticides, and the frequency of accidents and spills that can introduce hazardous chemicals. In colder climates, the amount of deicer applied to melt ice and snow can also influence the level of certain pollutants in road runoff and its impacts on local water quality.

Design Considerations

Road and bridge maintenance programs have a number of options for reducing the level of pollutants generated during the maintenance of existing road surfaces. Changes in the methods used for maintaining road surfaces, removing debris and sediment from roadways, and cleaning of runoff control structures can help improve the overall quality of storm water discharges from roads and bridges.

Proper planning for road and bridge resurfacing operations is a simple but effective method to control pollution. Many techniques can be implemented to control the impacts of this maintenance operation. First, paving operations should be performed using concrete, asphalt, or other sealers only in dry weather situations to prevent contamination of runoff. Second, proper staging techniques should be used to reduce the spillage of paving materials during the repair of potholes and worn pavement. These techniques can include covering storm drain inlets and manholes during paving operations; using erosion and sediment control measures to decrease runoff from repair sites; and utilizing pollution prevention materials such as drip pans and absorbent material for all paving machines to limit leaks and spills of paving materials and fluids.

Finally, resurfacing operations could employ porous asphalt for pothole repair and for shoulder areas to reduce the level of storm water runoff from road systems. For more information on permeable road surface materials, see the Porous Pavement fact sheet.

Good cleaning practices can help diminish impacts to storm water runoff. Sweeping and vacuuming of heavily traveled roadways to remove sediment and debris can reduce the amount of pollutants in runoff. Street sweeping as a pollution source control is discussed more extensively in the Parking Lot and Street Cleaning fact sheet. Regular cleaning of runoff control structures such as catch basins can help reduce sediment loads in runoff that will end up in local waterways (see Catch Basins fact sheet).

Proper application of road salt or other deicers also reduces storm water pollution. By routinely calibrating spreaders, a program manager can prevent over-application of deicing materials. In addition to reducing the effects of these materials on the aquatic environment, cost savings may be realized due to reductions in the purchase of deicing materials. Training for transportation employees in proper deicer application techniques, the timing of deicer application, and what type of deicer to apply will also determine the impacts on water quality and aquatic habitat.

Maintenance practices for roadside vegetation also determine the storm water quality of road runoff. Restrictions on the use of herbicides and pesticides on roadside vegetation, and training to ensure that employees understand the proper handling and application of pesticides and other chemicals, can help prevent contamination of runoff. Selection of roadside vegetation with higher salt tolerances will also help to maintain vegetated swales and biofilters that filter out runoff. For more information on vegetated storm water practices, see the Grassed Filter Strips fact sheet.

Bridge runoff may require additional maintenance practices to eliminate storm water runoff impacts. In addition to some of the roadway practices listed above improved, practices in bridge siting and design can help reduce water quality impacts. One technique is to avoid using bridge scupper drains for any new bridges and to routinely clean existing ones to prevent sediment and debris buildup. Scupper drains can cause direct discharges to surface waters and have been found to carry relatively high concentrations of pollutants (CDM, 1993). Program managers should consider endorsing retrofits of scupper drains with catch basins or redirecting water from these drains to vegetated areas to provide treatment. Other techniques such as using suspended tarps, booms, and vacuums to capture pollutants (e.g., paint, solvents, rust, and paint scrapings) generated during bridge maintenance will also help reduce impacts to receiving waters. In addition, using deicers such as glycol, urea, or calcium magnesium acetate (CMA) reduces the corrosion of metal bridge supports that can occur when salt is used.

Limitations

Generally, limitations to instituting pollution prevention practices for road and bridge maintenance involve the cost for additional equipment and training. Since maintenance of roadways and bridges is already required in all communities, staffing is usually in place and alteration of current practices should not require additional staffing or administrative labor.

Limitations may arise in the location of new bridges. The availability and cost of land and other economic and political factors may dictate where the placement of a new bridge will occur. Better design of the bridge to control runoff is required if it is being placed near sensitive waters. The practice of controlling paved areas to limit impervious surface might also be restricted by community regulations of required widths for roadways and shoulders.

