

FOLLOW THE WATER

-A Study of Drainage-

League of Women Voters of Seattle
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This study is produced in memory of
Virginia Richmond, an advocate for Seattle shorelines
who devoted much time and many resources to the
League of Women Voters of Seattle.

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Introduction

In the natural environment, the downward course of rainwater is slowed by many features as it moves on its path to the sea. These features include vegetation that breaks the fall of rain and slows its movement, and deep soils in which rainfall may be absorbed as groundwater or move downward through meandering streams into swamps, marshes, and estuaries. As rainwater moves through these paths, it is slowed and, in the process, it is filtered and purified. The resulting wetlands maintain the water table and provide habitat for vegetation and for fish and other native species during the various stages of their lives.

Water becomes a problem when it becomes runoff from eroded agricultural lands and hard surfaces such as paved streets, sidewalks, parking lots and rooftops. This runoff may be rainwater or it may be water from watering gardens or washing cars. This water is a problem because it runs off quickly and carries contaminants with it including the oil and chemicals found on streets, and the fertilizers, pesticides, and weed killers used on lawns, gardens, parks, and golf courses. It may include chemicals used in building materials or for deicing the streets, and the particles shed from tires and brake linings. It may include banned pollutants leaking from old sources or sewage from poorly functioning septic tanks or system overflows during heavy rains.

When these waters run off quickly, the amount and speed of the flow may result in flooding, damage to stream beds and infrastructure, destruction of riparian habitats, damage to properties and the reforming of landscapes. Since these waters have not been slowed or filtered on their way, the contaminants they carry end up in our streams, rivers, lakes and other bodies of water.

Stormwater and wastewater impact the local environment. Governments, environmental groups and individuals are concerned about flooding, threatened species, habitat destruction, and the many pollutants in local waters. The focus of this article is runoff, whether best described as wastewater or stormwater, the

history of its management and changing practices in response to evolving research.

Clean Water Is Essential

Clean water is essential for life as we know it. Historically, systems for delivering water to populations were in existence in the Middle East as long as 4,000 years ago. Systems for supplying water were usually followed by systems for disposing of waste and keeping the water supply clean. Lack of communication and scientific knowledge led to crisis after crisis in settled areas throughout the world as residents failed to grasp the dangerous connection between wastes and drinking water.

An abundant and continuing supply of clean fresh water and the responsible disposal of polluted waters remain a worldwide problem. Throughout the world, groups concerned about the survival of species, habitat preservation and destructive flooding are rapidly changing their approaches to wastewater management.

Although Seattle and King County, unlike many areas of the world, have a good drinking water supply, the destructive impacts of traditional wastewater and stormwater management are becoming apparent. Realization of the impacts of traditional methods of stormwater has led to changes through the years in the ways stormwater and wastewater are managed.

The Seattle Story

In the 1860s, shortly after settlement, Seattle's water supply was uncertain and waste materials piled up. Those were the days of outhouses, chamber pots, and garbage and animals in the streets. Seattle's population grew rapidly during the latter part of the 1800s, and its haphazard water and sewer systems gained the city a reputation as an unhealthy setting. Outbreaks of cholera and typhoid were the impetus for developing a protected water supply, sewers and storm drains. The great fire of 1889 provided the opportunity for developing what were then considered state of the art water and sewage systems. These included wood pipes, cesspools, and garbage hauled to landfills. By the early

1900s Seattle boasted of being the world's healthiest city. (SPU history¹)

Economic Growth Takes Precedence

At the same time, changes were taking place that would have a long term impact on the city's environment. In 1905, dredging began at the mouth of the Duwamish, a first step in its conversion to an industrial waterway. Downtown hills were leveled and scraped. The soils were used to fill the tidal flats and to give Elliott Bay the familiar abrupt edge that is more conducive to industry and shipping than to natural habitat. Closing the gap between Puget Sound, Lake Union, and Lake Washington was also a long term goal, realized with the completion of the Ballard Locks and the Montlake Cut in 1917. Lowering Lake Washington nine feet meant that major changes in the area's drainage pattern also took place. The Ballard Locks became the outlet to the sea for Lake Washington. The Cedar River became the lake's major inflow. Dikes, levees and dams were built to control water flow and to make low-lying lands suitable for agriculture and industry.

Sewer Systems Are Developed

During the early 1900s, engineers built combined sewers, single pipelines that carried wastewater and stormwater into the nearest body of water. In 1913 Seattle completed a mammoth brick sewer, twelve feet in diameter, that ran across the north end of Seattle to Fort Lawton (Discovery Park) where a pipe carried the effluent out to a depth of about twenty-five feet. It was believed that dilution and natural forces would purify the water. Since the 1950s, cities have separated their stormwater and wastewater systems, but in parts of Seattle, the old system remains.

