

Toxics in surface runoff to Puget Sound

In our state's effort to restore and recover Puget Sound, the Washington State Department of Ecology (Ecology) and other organizations are evaluating the loadings, pathways, sources, and hazards of toxic chemicals (toxics) released into the Puget Sound ecosystem. These studies will help guide decisions about how to most effectively direct resources to reduce toxic contamination in Puget Sound.

The study, *Toxics in Surface Runoff to Puget Sound: Phase 3 Data and Load Estimates*, www.ecy.wa.gov/biblio/1103010.html, represents one component of this larger effort. Earlier phases of the Puget Sound toxic loading studies identified surface runoff as the largest contributor of toxic chemicals to Puget Sound. The purpose of this study is to determine the relative chemical contributions from different land-cover types and to refine chemical load estimates. Ecology worked with a team of local experts and used independent third-party review to ensure that the scientific methods used were credible.

Ecology will combine information from these multiple studies to address the following questions about specific toxic chemicals in Puget Sound:

- Where do the toxic chemicals come from?
- How much is being delivered?
- What delivery pathways contribute toxic loads to Puget Sound?
- What is the relative importance of these chemicals?

Broad range of chemicals analyzed

The study analyzed many different chemicals and groups of chemicals in surface runoff including:

- Heavy metals
- Polycyclic aromatic hydrocarbons (PAHs)
- Flame retardants such as polybrominated diphenyl ethers (PBDEs)
- Polychlorinated biphenyls (PCBs)
- Total petroleum hydrocarbons
- Oil and grease
- Phthalates
- Pesticides (herbicides and insecticides)
- Semi-volatile compounds
- Nutrients

WHY IT MATTERS

Polluted stormwater runoff is the leading pollution threat to our lakes, rivers, streams, and Puget Sound. Broadly speaking, the primary contaminants in stormwater runoff are nutrients, bacteria, sediment, and toxic chemicals.

Nutrients from fertilizers and animal wastes (manure) cause algae blooms that can rob oxygen from water. Bacteria from animal wastes and failing septic systems can make people sick and can make shellfish unhealthy to eat. Fine sediments can smother aquatic habitats and carry toxic chemicals. Stormwater scours river channels, which creates erosion and muddy runoff that carries fine sediments.

Toxic chemicals may be our biggest challenge because they get into the ecosystem from so many diffuse and hard-to-trace sources. Once released, toxic chemicals can affect the environment and human health.

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Study characterized four land-cover types

Surface runoff includes stormwater as well as baseflow in rivers and streams draining to Puget Sound. Baseflow is the water in a stream or river before it rains and comes from underground sources called groundwater. Surface runoff was sampled from four land-cover types:

- Commercial/industrial
- Residential
- Agricultural
- Forest, field, and other undeveloped lands

The study collected water samples from small streams before and during storm events. From August 2009 through July 2010, samples were collected from 16 streams within the Puyallup River and Snohomish River watersheds. Monitoring took place during six storm events distributed over the fall, winter, and spring and during two periods of baseflow. Monitoring also included measuring the streamflows in these watersheds continuously during this study period.

Pollutant levels higher during storms

The study found toxic chemicals more frequently and at higher levels during storm events compared with the baseflow in streams between storms. Toxic loads were substantially higher during storm events than for baseflow across all four land-cover types.

Runoff pollutant levels higher from developed lands than from forested lands

During storm events, toxic chemicals were generally found most frequently and at highest levels in streams in commercial/industrial sub-basins and at lowest levels in forested sub-basins. Agricultural and residential stormwater also contained higher levels of many toxic chemicals compared to stormwater from forested lands.

A substantial number of storm-event samples, primarily from commercial/industrial lands, did not meet state and federal water quality or human health standards for several chemicals:

- Dissolved copper, lead, and zinc
- Total mercury
- PCBs
- Bis(2-ethylhexyl) phthalate
- Several carcinogenic PAHs
- Pentachlorophenol, a pesticide

Commercial/industrial lands have highest loading rate; forest lands have highest total load

Toxic loading *rates*, or the mass per unit of area, are highest in commercial/industrial lands compared to the other three land covers. Since commercial and industrial lands occupy less than 1 percent of the Puget Sound watershed, the *total* loads from commercial/industrial lands are lower than the other land covers.