Effectiveness

Limited data are available on the actual effectiveness of road and bridge maintenance practices at removing pollutants from storm water runoff. Table 2 examines the effectiveness and cost of some of the operation and maintenance practices recommended for storm water pollution control.

Table 2. Road and bridge maintenance management practices: cost and effectiveness (Source: USEPA, 1993)

<table>
<tr><th></th><th colspan="2">Effectiveness (% Removal)[a]</th><th>Cost</th></tr>
<tr><td>Maintaining Roadside Vegetation</td><td colspan="2">Sediment Control: 90% average
P and N: 40% average
COD, Lead, and Zinc: 50% average
TSS: 60% average</td><td>Natural succession allowed to occur
Average: $100/acre/year
Range: $50-$200/acre/year</td></tr>
<tr><td>Street Sweeping</td><td>Smooth Street
Frequent Cleaning:
TSS: 20%
COD: 5%
Lead: 25%</td><td>Smooth Street
Infrequent Cleaning:
TSS: N/A
COD: N/A
Lead: 5%</td><td>Average: $20/curb mile

Range: $10–$30/curb mile</td></tr>
<tr><td>Litter Control</td><td colspan="2">N/A</td><td rowspan="3">All are accepted as economical practices to control or prevent storm water impacts.</td></tr>
<tr><td>General Maintenance</td><td colspan="2">N/A</td></tr>
<tr><td>Minimizing Deicer Application</td><td colspan="2">N/A</td></tr>
</table>

[a]P=phosphorus; N=nitrogen; TSS=total suspended solids; COD=chemical oxygen demand

Although data may be limited on cost and effectiveness, preventative maintenance and strategic planning are time-proven and cost-effective methods to limit contamination of storm water runoff. It can be assumed that the management practices recommended will have a positive affect on storm water quality by working to reduce pollutant loads and the quantity of runoff. Protecting and restoring roadside vegetation, removal of debris and sediment from roads and bridges, and directing runoff to vegetated areas are all effective ways to treat storm water runoff. Other practices, such as minimizing deicer application, litter control, and proper handling of fertilizers, pesticides, and other toxic materials, work to control some of the pathways of storm water pollution. Employing good road and bridge maintenance practices is an efficient and low-cost means of eliminating some of the impacts of pollutants associated with road systems on local streams and waterways.

Cost Considerations

The maintenance of local roads and bridges is already a consideration of most community public works or transportation departments. Therefore, the cost of pollutant reducing management practices will involve the training and equipment required to implement these new practices. Cost data for some of the new practices that have been recommended are included in Table 2.

Costs may vary greatly in the type of deicer selected for application. Table 3 includes a comparison of four different deicers and the cost for application. It should be noted that CMA has a higher cost than the other deicers, but that reductions in corrosion to infrastructure, damage to roadside vegetation, and amount of material used may offset the higher cost.

Table 3. The estimated cost of four deicer types (Source: Caraco and Claytor, 1997)

Deicer Type	Material Cost Per Ton	Cost Per Lane Mile Per Season
Sodium Chloride	$20–$40	$6,371–$6,909
Calcium Chloride	$200	$6,977–$7,529
Calcium Magnesium Acetate (CMA)	$650–$675	$12,958–$16,319
CG-90 Surface Saver	$185	$5,931–$6,148

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Septic System Controls

Pollution Prevention/Good Housekeeping for Municipal Operations

Description

Workers test a drain field (Source: Texas A&M University, 1996)

Septic system source control refers to the use of outreach programs to educate homeowners about the proper operation and maintenance of their septic systems to reduce the likelihood of failure. Septic systems are designed to treat wastewater by separating solids from liquids and then draining the liquid into the ground. Sewage flows into the tank where settling and bacterial decomposition of larger particles takes place, while treated liquid filters into the soil. When system failures occur, untreated wastewater and sewage can be introduced into ground water or nearby streams and water bodies.

Pollution prevention practices are designed to restrict pollutant and nutrient loads from improperly functioning septic systems from entering local water sources. These loadings occur for a number of reasons, including improper siting, inadequate installation, or system operation failures (see Failing Septic Systems fact sheet). As many as 75 percent of all system failures have been attributed to hydraulic overloading (Jarrett et al., 1985). Failures may also occur due to lapses in the regular inspection and maintenance that are required to ensure proper operation during the design life of the septic system. Homeowners may be unaware of the age of their system and whether preemptive planning is necessary before the system fails.

