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Residential Car Washing

New data - and controversy - the state of Washington

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Society has been slow to recognize the link between individual behaviors and practices, and the detrimental impacts that they may have on our natural aquatic resources. One of these practices, residential car washing, may give rise to surface-water-quality problems that can be felt well beyond the front yards and driveways of the communities where it occurs.

Portrayed as innocuous, residential car washing is a common scene during any weekend, in any cul-de-sac, in any neighborhood, and in any city across America's vast patchwork quilt—including our town, Federal Way, WA. The conventional wisdom for many washing their cars is this: Once vehicle wash water gets hosed off the pavement and disappears down the drain, it is out of sight and out of mind.

In some instances, car washing is carried out on lawns, in side yards, or on graveled areas. However, in most cases, it is performed on impervious surfaces—that is, driveways or streets—where the wash water drains directly into the municipal separate storm sewer system (MS4). In an attempt to better understand the nature of these discharges to the MS4 and to quantify their potential impacts, the Water Quality section of the Surface Water Management Division of Public Works in Federal Way embarked on a small study to illustrate the links between car washing, stormwater, local surface waters, and Puget Sound.

Most citizens falsely assume that stormwater is treated before it gets to streams, wetlands, and other waterbodies. They may ask, "What could be so dangerous in the harmless-looking white-with-foam river running into the street and oozing headlong into a stormwater catch basin?" For these folks, there are no apparent water-quality impacts, because from every shoreline and bluff vantage point, their view of Puget Sound appears as sparkling and unaltered as ever.

Fed by seasonal freshwater from the Olympic and Cascade Mountain watersheds, Puget Sound is a 90-mile-long saltwater estuary in rapidly growing western Washington. This threatened waterbody provides recreation for people and is home to a diverse, but endangered, ecosystem.

In 2007, the Washington State Legislature created the Puget Sound Partnership (PSP), an effort undertaken to implement a strategic and bold plan to restore this regionally important waterbody by 2020. At the end of 2008, the PSP issued an Action Agenda that spells out measurable goals for Puget Sound's recovery by demonstrating the complex connections between the land and water. With a good deal of alarm, the PSP emphasizes, in no uncertain terms, that urban stormwater runoff poses a major threat to the ecosystem health of Puget Sound.

Photo: Daniel Smith
Foam from residential car washing runs into a storm drain.

The findings presented here show that most residential car washing is a source of stormwater pollution. We are hopeful that the release of this credible, community-based, homegrown information will help the residents of Federal Way, as well as other communities, connect the dots between their own actions, the associated impacts, and their shared environmental responsibilities.

Regulatory Background
Nearly 10 years ago, the EPA issued the National Pollutant Discharge Elimination System (NPDES) stormwater Phase II program regulations (40 CFR Part 122). In essence, the ruling was a federal mandate established to address discharges from small MS4s in an effort to reduce sources of stormwater pollution that impact water quality.

The EPA's primary role in the NPDES program was to develop the overall regulatory framework. Under the ruling, authorized states (including Washington) were permitted to tailor their stormwater discharge control programs so that water-quality needs and objectives could be addressed through a fine-tuning and adjustment of the regulatory process at a state level. In early 2007, the Washington state Department of Ecology (DOE) issued the Western Washington Phase II Municipal Stormwater Permit. More than 100 jurisdictions are subjected to this permit, including Federal Way.

The Phase II rule requires that all affected municipalities implement a series of individualized programs designed to control non-stormwater discharges, including both public education and procedures to detect and eliminate stormwater pollutants (illicit discharges). With some exceptions, the EPA defines an illicit discharge as "any discharge to an MS4 that is not composed entirely of stormwater."

As such, Phase II jurisdictions are to "effectively prohibit through ordinance, or other regulatory mechanism, illicit discharges into the MS4, and implement appropriate enforcement actions as needed." The Western Washington Phase II Municipal Stormwater permit requires the development of a regulatory mechanism by August 2009 that effectively prohibits non-stormwater discharges, illegal discharges, and dumping into the MS4 to the maximum extent allowable under state and federal law.

By definition, residential car washwater is a non-stormwater discharge; however, the EPA ruling sets it and other types of non-stormwater discharges (including water-line flushing, landscape irrigation, and dechlorinated swimming pool discharges) apart. These discharges would only be included in the scope of an illicit discharge detection and elimination (IDDE) program if they were identified as *significant contributors of pollutants* to the MS4. In these cases, a municipality could require specific stormwater controls for the activity, or could prohibit the discharge completely.

If this sounds vague, it's because it is. A former EPA senior analyst with the Office of Water stormwater programs admits that the permit is "mushy." But he believes that existing within that mushiness is a degree of flexibility that will be a benefit to regulated MS4s when implementing an effective program.