Many of Seattle's early sewer lines were combined lines. One thousand miles of these lines continue to serve the city. When heavy rains hit the system, the lines cannot contain the waters and there are overflows. These overflows take place at identified sites known as Combined Sewage Outflows (CSOs) and continue to dump

untreated wastewater into local bodies of water. (See article on Stormwater, p. 36)

New Highways Bring New Suburbs

During the 1950s and '60s, the national highway system was built and the suburbs grew rapidly. Suburban development continued the common practices of clearing forests, scraping off topsoil prior to construction, and channeling runoff and wastewater into gutters or pipes where it could move swiftly to the nearest large body of water. The increasing miles of highways, streets, and sidewalks, a part of the urban and suburban scene, became collectors of harmful substances that moved along quickly into the drainage system, causing more problems.

This Water Is Filthy

The history of the management of runoff is a story of missteps, probably led by a vision of economic opportunities and a limited view of the ecosystem. Seattle's boast in the early 1900s of being a healthy city was premature. The drinking water supply was clean, but by the 1950s Lake Washington was grossly polluted and the beaches of Fort Lawton (Discovery Park) were covered with slime. Sewage was typically piped out into the nearest body of water in the hope that dilution and dispersion would make it go away. Civic activist Jim Ellis and other civic leaders, including the League of Women Voters, initiated a campaign to clean up local waters through a King County governance system known as Metro that would establish a regional waste disposal system. After much discussion, the people voted for the measure in 1958. Metro built a plant at West Point (Discovery Park) to provide primary treatment. Primary treatment removes about half of the solids from sewage and then chlorinates the discharge to kill harmful organisms. At the time, this was standard wastewater treatment. The West Point plant opened in 1962 and is now described as a secondary treatment plant.

Additional plants were built at Renton and Carnation. Both of these plants provide additional treatment and produce some reusable effluent. The next major addition to King

County's wastewater management system will be the Brightwater plant in Snohomish County. Discussions are taking place as to potential uses for the reusable water that the plant will be able to produce.

The area continues to pride itself on the cleanliness of Lake Washington and other local waters now safely used for swimming, fishing, and a variety of recreational purposes.

The View of the World Expands

In 1962, Rachel Carson's book *Silent Spring* was published. Her immediate concern was the impact of the indiscriminate use of pesticides on the birds she loved to watch. As a result of her book, people became concerned not only about their own health but about the health of the planet. The concept of ecology grew in the 1960s, and the public pressured Congress and President Nixon to take some action. In 1969, Nixon set up a cabinet level Environmental Quality Council and a Citizens' Advisory Committee on Environmental Quality. With the current concern for the environment and the ecosystems that it encompasses, it is hard to comprehend the lack of awareness of those concepts fifty years ago. Congress passed the National Environmental Policy Act (NEPA) in December of 1969, and President Nixon signed it on January 1, 1970. The bill was comprehensive and called for the establishment of a Council on Environmental Quality. It was described by Senator Gaylord Nelson as the most important piece of environmental legislation in our history.

The first Earth Day was held on April 22, 1970, and 20 million Americans came out for peaceful demonstrations. The Environmental Protection Agency (EPA) was established with subsequent legislation. After a flurry of discussion and negotiation, the EPA assumed many of the responsibilities such as air and water quality that had been the responsibility of other agencies. Bill Ruckelshaus, an assistant attorney general, was appointed the first director, and although the first years of the agency are described as rather chaotic, his energetic leadership is credited with establishing the agency as a vigorous advocate for the environment.

The Clean Water Act (CWA) had been passed in 1948, with amendments in 1972 and 1977. The act established the basic structure for regulating discharges into the waters of the U.S. Under the CWA, the EPA implemented pollution control programs and set wastewater standards for industry. It became unlawful to discharge any pollutant into navigable waters without a permit. That permit system, the National Pollution Discharge Elimination System (NPDES), established by the EPA, controlled point sources. Point sources are municipal or industrial pipes or ditches that lead to a body of water.

Ruckelshaus, in speaking of those early days, said that at the time he felt that the technologies existed to control pollutants and keep them at acceptable levels at reasonable cost; that national standards and enforcement were what was needed to solve the problem. He later noted that he was wrong on all counts. (Lewis²)

Many of the early examples of pollution were blatant. Rivers burned, death rates increased with air pollution and sewage piled up. But Ruckelshaus soon learned that identifying and controlling many pollutants is not an easy task. It often requires research over a long period of time. Think of DDT, the PCBs, asbestos, etc. Banning a practice or chemical has an economic impact, and decisions are subject to political pressure. The current interest in organic products suggests that the public has become unsure of the safety and long term effects of the many additives that may have tainted the products in the marketplace.