Applicability

Outreach regarding septic systems controls is applicable for large lot development in rural areas that are not served by sewer. When septic systems are used for wastewater treatment, there is a need for educational outreach and training to avoid system failures for owners of both new and existing systems. Septic system maintenance education is extremely important in coastal areas for shoreline development near shellfish beds and spawning areas, where septic effluent discharges can influence water quality and lead to bed closures and algal blooms. There is also a significant need for educational outreach regarding septic system maintenance near lake shoreline developments, where nitrogen inputs can lead to lake eutrophication.

Implementation

The most effective way to control on-site wastewater problems is through a comprehensive management program. An onsite wastewater management program can reduce water quality degradation and save local governments and homeowners time and money, as well as better tracking of the performance of routine maintenance practices. This comprehensive plan is administered by one agency that has ultimate responsibility for all aspects of wastewater management, including on-site disposal systems. (see Failing Septic Systems fact sheet).

Public outreach and training are vital elements in the control of septic system failure. Many of the problems associated with improper septic system functioning may be attributed to a lack of homeowner knowledge of operation and maintenance of the system. Educational materials for homeowners and training courses for installers and inspectors can reduce the incidence of failure. Education is most effective when used in concert with other source reduction practices, such as phosphate bans and use of low-volume plumbing fixtures. Simple messages that can be conveyed to homeowners to reduce system failures and ensure proper functioning include

- Do not wait until septic system shows sign of failure. Inspect the system annually and have it pumped-out at least once every 3 years.
- Keep records of pumping and maintenance and a map of the location of your system and drainfield.
- Practice water conservation indoors and divert roof drains and surface water away from the system.
- Use caution in disposing materials down the drain. Household chemicals can kill the bacteria that make the system work and nondegradable materials (cigarette butts, etc.) can clog the system.
- Keep heavy equipment and vehicles off your system and drainfield.
- Don't cover your drainfield with impermeable surfaces that can block evaporation and the air needed for effluent treatment.

In addition to the general suggestions above, there are other management measures which can be implemented to help maintain a properly operating system. These measures include the following:

Chemical Additive Restrictions

Organic solvents are often advertised for use as septic system cleaners. Little evidence shows that such cleaners perform any useful functions, and they might instead exterminate the microbes necessary for waste treatment, resulting in increased discharge of pollutants. In addition, the chemicals themselves often contain constituents that are listed with U.S. EPA as priority pollutants. Restrictions on the use of these additives can prevent improper system operation and ground water contamination (USEPA, 1993).

Phosphorus Detergent Restrictions

Conventional septic systems are usually very effective at removing phosphorus (see the Failing Septic Systems fact sheet). However, certain soil conditions combined with proximity to sensitive surface waters can result in phosphorus pollutant loading. If such conditions are sufficiently prevalent within areas of concern, restrictions or bans on the use of detergents containing phosphate can be implemented. Eliminating phosphates from detergent can reduce phosphorus loads to septic systems by 40 to 50 percent (USEPA, 1993). As of October 1993, 17 states had enacted phosphate detergent restrictions or bans (Osmond et al, 1995).

Elimination of Garbage Disposals for Households Served by Septic System

Garbage disposals contribute to the loading of suspended solids, nutrients, and biological oxygen demand (BOD) to septic systems, as well as increasing the buildup of solids in septic tanks. Garbage disposals can double the amount of solids added to a septic tank, creating the need for more frequent pumpouts.

Proper Septic System Maintenance

Depending on soil conditions and other factors, septic systems have a failure rate of 5 to 35 percent. When they fail, septic systems can discharge untreated or partially treated wastewater into groundwater. As a result, it is important to ensure that septic systems are maintained and operating properly. This can be accomplished by homeowners or trained inspectors through regular inspections of onsite systems. During inspections, the holding or septic tank should be checked to determine whether or not pumping is necessary. Additionally, the inspection port should be opened and the baffles checked to ensure that they have not been damaged since the last inspection. The absorption field should also be checked for flooding or sogginess, which are indicators of a clogged system or excessive water use. Finally, the entire area should be checked for odors or damp or soggy areas, which are indicative of a leak in the system.