Controversy Unfolds
Toward the latter part of 2008, a flurry of misinformation raced around numerous media outlets proclaiming that residential car washing would be banned in the state of Washington. Many people were incensed that government agencies would outlaw the washing of vehicles on private property.

Reacting to the firestorm, the DOE launched a full court press to set the record straight. In September alone, the DOE issued several news releases, a fact sheet, a guidance document to cities and counties, and a two-page letter from director Jay Manning explaining that the act of residential car washing would not, and should not, be banned.

Although most of the DOE communiqués listed the harmful constituents of residential car washwater such as soaps, oils, greases, toxic metals, and other chemicals that pollute the water and harm fish, the agency began recommending to local jurisdictions the following compliance path: Take the education road first in efforts to change behavior and improve surface water quality.

Sandy Howard, communications manager with the DOE's Water Quality and Environmental Assessment Programs, acknowledges that this is where the agency decided to land, and admits that it will be up to each permitted entity to decide how hard of a compliance line it needs to draw in order to eliminate or reduce the prohibited discharges to "insignificant" levels.

"People have to want to do the right thing, but often times they simply don't know what to do," she says. "It's a challenge to change people's behaviors, but we have to help them understand that storm drains lead to surface water with little or no treatment. First, we have to get through this learning phase."

Sampling Design
In most cases, attempting to sample and quantify stormwater contaminants generated by common residential activities can be daunting.

Photo: Daniel Smith
Water sample from a local charity car wash

These elusive constituents, which are invisible to the naked eye, include fertilizers, herbicides, and pesticides dissolved in surface runoff from lawns and bacterial loadings produced by poor pet waste management practices. Depending on the frequency and volume of stormwater flows, concentrations of these pollutants (the classic nonpoint discharges) can be highly variable.

Conversely, car washwater streaming into our neighborhood stormwater structures presents a more simplified sampling opportunity. Like low-hanging fruit, it offers a much easier target to examine: the flow stream is often foamy and visible, it can be readily captured as it drops into a catch basin, the concentration of contaminants is relatively consistent, the discharges occur predictably on nice days, and the transport of pollutants generated by the activity is not dependant upon fluctuating stormwater runoff.

In its own way, residential car washwater itself could be considered a point-source discharge to the MS4. But sampling many individual driveway or street locations around the city in an effort to examine the issue would be difficult with respect to timing, coordination, and potentially uneasy interactions with the public.

Instead, car washwater generated at several fundraising events was sampled by city staff in an effort to replicate discharges generated by residential washing activities. Specifically, the study utilized car washwater from five distinct weekend fundraising events in the city of Federal Way during the summers of 2007 and 2008. The events were typical, and included groups washing cars and trucks for donations at settings such as commercial business locations and church parking lots.

Because of the large number of vehicles washed and the volume of washwater generated, event organizers were required to install a car wash kit to divert the flow away from the stormwater system. The kit, supplied by the city at no cost, includes power cords, hoses, a small submersible pump, and a plastic insert that fits into catch basin structures that receive the soapy flow.

Photo: Daniel Smith
Sampling setup at the charity car wash

All water flowing across the pavement in the car washing area was collected within the catch basin insert. Collected car washwater was pumped through a hose to a sanitary clean-out, to a sanitary sewer manhole, or to pervious areas on site. By means of this setup, discrete grab samples of the washwater were easily retrieved from the car wash kit discharge hose during the midpoint of each scheduled event.

Laboratory guidance was used to determine the number and type of sample containers used, the correct sample volume, and the proper sample preservatives required for each parameter analyzed. The samples were immediately chilled in a cooler, stored in a refrigerator, and delivered to Test America Laboratories in Fife, WA. Chain-of-custody was maintained throughout the process.

Results

The EPA notes that washwater generated from outdoor car washing may contain many types of contaminants, including large amounts of petroleum hydrocarbons, heavy metals, and nutrients. In addition, data provided by the International Carwash Association (ICA) representing wastewater discharged to publicly owned treatment works from various commercial facilities indicate a similar inventory of pollutants generated by car washing activity (ICA 2002).