Many historic practices of businesses and governments in using and disposing of environmentally detrimental materials that were not regulated at the time of their use have led to highly polluted sites that impact the health of people who live near them and damage the ecosystems of which they are a part. In King County, the Duwamish River and the industrial areas adjacent to it form such a site.

In 1980, the Superfund legislation was passed. It created a tax on the chemical and petroleum industries from which a trust fund

was established for cleaning up abandoned or uncontrolled hazardous waste sites. The Duwamish River was listed as a Superfund site in 2001. There are several other Superfund sites as well in the Harbor Island area and in Lake Washington. (Superfund³) (See Duwamish River, p.35)

State Responds to Growing Environmental Concerns

At the state level, Governor Dan Evans won passage of the State Environmental Policy Act (SEPA) in 1971. SEPA requires that governmental agencies consider environmental factors in developments that may impact the environment. If initial government review indicates an action such as building a bridge or a highway or siting a business meets certain criteria, the preparation of an Environmental Impact Statement (EIS) is required.

The state also passed the Shoreline Management Act by public referendum in 1972.

The act has three broad goals: 1) to protect shoreline natural resources 2) to promote public access and 3) to encourage water-dependent uses. The Shoreline Management Act applies to all marine shorelines, such as Puget Sound, and larger lakes and rivers. It also applies to upland areas within 200 feet of the shoreline edge, floodplains and associated wetlands. The Seattle Shoreline Master Plan was last updated in 1987, and a current update is scheduled for completion by 2009. The state requires local governments to periodically update the shoreline regulations within their boundaries, consistent with state guidelines.

The Growth Management Act (GMA) was signed into law by Governor Booth Gardner in April of 1990. The concept was controversial, and the measure was a compromise. Since adoption, it has been amended regularly but it has established guidelines for managing growth in Washington's most populous counties. The GMA requires that jurisdictions within the designated counties develop comprehensive plans that are regularly updated.

The GMA requires that local governments

protect wetlands, fish and wildlife habitat, and areas that are flood-prone, are subject to landslides, or are necessary for groundwater recharge. Ordinances governing critical areas, stormwater, clearing and grading are collectively known as Critical Areas Ordinances (CAO). The purpose of the CAO is to protect health, safety, and environmentally sensitive areas.

Critical areas and ecosystems include:

- wetlands
- areas important for fish and wildlife
- riparian corridors
- geologic hazard areas such as landslide and liquefaction-prone slopes
- flood prone areas
- abandoned landfills
- Seattle fault zone and areas at risk from tsunamis, seiches and lahars

King County and Seattle updated their Critical Areas Ordinances in 2006. The revisions focused on widening the buffer size for many wetlands, increasing protection of shoreline habitat for fish and wildlife, prohibiting the use of pesticides and fertilizers within fifty feet of streams, wetlands, and shorelines, and limiting development and encouraging vegetation along creek corridors. Opposition in the county centered on the ordinances extending the width of wetland buffers and limiting land clearing in critical areas.

In 1995 the GMA was amended to require counties and cities to include the best available science in establishing policies and regulations to protect critical areas. Periodic review of such ordinances by counties and cities is required by a schedule established by the state. (GMA⁴)

King County Plans

The growing national environmental awareness of the 1960s–1970s was also reflected in local actions. King County won national recognition for its Comprehensive Plan adopted in 1964, which relied on written policies to guide land use decisions. While the plan was a significant step for the county, it did not fully anticipate the effect of the rapid growth that the county would experience and did not provide the framework

to coordinate the plans of private enterprise and public service that growth produced.

The county then embarked on a study that led to the development of the 1985 King County Comprehensive Plan. This plan:

- established links between policies and implementation,
- established the Urban Growth Boundary that differentiated between rural and urban areas with specific policies for each area,
- provided for the preservation of critical areas, open spaces and resource lands.

Prior to the passage of the GMA in 1990, King County and the neighboring counties of Pierce, Snoqualmie and Kitsap formed the Puget Sound Regional Council (PSRC), which now serves as the multi-county planning body required by the GMA. The PSRC developed VISION 2020 as its initial long term planning document and is now working on VISION 2040.

In 1994, King County adopted its first comprehensive plan as required under the terms of the GMA. The plan undergoes substantive revision every four years and those revisions were completed in 2000, 2004 and 2008. Each revision has broadened the scope of the plan and included goals directly related to the environment. (King County⁵)

Flooding Is an Area-Wide Problem

Residents of Western Washington are surely aware that flooding is a widespread problem. Responding to snow melts and heavy rains is challenging. Ideally, fall and winter rains fall as snow in the mountains that melts gradually in the spring and summer. The records indicate that the type of flood expected to happen in the area every 100 years is happening more frequently. King County has been declared a federal disaster area ten times since 1990. Flooding has occurred in all the major river systems in King County during that time period.

