



6PPD Action Plan and Alternatives Assessment

Progress Report and Recommendations

Hazardous Waste and Toxics Reduction Program

Washington State Department of Ecology

Olympia, Washington

October 2024, Publication 24-04-053

Publication Information

This document is available on the Department of Ecology's website at:

<https://apps.ecology.wa.gov/publications/summarypages/2404053.html>

Contact Information

Hazardous Waste and Toxics Reduction Program

P.O. Box 47600

Olympia, WA 98504-7600

Phone: 360-407-6700

Website: [Washington State Department of Ecology](http://www.ecology.wa.gov)¹

ADA Accessibility

The Department of Ecology is committed to providing people with disabilities access to information and services by meeting or exceeding the requirements of the Americans with Disabilities Act (ADA), Section 504 and 508 of the Rehabilitation Act, and Washington State Policy #188.

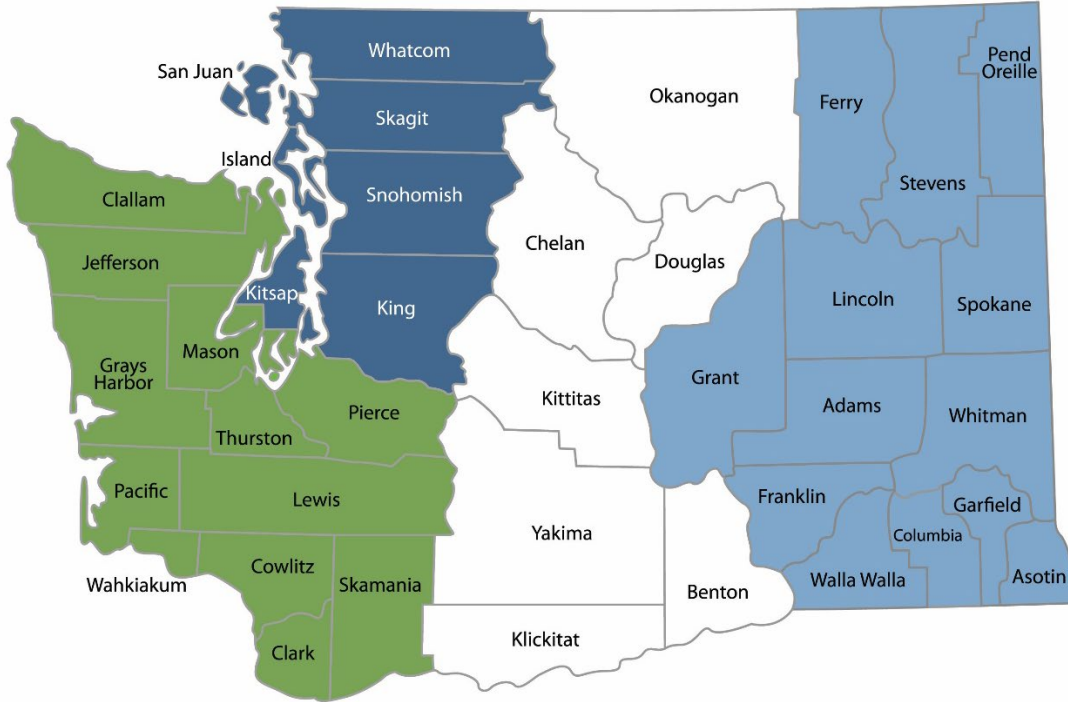
To request an ADA accommodation, contact Ecology by phone at 360-407-6700 or email at hwtrpubs@ecy.wa.gov. For Washington Relay Service or TTY call 711 or 877-833-6341. Visit [Ecology's website](http://www.ecology.wa.gov)² for more information.