Based on this information, a list of parameters to be analyzed was developed. The parameters tested are shown in Table 1. The following presents a brief description of the general pollutant categories that were selected to be tested for this study:

Petroleum hydrocarbons (gasoline, diesel fuel, motor oil, fluids, and lubricants) from automobile engines, leaks, and fuel combustion processes
Heavy metals resulting from normal wear of auto brake linings (copper), tires, exhaust, and fluid leaks
Phosphorous- and nitrogen-containing detergents contained in wash water from cleaning vehicles (nutrient loading)
Surfactants in detergents and cleaning formulations (both synthetic and organic agents) that lower the surface tension of water, allowing dirt or grease to be washed off of cars
Solids washed from vehicle exteriors and impervious surfaces

There are many other specific chemicals that we did not test for, but that a more comprehensive study would have evaluated. These compounds—degreasers, metal brighteners, waxes, and other potentially toxic components—are more extensively addressed by recent studies investigating the overall aquatic toxicity of car wash effluent and synthetic detergents (Abel 2006 and Brasino et al. 2007).

The estimated annual pollutant loadings to the city's MS4, shown in Table 1, were calculated by converting sample concentrations to mass and then multiplying by the estimated number of residential car washings carried out in Federal Way over the course of a year. Our goal is to fashion the study results in a simple and meaningful way that will be presented to residents in future public education campaigns.

We used the following assumptions and conversion factors to estimate annual pollutant loadings delivered to the MS4 by residential car-washing activities:

An estimated 62,000 passenger cars and trucks are registered in Federal Way (WDOL 2009).
Thirty-eight percent of car owners wash their cars in the driveway (ICA 2005).
Contaminant loadings were calculated from an estimate of the annual number of residential car washes performed in Federal Way that drain to the MS4. The final loading figures were based in part upon data presented in a study of Puget Sound area car wash behaviors (Hardwick 1997). (See note.)
Twenty gallons is the average amount of water used to wash a vehicle (based upon field observations and simulations using a low-flow nozzle).
Eighty percent of driveway car washwater drains directly to the MS4.
The average weight of used motor oil is 7.0 lb/gal (USEPA 1993).
The average weight of gasoline is 6.1 lb/gal (USDOE 2009).
The average weight of #2 diesel fuel is 7.0 lb/gal (USDOE 2009).
The weight of ammonia is 5.15 lb/gal at 60°F (USDOL 2009).

The following is a brief discussion concerning several of the crucial pollutants detected, including their impacts to the city's stormwater system and their potential effects on downstream water quality:

Approximately 190 gallons of petroleum hydrocarbon waste (gasoline, diesel, and motor oil). Compounds in petroleum hydrocarbons are highly toxic, and, in the surface water environment, they can cause harm to wildlife through direct physical contact, contamination by ingestion, and the destruction of food sources and habitats.

Photo: Washington Department of Ecology
Trying to change public attitudes and behavior

Bottom-dwelling or bottom-feeding aquatic organisms may ingest petroleum contaminants and transmit them up through the food chain until they accumulate in dangerous concentrations in fish. Hydrocarbons also harm fish directly, and damaged fish eggs may not develop properly (USEPA 2003). Additionally, oil can be particularly problematic because a single spilled cup can contaminate the surface area of a waterbody the size of a football field (USEPA 2003).

Approximately 14 pounds of dissolved copper. Exposure to dissolved copper may be sufficient to impair the sensory biology (olfactory system) of coho salmon (Oncorhynchus kisutch), listed as a Species of Concern under the Endangered Species Act. Coho and other salmonids rely on their sense of smell for critical behaviors such as homing, foraging, and predator avoidance. Sublethal impacts on olfactory function may reduce the chances of survival or reproduction of individual salmon and, therefore, are a concern for the survival of salmon populations within the Pacific Northwest (Baldwin et al. 2003). Dissolved copper is also toxic to phytoplankton, the base of the aquatic food chain (NRC 2008).

Almost 400 pounds of nutrients (phosphorous and nitrogen). An increase in nutrient loading to a surface water body leads to excessive plant growth and decay. This creates low dissolved oxygen levels, changes in animal populations, and an overall degradation of water quality and aquatic habitat. This process is known as eutrophication. In the 2008 water quality assessment, DOE found numerous locations in South Puget Sound impaired due to a lack of dissolved oxygen caused by excess sources of nitrogen from human-related pollution.

Nutrient availability also impacts the formation of hazardous algal blooms (HABs), which can produce high concentrations of nerve or liver toxins in the water column at levels that pose human health concerns (WDOE 2009a). HABs in Washington ponds, lakes, and reservoirs (including Federal Way) have been documented at an increasing rate over the past 25 years (WDOH 2008).

Approximately 60 pounds of ammonia. Forms of nitrogen (ammonium), in combination with pH and temperature variations, can be toxic to fish. When this toxic combination occurs, large amounts of oxygen in the water are consumed, subsequently stressing or killing fish and other aquatic organisms (King County 2009).