The Kent and Sammamish Valleys were once part of extensive wetland systems that have been converted to agricultural and industrial use

through damming and an extensive levee system. The areas are subject to flooding.

Traditional flood protection strategies included the construction of hard faced levees and the removal of sediment and large wood from streams. A major purpose of the strategies was to allow for increased development. Traditional approaches were not sensitive to the importance of habitat and its preservation.

The King County Council has been authorized by state ordinance to establish and serve as the board of supervisors of the King County Flood Control District. In 2007 the council adopted the King County Flood Hazard Management plan, which identifies and recommends policies, projects and programs to address flooding in King County. The council authorized a ten year property tax levy to fund the projects.

The King County Council's current efforts to deal with floods in unincorporated areas of the county indicate emerging approaches to flood control. The flood hazard management plan is broad in its approach, considering existing development, habitat, open space, agriculture and recreation. It attempts to accommodate river processes rather than control them. The plan includes building levees that are setback from the streams and support a riparian habitat, acquiring properties that repeatedly suffer losses, changing standards for buildings in areas susceptible to flooding, and improving warning systems and public education.

In the Sammamish Valley, more agricultural in nature, building standards have also been changed and farmers have been allowed to build elevated pads where animals, feed supplies and equipment can be moved in times of high flood risk. (Flooding⁶)

And Then The Salmon Disappeared

In 1999, the Puget Sound Chinook were listed as a threatened species under the terms of the Endangered Species Act (ESA). The federal Endangered Species Act was first passed in 1969 and has been amended several times since. When a species is listed as threatened, the ESA

requires that a recovery plan be developed and approved. For the Puget Sound Chinook, it required a collaborative effort among federal, state, tribal and local governments as well as business and environmental organizations.

Water management in Washington is an extremely complex subject. The state is divided into sixty-two Water Resource Inventory Areas (WRIAs) or major watersheds. WRIA 8 includes the Sammamish-Cedar system and WRIA 9 includes the Green-Duwamish system. Each WRIA includes many local governmental jurisdictions. The February 2007 League of Women Voters publication summarizes a state study on water resources that gives extensive background on the state's water resources. (Voter⁷)

Prior to 1850, the areas encompassed in WRIAs 8 and 9 were heavily forested, with meandering streams and numerous wetlands. Lowering the level of Lake Washington also lowered Lake Sammamish and affected many of the wetlands around it. The Sammamish River, like the Duwamish, was straightened and much of its shoreline hardened. In summary, through the years, local policies have created conditions that are detrimental to the survival of salmon. They have altered the flow and temperature of streams, altered the flood plains, cleared riparian vegetation, altered the stream beds and have also added chemicals, heavy metals and a slew of other pollutants.

Less than half of steelhead and salmon stocks in Puget Sound are considered healthy. Statewide, sixty-five percent of estuary miles have temperatures exceeding state water quality standards. Fifty-seven percent of the streams assessed in the Puget Sound lowland exceeded the standards for fecal coliform bacteria.

The decline of the Chinook is generally attributed to four factors: habitat, hydropower, harvest, and hatcheries. In response to the listing, the fourteen watershed groups which surround Puget Sound came together to develop a shared strategy. The strategy which also included the threat of pollution as a factor was presented for public comment and then

submitted and adopted as the Puget Sound Salmon Recovery Plan in January of 2007. Habitat is the focus of the planned strategy since this is the one of the factors over which local jurisdictions have the most control. (Salmon⁸)

And Puget Sound Is In Trouble

The Puget Sound Partnership (PSP) was created by the state legislature in 2007 to lead efforts to restore the health of Puget Sound. The initial organizing group established was the PSP with Bill Ruckelshaus as its chair. This group is now known as the Leadership Council. The group then recommended David Dicks as the Executive Director of a newly established Puget Sound Partnership. The partnership was given three charges by the Legislature: 1) to establish an action agenda with the goal of accomplishing a 2020 cleanup of Puget Sound. 2) to develop measures of accountability and 3) to educate the public.

An Ecosystem Coordination Board is chaired by King County Executive Ron Sims. A nine member science panel chaired by UW Tacoma professor Joel Baker provides independent scientific advice.

An initial task of the partnership was to develop an action agenda for producing a healthy Puget Sound by 2020. A draft Puget Sound action plan was released in November, 2008. The action plan was adopted after public comment, and the partnership fulfilled its obligation to submit the action agenda to the legislature by December 1, 2008.

David Dicks, PSP executive director, in a presentation at a Plymouth Congregational Church Sunday Forum, outlined the strategies that he thought were essential for saving Puget Sound. He said that we must maintain the best places that now exist. He cited feeder bluffs as an example. Feeder bluffs crumble into the water, add nutrients and maintain the beaches below with needed sand. This need can create tensions. People who live at the top of those bluffs are trying to stop the soil from sliding out

from under them, although it is badly needed to maintain the beaches below.