The holding tank should be pumped regularly, with the frequency depending on the capacity of the tank, the flow of wastewater, and the volume of solids in the tank. First, a tank's capacity might become too small if new high-water-use technologies such as a hot tub or whirlpool are installed, or if more people move into the house than when the system was originally installed. Second, when more people move into a house, the wastewater flow will increase, requiring more frequent pumping. Finally, if the house has a garbage disposal or if the occupation of someone in the household results in their having excessively soiled clothing, the volume of solids entering the tank might be greater than usual and require more frequent pumping. These factors should be accounted for when determining how frequently to pump a septic tank.

Table 2 lists estimates of how frequently septic tanks should be pumped on average, based on the size of the tank and household size (NSFC). These values were calculated assuming there was no garbage disposal, which can increase solids by up to 50 percent. Individuals can determine specifically when the holding tank should be pumped by occasionally checking the depth of solids and the level of scum built up on top of the water in the tank. As this can be an unpleasant chore, it is best to have the tank routinely pumped by a certified contractor approximately every 3 years.

Limitations

As with all pollution prevention measures, public ignorance about the suggested practices may be the biggest limitation to septic system source control. Many residents appear to be either unaware of or unwilling to implement the necessary steps to ensure the proper operation and maintenance of their septic systems. A recent survey of residents in the Chesapeake Bay region found that 50 percent of septic owners had not had their systems inspected within the last 3 years and that 46 percent had not had their system cleaned within the same time frame (Swann, 1999). Twelve percent of residents did not even know where their septic system was located. This finding indicates that residents are not receiving the necessary information on septic system care to prevent or reduce the incidence of failure.

Table 2. Estimated septic tank pumping frequencies in years

Tank Size (gallons)	Household Size (number of people)					
	1	2	3	4	5	6
500	5.8	2.6	1.3	1.0	0.7	0.4
750	9.1	4.2	2.6	1.8	1.3	1.0
900	11.0	5.2	3.3	2.3	1.7	1.3
1,000	12.4	5.9	3.7	2.6	2.0	1.3
1,250	15.6	7.5	4.8	3.4	2.6	2.0
1,500	18.9	9.1	5.9	4.2	3.3	2.6
1,750	22.1	10.7	6.9	5.0	3.9	3.1
2,000	25.4	12.4	8.0	5.9	4.5	3.7
2,250	28.6	14.0	9.1	6.7	5.2	4.2
2,500	31.9	15.6	10.2	7.5	5.9	4.8

Effectiveness

Failing septic systems have been linked to water quality problems in streams, lakes, shellfish beds, and coastal areas. Improvements in system operation and maintenance should be a strong element in watershed plans for those areas where septic systems are used for wastewater treatment. Public education and outreach regarding septic system operation and maintenance can be assumed to produce some positive effect on water quality, but studies on resident behaviors regarding septic pollution prevention practices are limited. Instead, effectiveness of septic source controls is most often measured in the number of informational packets mailed out or the number of attendees for training workshops.

While this may help to define the demand for information, it gives no indication of whether the operation and maintenance practices presented are implemented. To better determine whether pollution prevention outreach is being effective, residential surveys should be part of any program seeking to educate residents on septic systems and their influence on water quality.

Cost Considerations

The cost of septic system pollution prevention programs can vary greatly, depending on factors such as staff time, outreach components, and the extent of septic use within a region. Table 3 provides some examples of programs from various parts of the country and the expenditures for septic outreach.

Once a program is well established, the cost of creating educational materials and training programs decreases and funding can be redistributed to those outreach techniques that have proven to be the most successful. Programs should be sure to secure some funding for media outreach (especially television), as this often ranks as the most popular information source in surveys of resident preferences.