Most toxic chemicals were infrequently found in runoff from forested lands. However, forested lands occupy 83 percent of the land surface draining to Puget Sound. When contributions are added across all forest land, the combination of low chemical concentration but high streamflow volume translates to high chemical loads. Loads from forested lands may represent naturally occurring chemicals, chemicals deposited from the atmosphere, or other human sources of chemicals.

The highest chemical levels were found in stormwater from the most developed land uses. This is also where violations of water quality and human health standards occurred. However, looking only at the *total* chemical load for the Puget Sound watershed as a whole may mask these hot spots in the ecosystem where localized high levels occur.

Study refines loading estimates

This surface runoff study used locally-derived contaminant levels to estimate loads. Levels in this study were lower than in the Phase 1 and 2 analyses because streams were sampled directly. Phase 1 and 2 relied on initial estimates based on a literature search of historical data from other regions and a mix of data from streams and stormwater conveyance systems. By collecting samples directly from streams, Ecology took into account environmental processes such as dilution, deposition, degradation, and other mechanisms that reduce concentrations of pollutants as they move away from their sources. PBDEs are an exception since concentrations were higher compared with those used for earlier load estimates.

Loads (pounds per year)	Oil & Grease (pounds per year)	Petroleum (pounds per year)	Zinc (pounds per year)	Copper (pounds per year)	Total PAHs (pounds per year)
Estimates based on local sampling:					
Phase 3	18,000,000 – 23,000,000	710,000 – 800,000	250,000 – 300,000	61,000 – 140,000	300 – 600
Initial estimates based on historical data:					
Phase 1*	21,000,000 – 120,000,000	Not distinguished from oil & grease	380,000 – 1,400,000	110,000 – 440,000	7,800 – 63,000
Phase 2**	13,000,000 – 92,000,000	Not distinguished from oil & grease	220,000 – 970,000	69,000 – 320,000	3,000 – 27,000

* www.ecy.wa.gov/biblio/0710079.html

** www.ecy.wa.gov/biblio/0810084addendum2.html

The local sampling effort in this study also distinguished between petroleum and “oil and grease,” which was not done for the Phase 1 and 2 analyses. Oil and grease is a pollutant that has been used as a surrogate for petroleum in other loadings studies but is not a direct measure of petroleum. Oil and grease can include other components such as animal fats, vegetable oils, soaps, and other biological oils. The local data indicate a similar amount of oil and grease compared to previous estimates. The laboratory method for total petroleum hydrocarbons provides a more direct estimate for petroleum-based products alone. Petroleum-based contributions are much lower than the total oil and grease load, although petroleum remains the largest contributor by mass of any other contaminant sampled. Petroleum loads are roughly two to three times more than zinc, the next largest contributor by mass to Puget Sound.

In addition to using local experts to inform and review the study, Ecology requested that the U.S. Environmental Protection Agency (EPA) manage a paid independent peer review by a panel of national experts. Some independent reviewers commented that the methods agreed upon by our local experts may underestimate loadings.

Conclusions

- Surface runoff is the largest contributor for most chemicals sampled.
- Pollutant levels are higher during storms than baseflow.
- Commercial/industrial areas have higher loading rates than other land-cover types.
- Petroleum-based contributions are much lower than the total oil and grease load, although petroleum remains the largest contributor by mass of any other contaminant sampled.

What's next?

Information from the report will be combined with other studies from the toxics loading project to provide context for the loading estimates by identifying their sources and potential hazards. Ecology and its partners will use the information to help hone strategies for controlling toxic chemicals in the Puget Sound ecosystem. These strategies will be refined over time to reflect new information and new approaches for toxics reduction in Puget Sound.

Websites

Control of Toxic Chemicals in Puget Sound web page:

www.ecy.wa.gov/programs/wq/pstoxics/index.html

The focus sheet, *Update: Control of Toxic Chemicals in Puget Sound*:

www.ecy.wa.gov/biblio/1103012.html

The report, *Toxics in Surface Runoff to Puget Sound: Phase 3 Data and Load Estimates*:

www.ecy.wa.gov/biblio/1103010.html

This focus sheet, *Focus on: Toxics in Surface Runoff to Puget Sound*:

www.ecy.wa.gov/biblio/1103025.html

Glossary

For definitions of terms used in this focus sheet, see the report listed above.

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