¹ www.ecology.wa.gov/contact

² www.ecology.wa.gov/accessibility

Department of Ecology's Regional Offices

Map of Counties Served



Southwest Region 360-407-6300	Northwest Region 206-594-0000	Central Region 509-575-2490	Eastern Region 509-329-3400
---	---	---------------------------------------	---------------------------------------

Region	Counties served	Mailing Address	Phone
Southwest	Clallam, Clark, Cowlitz, Grays Harbor, Jefferson, Mason, Lewis, Pacific, Pierce, Skamania, Thurston, Wahkiakum	PO Box 47775 Olympia, WA 98504	360-407-6300
Northwest	Island, King, Kitsap, San Juan, Skagit, Snohomish, Whatcom	PO Box 330316 Shoreline, WA 98133	206-594-0000
Central	Benton, Chelan, Douglas, Kittitas, Klickitat, Okanogan, Yakima	1250 W Alder St Union Gap, WA 98903	509-575-2490
Eastern	Adams, Asotin, Columbia, Ferry, Franklin, Garfield, Grant, Lincoln, Pend Oreille, Spokane, Stevens, Walla Walla, Whitman	4601 N Monroe Spokane, WA 99205	509-329-3400
Headquarters	Across Washington	PO Box 46700 Olympia, WA 98504	360-407-6000

6PPD Action Plan and Alternatives Assessment

Progress Report and Recommendations

Hazardous Waste and Toxics Reduction Program
Washington State Department of Ecology
Olympia, WA

October 2024 | Publication 24-04-053



Table of Contents

- Executive Summary 6**
- Progress Report 8**
 - Legislative directive8
 - 6PPD Alternatives Assessment update8
 - 6PPD Action Plan update12
 - Conclusion.....19
- Appendix A. Ecology’s 6PPD Work 21**
 - 2021–2023 operating proviso21
 - 2022 supplemental operating budget proviso.....22
 - 2023–2025 operating budget proviso22
- Appendix B. Action Plan Advisory Committee 27**

Executive Summary

N-(1,3-dimethylbutyl)-N'-phenyl-p-phenylenediamine (6PPD) is an antioxidant and anti-ozone chemical used in motor vehicle tires to prevent tire cracking and promote longevity. It is a human skin sensitizer and reproductive toxicant. In 2020, researchers at Washington State University and the University of Washington discovered that when 6PPD reacts with ozone in the air it leads to the harmful transformation product 6PPD-quinone (6PPDQ). Researchers have identified 6PPDQ as the second most toxic chemical to aquatic life ever measured. It causes rapid mortality to species of cultural and environmental significance like Coho salmon. Researchers have found both chemicals in people.

In both the 2022 Supplemental Operating and 2023 Operating budgets, the Washington State Legislature provided funds to Ecology to work on issues related to 6PPD.

- The 2022 proviso directed Ecology “to complete a full safer alternatives assessment of the 6PPD compounds used in tires. The assessment shall incorporate and evaluate toxicity data of alternatives on Coho and other species.”³
- The 2023 proviso directed Ecology “to develop an action plan and complete a safer alternatives assessment for 6PPD, including obtaining any data necessary to complete the alternatives assessment.” As part of this work, the Legislature requested that Ecology provide a progress report on the Action Plan and Alternatives Assessment by December 31, 2024.⁴

This document fulfills the progress report requirement.

We currently lack data to determine whether any chemical alternatives are safer than 6PPD. To make progress on our Alternatives Assessment, we are funding research to fill these data needs. We have also published [6PPD Alternatives Assessment Hazard Criteria](#),⁵ which contains the toxicity criteria we will use to conduct the assessment.