Dicks said that we must maintain or recreate some of the historic functions of the wetlands that bordered many bodies of water. He noted the restoration of the Nisqually Delta and the removal of the Elwa Dam as examples of that kind of action. Shoreline Management and Critical Areas regulation also serve that purpose. Dicks pointed out that most of the pollutants coming into the Sound are from non-point sources, namely runoff. He estimated that an average of 150,000 pounds of pollutants reach the sound each day from these non-point sources. (PSP⁹)

Dicks believes that the organization for saving Puget Sound has to be restructured. There are hundreds of organizations with thousands of members that have a strong interest in the local environment and actively pursue specific goals. Coordination is needed to establish priorities and to develop relevant action plans.

People for Puget Sound is a nonprofit organization under the leadership of Kathy Fletcher that has been a tireless advocate for the protection of Puget Sound and the Straits of Juan de Fuca. It has spearheaded the campaign to pass required legislation and educate the public. The Puget Soundkeeper Alliance is another active organization, whose mission is to track down and stop the discharge of toxic pollutants into its waters. (People¹⁰) (Keepers¹¹)

Some Decisions Were Shortsighted

The city's history has come back to haunt us. Streets were paved, hills flattened, rivers straightened, and wetlands filled to become agricultural areas or to facilitate growth in urban areas. It is hard to believe that the areas that now make up the parking lots and athletic fields near Lake Washington were once a city dump. Piling trash in the wetlands seemed like a good way to deal with the wetlands and the trash. Stormwater systems were developed to move runoff quickly into the pipes that led to bodies of water or later, treatment plants.

Streams were often diverted into underground pipes or through culverts and frequently used as a dumping ground for trash. Shorelines were hard-surfaced so that waters would move along quickly rather than spread out into adjacent wetlands. Dams, dikes and levees were built to keep water out of lowlands so they could be used for other purposes.

Another source of pollution related to stormwater is the incorporation of sewage into runoff waters. There are several sources of such wastes. One is the actual presence of animals or animal waste in waterways. Another is failing septic systems in areas where sewer lines may not be established. Another is the situation where sewer and storm drainage lines are not clearly separated and heavy runoff results in overflows of untreated sewage that is carried into local bodies of water.

Polluted runoff is also produced by construction practices that scrape off the forests and soil surfaces developed over thousands of years as repositories and filtering systems for the rain water that falls on them. This is particularly a problem in suburban areas where land is often prepared for development by clearing and bulldozing in preparation for building. Destroying the natural vegetation, especially the forests, is now recognized as a destructive practice with long-term effects.

Take a New Look

It is becoming apparent that the accepted practices of businesses, builders, residents, gardeners and governmental agencies contribute to a system in which the polluted runoff from those activities is proving to be a major factor in hindering the goal of achieving clean waters and a healthy environment.

Current research suggests that the earth functions as an ecological system with myriad subsystems:

- That vegetation, notably forests, plays a major role in maintaining a healthy environment;
- That pollutants are best eliminated at the source;

- That efforts should be made to limit the amount of wastewater and more natural pathways should be developed for its incorporation into the environment.

The City System at Work

Seattle Public Utilities is the city department that manages waste, runoff and water within the city of Seattle. It was organized in its present form in 2006. The activities of the department are prescribed by the many requirements of the Washington State Department of Ecology and the federal mandates administered by that department. The SPU is now operating under a Comprehensive Drainage Plan adopted by the city council in 2005. Earlier comprehensive plans focused on major flooding problems in specific drainage basins in the city.

The current plan expands the surface water management role of SPU to include the following programs:

- Stormwater conveyance and flow control,
- Aquatic resource protection of both water quality and habitat,
- Public asset protection.

The stormwater conveyance program works to alleviate flooding and focuses on protection of health and safety and on protection against property damage. SPU has addressed, but not solved, most flooding problems associated with the main piping system and is now working to try to solve drainage problems locally using detention and infiltration.

Water quality programs continue to focus on controlling pollution at the source, and the drainage plan requires expanded monitoring activities. For habitat protection, the plan includes an increased focus on habitat including improving and protecting habitat conditions along creeks and affected shorelines.

The public asset protection program focuses

on protection of drainage and wastewater infrastructure from undue risks and liabilities due to landslides; and on mitigation of the direct effects of system operation on or within landslide prone areas, including protection of other properties from landslides that could be caused by inadequate city infrastructure.

The SPU Drainage Plan is under review. Urban creek stewards who expressed their concerns about current practices were urged to participate in developing the revised plan.

