The science of stormwater - King County

http://www.kingcounty.gov/services/environment/water-and-land/stormwater/introduction/science.aspx

What is stormwater, where does it come from, and why is it important?

Many of our water pollution problems are due in large part to pollutants that are washed off the land by storms. The quality of stormwater from public facilities, commercial and industrial businesses, residences, and agricultural lands is an increasing concern nationwide. Many people believe that stormwater is "clean" and that it does not harm water quality. This perception is understandable since the amount of pollution from any one spot is not usually significant by itself. But when all these small amounts are combined, they can cause big water quality problems.

In vegetated areas such as forests, fields and wetlands rain water seeps into the ground. However, when rain falls on paved and other hard surfaces it runs off and is conveyed by pipes and ditches directly to King County's lakes, wetlands, and streams. **This water that flows across the land is called stormwater runoff. Stormwater runoff although starting as rain, collects pollutants when it hits the ground and travels.** For example, runoff from parking lots picks up oil and grease dripped from cars, asbestos from worn brake linings, and zinc from tires. Pesticides, herbicides, and fertilizers are washed off from landscaped areas, and soils are washed away from construction sites. Any substance found on the ground can wind up in stormwater runoff.

Storm drains lead to lakes and streams

Storm drainage systems are designed to decrease the chance of flooding in areas that have been developed with homes, businesses, and roads. The rainwater that used to seep into vegetated areas now must be collected and carried elsewhere. The storm drainage system collects this storm water runoff and carries it to the nearest wetland, lake, stream, or to Puget Sound. In urban areas the storm drainage system consists of drains and underground pipes. Storm drains are normally located in streets and parking lots. In rural areas the storm drainage system may be in the form of ditches that carry the stormwater along a roadside or piece of property. These drainage systems are meant to carry only unpolluted stormwater to the nearest natural body of water. **Putting oil, antifreeze, detergents, and other material into the storm drainage system is the same as dumping them directly into a lake or stream.**

The sanitary sewer system is different. Sanitary sewer drains lead to the sanitary sewer system and end up at a wastewater treatment plant. This system carries household wastewater and some permitted industrial wastewater. The wastewater in this system is treated before being discharged into a natural water body.

Keeping pollutants out of the water isn't just a good idea - it's the law. The Washington State Water Pollution Control Law (RCW 90.48) and the King County Code (KCC 9.12) prohibit the discharge of pollutants to the storm drainage system, surface water and groundwater. Direct dumping of material or polluted stormwater can negatively affect

every water body it enters. Pollution can cause: algal blooms that cause taste and odor problems and impaired recreation and aesthetics; lesions and tumors in fish and other animals; destruction of fish spawning areas and other habitat for plants and animals; decrease in fishing, swimming, and boating opportunities.

Many people know that it is illegal to dump toxic chemicals or other material down a storm drain. But you also are polluting if you allow pollutants to be washed into a storm drain with stormwater runoff or with wash water. For instance, **you may be polluting if you:**

- allow wash water from engine or equipment or car washing to enter a storm drain;
- spill antifreeze or other material without cleaning it up;
- allow materials or wastes stored outside to leak on the ground; or
- clear land without taking steps to prevent erosion.

How is stormwater polluted

Any substance that can render water harmful to people, fish, or wildlife or impair recreation or other beneficial uses of water is considered a pollutant. The broad categories of pollutants and their effects on fish and wildlife are described below.

Oils and greases

Oils and greases are a common component of stormwater runoff pollutants, primarily because there are so many common sources: streets and highways, parking lots, food waste storage areas, heavy equipment and machinery storage areas, and areas where pesticides have been applied. The familiar sight of a rainbow-colored puddle or trickling stream in parking lots, driveways, and street gutters is a reminder of the presence of oils and greases in stormwater runoff. Oils and greases can be petroleum-based or food-related (such as cooking oils). No type of oil or grease belongs in surface water. Oil and grease are known to be toxic to aquatic organisms at relatively low concentrations; they can coat fish gills, prevent oxygen from entering the water, and clog drainage facilities (leading to increased maintenance costs and potential flooding problems).