Ecology and a team of subject matter experts from [Washington state partner agencies](#)⁶ began working on the 6PPD Action Plan in fall 2023. This work included identifying data needs and drafting preliminary recommended actions to reduce impacts from 6PPD and 6PPDQ. In December 2023, we convened an advisory committee consisting of 52 members (see Appendix B for a list of members), including federal, municipal, and Tribal government partners, researchers, industry experts, and community-based organizations. Ecology and our partner agencies consulted with the 6PPD Action Plan advisory committee to identify and refine recommended actions. Implementing the recommendations developed by this collaboration will allow us to respond quickly to rapidly emerging research while we continue our current work on 6PPD. Some of these recommendations include:

³ <https://lawfilesexternal.wa.gov/biennium/2021-22/Pdf/Bills/Session%20Laws/Senate/5693-S.SL.pdf>

⁴ <https://lawfilesexternal.wa.gov/biennium/2023-24/Pdf/Bills/Session%20Laws/Senate/5187-S.SL.pdf>

⁵ <https://apps.ecology.wa.gov/publications/SummaryPages/2304036.html>

⁶ Washington State Departments of Health, Fish and Wildlife, Commerce, Transportation, and Natural Resources; Washington State Recreation and Conservation Office, and Puget Sound Partnership.

- Define a broader class or subclasses of *para*-phenylenediamines (PPD chemicals), which are broadly used as antioxidants or antiozonants in rubber and other product.
- Identify consumer products that are sources and uses of these chemicals.
- Conduct research and testing on a variety of chemicals, best practices, remediation techniques, and consumer products connected with 6PPD and 6PPDQ, including effects on wildlife and habitats.
- Assess issues related to proper storage, handling, and disposal methods of tires and post-consumer recycled tire waste products that designate as dangerous waste.
- Prioritize waste tire cleanups according to potential harm to the environment and human health.
- Adopt water quality criteria for 6PPDQ to protect aquatic life and apply the new criteria to water quality permits upon approval from EPA.
- Form a statewide 6PPD communications collaborative group to support timely information sharing; identify and engage with overburdened communities; and implement reporting and hazard communication on 6PPD and 6PPDQ in overburdened, underserved community media outlets (e.g., radio, newspaper).

Washington state agency partners have identified a number of recommended actions for the 2025–2027 Biennium, including activities such as expanding research and monitoring and assessing potential health hazards. Ecology and Washington state agency partners, in consultation with the advisory committee, will continue to update and develop recommendations as we learn more about 6PPD and 6PPDQ. In the future, Ecology will work with these partners to develop a set of comprehensive recommendations to reduce the impact of these chemicals on people and the environment. We will publish these recommendations in an action plan, which will also identify, characterize, and evaluate uses and releases of 6PPD and related chemicals. Based on current research funding and progress, we expect to complete the Alternatives Assessment in late 2026 and submit the final Action Plan to the Legislature in early 2027.

Progress Report

Legislative directive

In 2023, the Washington State Legislature adopted a proviso in the [Operating budget](#)⁷ that directed Ecology to develop a 6PPD Action Plan and Alternatives Assessment, as follows:

(17) \$2,702,000 of the model toxics control operating account— state appropriation is provided solely for the department to develop a 6PPD action plan and complete a safer alternatives assessment of the 6PPD compound used in tires, including obtaining any data necessary to complete the alternatives assessment. The action plan should identify, characterize, and evaluate uses and releases of 6PPD and related chemicals, and recommend actions to protect human health and the environment. The department shall provide a progress report on the action plan and alternatives assessment to the governor's office, the office of financial management, and the appropriate committees of the legislature by December 31, 2024. The department may provide funding from this subsection to the University of Washington and Washington State University for the purposes of this subsection.

This report fulfills the progress report directive.

6PPD Alternatives Assessment update

Every tire on the road right now uses 6PPD as the primary ingredient that protects the tire from ozone. There are no widely used substitutes for 6PPD, which makes identifying and assessing alternatives challenging.

Alternatives assessment

At the time of this report, we do not have sufficient data to determine whether there are any existing replacement chemicals that will provide the same performance and safety function in tires or whether any of those chemicals are safer than 6PPD. A completed alternatives assessment would help answer both those questions.

In 2022, the Legislature [provided funding and directed Ecology](#) to, “complete a full safer alternatives assessment of the 6PPD compounds used in tires. The assessment shall incorporate and evaluate toxicity data of alternatives on Coho and other species.”⁸ At that time, we contracted with researchers at University of Washington – Tacoma and Washington State University to conduct toxicity testing and purchase equipment.