The Federal Clean Water Act requires that jurisdictions that discharge stormwater into surface waters have a permit. These permits originated in the early 1990s, and were first required of large cities, state departments of transportation, and large county-owned stormwater facilities. The permits were called Phase I National Pollutant Discharge Elimination System regulations (NPDES). Seattle is now involved in the process of meeting the standards in the state's stormwater manual and renewing its NPDES permit. The permit will next be updated in 2012. Smaller cities are now subject to Phase II requirements. Eighty additional cities in Washington are now subject to permitting and must prepare a plan consistent with the state's stormwater manual. (SPU Planning¹²)
(See Stormwater Article, p.36)

What Have We Learned

Runoff and habitat destruction are critical factors that must be addressed in maintaining clean waters, maintaining and restoring native species, and maintaining Puget Sound. What is also becoming apparent is that individual and governmental practices contribute to the amount of pollutant material in runoff.

Rapid Runoff Is Costly

The costs of traditional systems of stormwater management are being recognized. Runoff is being widely recognized as a major source of pollution but the rapid movement of large amounts of fast moving water has many

other impacts. The water moves rapidly over hard surfaces picking up pollutants on the streets and carrying them swiftly to a body of water or piping system. When these waters enter streams, they damage the existing habitats and often overflow. They overwhelm the sewer system and cause overflows into local bodies of water. They cause flooding and landslides, and destroy homes, agricultural lands, plant cover and infrastructure.

It is estimated that one-third of the pollution in Washington waters comes from stormwater sources. After rainstorms, twenty-three different pesticides have been found in Puget Sound streams. The impact of rapid runoff on the salmon population as it affects water quality and habitation has already been discussed. In addition, thousands of acres of potential shellfish production areas have been destroyed or contaminated.

Within Seattle's current drainage system, in which wastewater and stormwater are carried in many of the same pipes, heavy stormwater flows result in overflows that carry pollutants into local bodies of water.

Stormwater Management Is Changing

In 1997, planners in Prince George County, Maryland indicated that they were going to use a new approach to cope with the problems caused by traditional methods of stormwater management even if it contradicted current and past practices. They were going to use decentralized small scale source control techniques to manage runoff. Those techniques became known as Low Impact Development (LID) practices. Now, less than a dozen years later, LID techniques are used worldwide and are highly publicized. Traditional practices resulted in inconsistent flows, varying water temperatures, polluted runoff and habitat destruction. LID practices attempt to stop pollutants at the source, preserve native soils and vegetation, and use natural and small storage features that allow water to infiltrate the ground slowly. These techniques are now widely used and subject to ongoing research, experimentation and regulation.

Such terms as Best Available Science (BAS), Best Management Practices (BMP), LID (Low Impact Development) and Natural Drainage Systems (NDS) are becoming accepted terminology in coping with runoff and habitat preservation. Best management practices are generally applied to locations that use materials or methods of operation that may allow pollutants to become part of the runoff if they are not carefully controlled. Methods of storage, emergency plans and temporary covers are required for businesses that may have polluting materials on site. Best management practices also include preserving site topsoil and vegetation where possible, reducing compaction and amending disturbed soils with compost to restore healthy soil functions (NDS¹³)

To illustrate, traditional development and low impact development approaches are described below.

Traditional building practices:

- Building site scraped and regraded, topsoil hauled away.
- Roofed buildings fill as much of the allotted space as the code allows.
- Building materials not evaluated in terms of chemical runoff.
- Gutters carry water from the roof to downspouts to the sewer lines.
- Impervious walkways, patios, and driveways.
- Buildings face a paved street with gutters that open to the sewer lines.
- Probably a sprinkler system installed to water a grassy lawn.
- Shrubbery chosen on a questionable basis.

Low impact development: (High Point Development in West Seattle)

- Minimal grading, topsoil stockpiled and reused.
- Approximately 2500 new trees added.
- A pond that collects and cleans stormwater runoff and directs the cleaned flow into Longfellow Creek.
- Over twenty-one acres of open space.

- Parks and open spaces maintained by organic landscaping methods.
- Pedestrian-friendly narrow streets and wide planting strips.
- Porous pavements and swales.
- Natural drainage system for entire 120-acre site.
- Native/drought resistant plants. (SHA ¹⁴)

Seattle Develops a Plan

The Seattle Urban Creeks Legacy originated in 1999 as part of Seattle's Millennium Celebration. It was, in part, a response to an active citizen effort to daylight local streams. The city's four largest streams were chosen: Longfellow, Piper, Thornton and Taylor Creek. The basic goals were to improve the habitat, improve water quality and control creek flow. A major accomplishment of the project was the development of the creek stewardship program and its public education component. Most residents know their watershed. School children watch salmon eggs mature in tanks and take the young salmon to neighborhood streams. The stewards are knowledgeable about their area, its problems and needs.