Approximately 2,200 pounds of surfactants. In surface water environments, surfactants are acutely toxic to aquatic life, stripping fish gills of natural oils, thereby interrupting the normal transfer of oxygen.

Approximately 34,000 pounds of solids. Sediment, the most common pollutant in stormwater runoff by volume and weight, makes streams and lakes less suitable for fish life, plant growth, and human recreation. 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 (King County 2009).

The results of this study are consistent with the findings of the Puget Sound Partnership 2008 Action Agenda declaring that pollution-related water quality problems in the freshwaters and marine waters of Puget Sound include excess nutrients and contamination by toxic chemicals draining from urban areas. The Action Agenda also points out that pollution entering Puget Sound's rivers, lakes, and marine waters does so through a variety of pathways, and that surface water runoff appears to be the primary transportation route, with the most concentrated loads coming from developed lands.

Given both the nature and concentration of the pollutants found in the car washwater tested, it is apparent that significant volumes of stormwater contaminants are generated annually from residential car washing activity in Federal Way. Stormwater carries these pollutants—soapy water and all—to storm drains in urban areas. The runoff then flows to surface waters with little or no water-quality treatment (WDOE 2009b). This study demonstrates that any standalone uncontrolled residential car wash might be considered inconsequential with respect to its contribution to the pollutant load being delivered to the MS4; however, when extrapolated over the entire city of Federal Way for a year, the pollutant loading becomes more significant.

As Will Appleton, surface water manager for Federal Way puts it, "It is akin to death by a thousand cuts. As a jurisdiction, we tend to focus on the big bleeders, but we are finding that only a holistic approach to water quality will work." He continues, "Our hope is that the community will help to apply the smaller Band-Aids."

Changing Behavior

Stormwater professionals have long known the general water-quality threats posed by residential car washing runoff. To counter these threats, environmental educators have utilized for many years both literature and advertising campaigns in attempts to change attitudes and affect behavior.

One iconic and timeless stormwater education effort features a photo of a nerdy guy decked out in tight, checkered shorts, black dress shoes, and black socks. Busy foaming up his late model Rambler, the man and his auto miraculously float on the surface of Puget Sound, illustrating the connection between one's actions and nonpoint-source water pollution.

The original printed product was developed more than 10 years ago through collaboration between various public agencies (Washington Department of Ecology, King County, and the cities of Seattle, Tacoma, and Bellevue). Still a powerful image, the print has made its way across the nation, with electronic versions currently found posted on municipal Web pages from Springfield, OR, to West Chester County, NY.

But are these efforts effective? In reviewing car-washing attitudes and habits contained in a series of surveys conducted by the ICA from 1999 to 2008, it appears that there is still work to do. Even though professional car-washing facilities employ water treatment systems and in many cases recycle the wastewater, the surveys indicate that the majority of home washers consistently feel that residential car washing is better for the environment than commercial car washes (ICA 2008).

Future Work

Residential car washing is certainly a hot-button issue that has evolved into a conundrum for entities trying to walk the tightrope between public discontent, permit compliance, and the preservation of our natural resources. The city of Federal Way recognizes the challenges average homeowners face as they struggle to implement car wash stormwater pollution prevention best management practices in their own driveways or neighborhood streets.

For starters, physical design limitations associated with a typical single-family development property may make it nearly impossible to effectively collect and pump the dirty water to a sanitary sewer. Options for onsite infiltration may not be available, as either gravel or grassy areas are usually not large enough on which to park a vehicle.

Much more difficult to address are less-tangible issues: the ingrained behaviors and attitudes that cause folks to choose residential car washing when there are other, more environmentally sound, alternatives.

Solving these challenges becomes more urgent when considering the population growth trends developed for Washington's 10 central Puget Sound counties. Currently, approximately 4.2 million people reside here, but the figure is expected to swell 1.3 million more by 2020 (WSOFM 2009). These census predictions show us how powerful and effective incremental behavioral changes by people can be, and how small change—when they benefit the environment—can translate into larger and more geographically significant water-quality improvements.

The good news is that other survey data indicate people will act more environmentally responsible as more accurate information is attained (NEETF 2005). Our public education program continues to embrace this concept and will follow the DOE's lead in utilizing the results of this study to craft more meaningful, effective, and accurate educational tools that describe the overall magnitude of stormwater pollution created by all home-based activities, including residential car washing.

For the seasoned stormwater professional, the data presented in this study may not be surprising. But for average residents, we hope that the amount of car washing contamination produced in their own community will be worrisome, causing them to be further concerned by the

prospects of pollutant loadings to our local salmon streams and Puget Sound when the sum of discharges from the entire western Washington region are considered.

Topics: Pollutants,Regulatory issues,Water-quality monitoring