Metals

Many heavy metals, including lead, copper, zinc and cadmium, are commonly found in urban runoff. Metals can contaminate surface and ground waters and concentrate in bottom sediments, presenting health problems for fish and animals that eat from the bottom. Reproductive cycles of bottom-dwelling species can be severely reduced, and fish inhabiting such metal-contaminated locations often exhibit lesions and tumors. Metals can also contaminate drinking water supplies. Industrial areas, scrap yards, paints, pesticides, and fallout from automobile emissions are typical sources of heavy metals in runoff.

Sediments

Sediment - often originating as topsoil, sand, and clay - is the most common pollutant in stormwater runoff by volume and weight. Sediments readily wash off paved surfaces and exposed earth during storms. Sediment may seem harmless enough, but it poses serious problems in the water. Excess sediment concentrations turn stream and lake water cloudy, making it less suitable for recreation, fish life, and plant growth. Sediment is of particular concern in fish bearing streams where it can smother trout and salmon eggs, destroy habitat for insects (a food source for fish), and cover prime spawning areas. Uncontrolled sediment can also clog storm drains, leading to increased private and public maintenance costs and flooding problems. Sediment is also of concern because many other pollutants including oils, metals, bacteria, and nutrients tend to attach to soil particles. Therefore when sediments enter water they usually carry other pollutants with them. Cleared construction sites and exposed earth are generally the greatest contributors of soil particles in surface waters. Other sources include erosion from agricultural lands, application of sand and salts to icy roads, fallout from pressure washing and sandblasting operations, dirt from equipment and vehicles, and dirt and grit from parking lots, driveways, and sidewalks.

Oxygen-demanding substances

Plant debris, food waste, and some chemical wastes fall into a category of water pollutants known as oxygen demanding substances. Such substances use dissolved oxygen in water when they decay or chemically react. If dissolved oxygen levels in water become too low, aquatic animals can become stressed or die. Salmon and trout are particularly at risk because they need high dissolved oxygen levels to live.

Animal wastes, food wastes, leaves and twigs, and other miscellaneous organic matter carried by stormwater runoff into surface water can lead to reduced oxygen levels. Slow-moving waters are particularly susceptible to oxygen depletion because aeration of the water by turbulence is lacking. Therefore, oxygen that is depleted in slow-moving waters due to the presence of excess organic matter or unnatural chemical compounds is not replaced. Reduced oxygen levels in these waters are often particularly severe after a storm.

Nutrients

Nutrients such as phosphorus and nitrogen are needed by plants to grow, but high levels can be harmful to water quality. Excess nutrient levels can over-stimulate the growth of algae and other aquatic plants, resulting in unpleasant odors, unsightly surface scums, and lowered dissolved oxygen levels from plant decay. Nutrients are most likely to pose a problem in slow moving water such as lakes or sluggish streams. Some forms of algae are toxic to fish and other aquatic organisms and may even cause death in animals that drink affected water. Algae can also cause taste and odors problems in drinking waters, foul-smelling odor in ponds and lakes, and problems with clogged water intakes, drains, and pipes. Heavy loading of nutrients into slow-moving waters can adversely affect many beneficial uses of the water. Forms of nitrogen (ammonium), in combination with pH and temperature variations, can cause water quality problems and be toxic to fish. This process consumes large amounts of oxygen in the water and subsequently stresses or kills fish and other aquatic organisms when oxygen levels are reduced. Ammonia toxicity, due to nitrogen in its ammonium form, can harm fish and other aquatic organisms.

Fertilizers, animal wastes, failing septic systems, detergents, road deicing salts, automobile emissions, and organic matter such as lawn clippings and leaves are all contributors to excessive nutrient levels in urban and agricultural stormwater runoff.