The city has spent millions of dollars on stream restoration. Creeks have become valuable community resources, but the salmon coming up Longfellow Creek are dying before they spawn. The flow in the creek is controlled, the habitat is restored but the fish are dying. Extensive research is underway and early indications suggest that the pollutants found in runoff are responsible.

SPU has been experimenting with natural drainage systems for several years. Overflows of local streams during heavy rainfall were becoming an increasing problem. The first natural drainage system constructed by the City of Seattle was the SEA Street project, completed in the spring of 2001. It was followed by the 110th Street Cascade, completed in 2003. The Broadview Green Grid was completed in the spring of 2005. The High Point system was completed in 2005.

SPU has partnered with the University of Washington and the Department of Ecology to monitor and evaluate these projects. For a current review of the status of each creek, see City of Seattle, *State of the Waters 2007*. (Waters¹⁵)

The City Develops a Strategy to Restore Our Waters

In 2004, Mayor Nickels instructed twelve city departments to conduct an inter-departmental review of everything the city does that affects water resources within the city limits and to develop a shared action plan. From this work, the city developed the plan called Restore Our Waters (ROW).

The initial directive from the mayor to twelve city departments was to develop a shared action plan that would:

- -focus the city's efforts towards achieving what is best for water quality and aquatic habitats,
- -establish city-wide priorities, a shared framework for investment, and best management practices,
- -develop a long-term framework for departments to work together on matters affecting local bodies of water,
- -streamline and coordinate city policies, regulations, and enforcement,
- -create educational opportunities that inspire others to take action on behalf of local bodies of water,
- -provide incentives for others to steward, protect, and restore these resources,
- -identify methods to leverage city funding of these efforts,
- -create a mechanism for stakeholder involvement.

The work resulting from this directive resulted in nine related action strategies that represent a broad but specific program for restoring the waters in the city.

Included in the proposed actions are:

Action 4: Make strategic changes in the city's policy and regulatory framework.

Action 5: Move forward on priority city

capital project investments.

Action 6: Make investments to ensure city operations support improved aquatic health.

These actions were selected because they represent specific responses to the goals listed above.

The city's required plans, the Comprehensive Drainage Plan, Stormwater Plan, Critical Areas code, and Shoreline Master Plan are challenged to meet the goals of ROW. In addition, forty priority capital investments for the city to make over the next ten years have been identified.

They include:

- -Seven water quality improvement projects targeting the lakes and Puget Sound,
- -Two major sediment removal projects for the Duwamish and Gasworks Park,
- -Four natural drainage projects that include the streams,
- -Comprehensive flow control strategies to reduce flows in high impact drainages (Thornton, Longfellow, Piper, Taylor),
- -Studies to assess and facilitate channel widening strategies on the major streams,
- -Fourteen shoreline habitat restoration projects,
- -Reforestation projects on creeks and key shorelines.

Funds for these projects have been included in Seattle's biennial budget.

Selected Activities Included In ROW

Seattle is recognized as a national leader in achieving green building standards on city-funded facilities and promoting green building in the community. The city's green building strategies include green roofs, rainwater harvesting, natural landscaping, natural drainage, on-site infiltration, and porous pavement systems. The Department of Planning and Development (DPD) is encouraging green building in the private sector through education. The DPD is proposing updates to the codes and facilitating the permit process. (ROW¹⁶)

Current Best Available Science and Best

Management Practices suggest:

- A narrow street that is made of permeable materials, and is bordered with plants, has no gutters and no grate that empties into the sewer system.
- A house or garage with a green roof.
- Downspouts that empty on to the front lawn or into a rain garden.
- A garden that is not watered, fertilized with chemicals or sprayed with insecticides, but is enriched with compost.
- A house whose components, roof, siding, etc., have been tested to make sure they are not shedding some polluting material.
- An increasing forest cover.
- Bridges and streets that have built in runoff collectors that treat the pollutants or funnel the water into natural pathways that filter the pollutants out of the system.

Individual Actions Are Important

Much of this article has focused on the change of public attitudes toward the environment, the emerging role of science, and role of government in developing and enforcing standards. It is also becoming apparent that a major current cause of pollution is in the runoff from the areas in which we live.

Individuals can limit runoff and pollutants if they:

Limit the amount of water used for plant and lawn irrigation. Choose plants that are drought resistant and suitable for the area in which they are planted. Most carefully chosen plants should require no supplementary watering after they are established.

Eliminate the use of chemical fertilizers, weed killers, and pesticides.

Never pour hazardous materials such as solvents, oil, weed killers, pesticides, etc. down the drain. Easily accessible hazardous waste disposal sites are available.

Properly dispose of unused medications.

Prevent erosion by maintaining natural vegetation and tree cover on slopes.

Eliminate grassy lawns that require much care and often serve no specific purpose. The habitat established in a neighborhood influences the bird and other species that survive there. Canada Geese love grassy lawns.