Table 3. Some examples of cost and staff time for septic outreach programs

Program	**Expenditure**	**Staff time (Full time equivalent)**	**Components**
City of Olympia, Washington	$40,000	0.5	• Flyers/brochures • Training workshops • System monitoring
Thurston County, Washington	$35,000	0.5	• Flyer/brochures • Discount coupons for septic pumping • Training workshops
Minnesota Cooperative Extension	$18,000	0.25	• Publications/videos • Flyers/brochures • Training Workshops/community Visits • Septic owners guide distributed with new permits • Satellite conferences for policy makers • Train the trainers program

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Storm Drain System Cleaning

Pollution Prevention/Good Housekeeping for Municipal Operations

Description

Storm drain systems need to be cleaned regularly. Routine cleaning reduces the amount of pollutants, trash, and debris both in the storm drain system and in receiving waters. Clogged drains and storm drain inlets can cause the drains to overflow, leading to increased erosion (Livingston et al., 1997). Benefits of cleaning include increased dissolved oxygen, reduced levels of bacteria, and support of instream habitat. Areas with relatively flat grades or low flows should be given special attention because they rarely achieve high enough flows to flush themselves (Ferguson et al., 1997).

Municipalities can hire professional plumbing services to remove trapped sediment and debris from storm drains with periodical flushing (Source: Drain Patrol, no date)

Applicability

This measure is applicable to all storm drain systems. The same principles can be applied to material and waste handling areas, paved and vegetated areas, waterways, and new development projects (Ferguson et al., 1997).

Limitations

While cleaning is necessary for all storm drain systems, there are limitations (adapted from Ferguson et al., 1997) as follows:

- Cleaning the storm drain by flushing is more successful for pipes smaller than 36 inches in diameter.
- A water source is necessary for cleaning. The wastewater must be collected and treated once flushed through the system.
- Depending on the condition of the wastewater, it may or may not be disposed to sanitary sewer systems.
- The efficiency of storm system flushing decreases when the length of sewer line being cleaned exceeds 700 feet.

Maintenance Considerations

Ferguson et al. (1997) report removal of 55 to 65 percent for nonorganic materials and grits and 65 to 75 percent for organics.

Cost Considerations

The cost of a vactor truck can range from $175,000 to $200,000, and labor rates range from $125 to $175 per hour (Ferguson et al., 1997). Ferguson et al. (1997) also cited costs of $1.00 to $2.00 per foot for storm drain system cleaning.

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Alternative Discharge Options for Chlorinated Water

Pollution Prevention/Good Housekeeping for Municipal Operations

Description

Chlorinated water discharged to surface waters has an adverse impact on local water quality. Swimming pools are a major source of chlorinated water discharged into sanitary and storm sewer systems. An average swimming pool holds 19,000 gallons of chlorinated water. Pools have high concentrations of chlorine, which is toxic to wildlife and fish.

Chlorinated water from swimming pools should not discharged to the storm sewer system or directly into a waterbody (Source: The Pool Guy, 2001)

Applicability

Many pool owners who live in cooler climates drain their swimming pools to reduce maintenance and potential damage from freezing during harsh winters. These individuals should not discharge pool water to the storm sewer system or directly into a waterbody and should investigate alternative discharge options.

Siting and Design Considerations

The Oregon Department of Environmental Quality suggests that

- Pool owners obtain permission from local sanitary sewer operators or municipal treatment plant operators and discharge to the sanitary sewer system.
- Discharge the chlorinated water to land, where it will not drain to local surface waters.
- Dechlorinate the water before draining the pool.

Montgomery County, Maryland's, Department of Environmental Protection (1997) provides the following guidelines to pool owners and operators:

- Community pools must discharge to the sanitary sewer using a surge tank.
- Residential pools must discharge backwash water to the sanitary sewer.
- If the only option for draining pool water is to discharge directly into the environment, water quality must comply with the applicable water quality criteria.
- Pool water must sit for at least 2 days after the addition of chlorine or bromine or until chlorine or bromine levels are below 0.1 mg/l.
- The pH of discharge water must be between 6.5 and 8.5 before it is discharged.
- Algicides such as copper or silver can interrupt normal algal and plant growth and should not be used.

- Total suspended solids must be below 60 mg/l—suspended particles should be allowed to settle out and the water should not appear murky. Settled material should not be discharged with pool water.
- Discharges to the environment should be directed over a land surface so that some level of filtration by soil particles can occur. The above water quality requirements also apply to land-applied water.

Limitations

Enforcement of safe discharge of chlorinated water may be difficult to achieve.

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