Toxic organic compounds

Pesticides and PCBs are toxic organic compounds that are particularly dangerous in the aquatic environment. Excessive application of insecticides, herbicides, fungicides, and rodenticides, or application of any of these shortly before a storm, can result in toxic pesticide chemicals being carried from agricultural lands, construction sites, parks, golf courses, and residential lawns to receiving waters. Many pesticide compounds are extremely toxic to aquatic organisms and can cause fish kills. PCBs are a similar class of toxic organic compounds. They can contaminate stormwater through leaking electrical transformers. PCBs can settle in sediments of receiving waters and, like pesticide compounds, present a serious toxic threat to aquatic organisms that come in contact with them. Many other toxic organic compounds can also affect receiving waters. These toxic compounds include phenols, glycol ethers, esters, nitrosamines, and other nitrogen compounds. Common sources of these compounds include wood preservatives, antifreeze, dry cleaning chemicals, cleansers, and a variety of other chemical products. Like pesticides and PCBs these other toxic organic compounds can be lethal to aquatic organisms.

Fecal coliform bacteria

Fecal coliform bacteria in water may indicate the presence of pathogenic (disease-causing) bacteria and viruses. Pet and other animal wastes, failing septic systems, livestock waste in agricultural areas and on hobby farms, and fertilizers can all contribute fecal coliform bacteria. This can be a problem for treatment of drinking water and can limit recreational use of a water body. Bacterial contamination has led to closures of numerous shellfish harvesting areas and public swimming beaches in Puget Sound.

pH

The pH value of water is an indication of its relative acidity. The pH value can range from 0 to 14, with a range of 6 to 8 being desirable for most bodies of water. Waters with very high (basic) or very low (acidic) pH are corrosive to metal surfaces and can cause biological problems for aquatic organisms and fish. There are several sources that can contribute to change of pH in runoff. These include industrial processes that discharge acidic wastewater, solutions used in metal plating operations, acidic chemicals used in printing and graphic art businesses, cement used in concrete products and concrete pavement, and chemical cleaners used in homes and businesses.

How stormwater pollution is controlled

The federal Clean Water Act mandates that cities and counties control the quality of stormwater runoff. One way to achieve this requirement is to implement pollution prevention measures on individual properties. **These measures are often referred to as Best Management Practices, or BMPs.**

Stormwater runoff seeps into the ground, drains to a storm sewer or a drainage ditch, or flows over the ground. Regardless of the way runoff leaves a site, it ends up in a stream, lake, wetland, groundwater, or Puget Sound.

Contaminated stormwater can negatively affect every waterbody it enters. Best Management Practices provide detailed information on what we are all required to do to reduce the contamination of surface water, groundwater, and stormwater from our properties. It shows that we are all doing our part to protect our quality of life. Stormwater BMPs are required for all properties except single family residences. Single family homeowners contribute to stormwater pollution as well, and there are things that they can and should do to reduce pollution.

BMPs - What exactly are they?

BMPs are methods of improving stormwater quality, and thus surface water and groundwater. BMPs encompass a variety of managerial, operational, and structural measures that will reduce the amount of contaminants in stormwater and improve the quality of our water resources.

BMPs are separated into two broad categories: source control and treatment.

Source-control BMPs prevent contaminants from entering water bodies or stormwater runoff. Some source-control BMPs are operational, such as checking regularly for leaks and drips, and educating employees about site clean-up procedures. Other source-control BMPs require use of a structure to prevent rainwater from contacting materials that will contaminate stormwater runoff. Examples of these BMPs include a covered area or berm to prevent clean stormwater from entering work areas.

In contrast, treatment BMPs are structures that treat the stormwater to remove the contaminants. Most treatment BMPs require elaborate planning, design and construction. No treatment BMP is capable of removing 100 percent of the contaminants in stormwater.