Use compost to improve soil. In the history of agriculture, the need for more land has led to the removal of forests and natural ground covers that preserved and enriched the soil in place.

Plan for patios and walkways that are not hard surfaced. Choose surfaces with spaces such as tile or brick that allow water to drain. Permeable sidewalk materials are also available.

Create areas such as flower beds or mini-collection areas where water can sink slowly into the ground.

Allow downspouts to drain into a garden area or a rain barrel.

Don't use the street as the place to wash the car. Commercial car washing sites are equipped to properly dispose of wastewater.

Maintain automobiles so they are not dripping liquids such as oil or coolant.

Limit the amount of organic material that goes into the drainage system. Many homes are equipped with garbage disposals that add organic compounds to wastewater.

Most of those materials may now be disposed of in yard waste containers.

Members of organizations, employee groups, and other associations, can:

Urge organizations to limit the use of fertilizers and pesticides.

Advocate for parking areas with flower beds and rain gardens.

Check the policies in place at the neighborhood school.

Review the policies and practices of the condominium association.

Citizens can:

Participate in area activities to preserve and enhance the watershed.

Follow and support the actions government to protect the environment.

Question governmental activities that seem to be in conflict with environmental goals.

Once More

Currently, the most effective ways of limiting pollution are:

- Controlling runoff.
- Stopping it at its source.
- Limiting the amount of wastewater.
- Developing more natural pathways.
- Eliminating practices that add pollutants.

Many of the above actions require major changes in the way government agencies do business. Others require cooperative neighborhood action with technical help. But individual actions are very important and can stimulate large-scale actions and changes in policies.

Endnotes

1	SPU history	Seattle Public Utilities, www.seattle.gov/util .
2	Lewis	Jack Lewis, "The Birth of EPA", <i>EPA Journal</i> , Nov., 1985.
3	Superfund	Superfund, www.epa.gov/superfund/ .
4	GMA	Growth Management Act, HistoryLink.org Essay 7759.
5	King County	History of Comprehensive Planning in King County, HistoryLink.org. Essays 7752 and 7874.
6	Flooding	Flooding and Floodplain Management in King County, Presentation to LWVS, 11/19 www.kingcounty.gov/environment/waterandland/flooding/flood-control-zone-district .
7	Voter	Denise Smith, "Challenges of Water Supply in Washington State," <i>Seattle Voter</i> , Vol. 48, No. 7, Feb. 2007.
8	Salmon	The Steering Committee, Proposed WRIA Chinook Salmon Conservation Plan. Feb., 2008 www.govlink.org/watersheds/8/planning/chinook-conservation-plan.aspx .
9	PSP	Puget Sound Partnership, www.psp.wa.gov .
10	People	People for Puget Sound, PugetSound.org .
11	Keepers	Puget Soundkeeper Alliance, PugetSoundkeeper.org .
12	SPU planning	Federal Clean Water Act, www.epa.gov/watertrain/cwa/ .
13	NDS	"Natural Drainage Systems Manage Stormwater, Create Greenspace," www.ecologycenter.org/terrain .
14	SHA	Seattle Housing Authority www.thehighpoint.com/uli_award_2007.php .
15	Waters	City of Seattle, <i>State of the Waters 2007</i> .
16	ROW	The Mayor's Restore Our Waters Strategy, City of Seattle, 2004.

Speakers Who Met With Committee

B. J. Cummings, Coordinator Duwamish River Cleanup Coalition,
 Julie Hall, Strategic Advisor, Seattle Public Utilities, Science, Sustainability and Watershed Branch
 Maggie Glowacki, Senior Planner, Fisheries Biologist, Dept. of Planning and Development
 Debra Ross, Planner, Project Planning and Delivery, Wastewater Treatment Division.
 Heather Trim, People for Puget Sound,
 Jason Wilkinson, Program and Policy Support, River and Floodplain management, Water and Land Resources Division, King County.

Committee Attended Three-Part Environmental Series at Plymouth Congregational Church:

1. Gene Duvernoy, Cascade Land Conservancy, November 2, 2008
2. David Dicks, Puget Sound Partnership, November 9, 2008
3. KC Golden, Climate Solution

Committee members also:

4. Attended Urban Stream Stewards Workshop in December, 2008
5. Attended the 2010 Combined Sewer Overflow Reduction Plan Workshop in September, 2008

Participated in Shorelines Field Tour: Shorelines Today and Tomorrow. Updating Seattle's Shoreline Master Program, Sept. 6, 2008. Led by Lorraine McConaghy, MOHAI, Maggie Glowacki, DPD, Judith Noble, SPU, and Eric Hansen, Port of Seattle.

General reference

Montgomery, David R., *Dirt, The Erosion of Civilization*, Univ. of California Press, 2007.