In 2023, the Legislature [provided additional funding](#) to, “complete a safer alternatives assessment of the 6PPD compound used in tires, including any data necessary to complete the

⁷ <https://lawfilesexternal.wa.gov/biennium/2023-24/Pdf/Bills/Session%20Laws/Senate/5187-S.SL.pdf>

⁸ <https://lawfilesexternal.wa.gov/biennium/2021-22/Pdf/Bills/Session%20Laws/Senate/5693-S.SL.pdf>

alternatives assessment.”⁹ In summer 2023, we developed proposed [6PPD Alternatives Assessment Hazard Criteria](#)¹⁰ to standardize how we would determine whether a chemical is safer than 6PPD. We accepted public comment on these criteria from June 14, 2023 to July 14, 2023, and received feedback from individuals representing academic institutions, industry, federal and local government, and the general public. We carefully reviewed these comments and then updated our criteria in response. You can read more about the changes we made based on this public comment period in our [6PPD Hazard Criteria Responsiveness Summary](#).¹¹

The process of developing our 6PPD hazard criteria enabled us to determine what additional data we needed to complete the Alternatives Assessment. We used these criteria to develop a list of toxicity, feasibility, and performance data needs for:

- The potential alternatives identified in the [6PPD hazard assessment](#),¹² and
- Other alternatives identified through collaboration with industry partners.

Ecology is currently funding research to fill these data needs.

When completed, the Alternatives Assessment will assess and compare possible alternatives to 6PPD and identify whether any feasible substitutes are safer to Coho salmon, other aquatic life, and humans. If we find safer alternatives exist, we must recommend regulatory, policy, or legislative actions to advance safer alternatives. In 2024, the Legislature passed [Substitute Senate Bill 5931](#),¹³ amending the Safer Products for Washington statute to add [6PPD as a priority chemical](#)¹⁴ and motorized vehicle tires containing 6PPD as a priority consumer product. If a safer alternative is feasible and available, Ecology could restrict the sale of tires containing 6PPD under the Safer Products for Washington program, [Chapter 70A.350 RCW](#).¹⁵

To identify a chemical as a safer alternative under Safer Products for Washington, it must meet the program criteria for “safer” and fulfill the same function as the chemical it would replace. A performance evaluation is not part of a hazard criteria but is a requirement to determine feasibility under the Safer Products for Washington program. Thus, we asked tire manufacturers and associations to review the identified alternative chemicals and share information about their known performance in tires.

The U.S. Tire Manufacturers Association shared concerns about the performance of the four alternatives that might be safer than 6PPD. Their review indicated that none of the chemicals identified as potentially safer than 6PPD provides the same level of tire performance and safety. They also indicated that chemicals similar to 6PPD are the most likely to be acceptable substitutes from a performance perspective but are also likely to form a quinone compound and have unknown impacts on Coho salmon.

⁹ <https://lawfilesexternal.wa.gov/biennium/2023-24/Pdf/Bills/Session%20Laws/Senate/5187-S.SL.pdf>

¹⁰ <https://apps.ecology.wa.gov/publications/SummaryPages/2304036.html>

¹¹ <https://apps.ecology.wa.gov/publications/SummaryPages/2304061.html>

¹² https://www.ezview.wa.gov/Portals/_1962/Documents/6ppd/6PPD%20Alternatives%20Technical%20Memo.pdf

¹³ <https://lawfilesexternal.wa.gov/biennium/2023-24/Pdf/Bills/Session%20Laws/Senate/5931-S.SL.pdf>

¹⁴ <https://apps.ecology.wa.gov/publications/SummaryPages/2304038.html>

¹⁵ <https://app.leg.wa.gov/RCW/default.aspx?cite=70a.350>

Hazard criteria

We published final [6PPD Alternatives Assessment Hazard Criteria](#)¹⁶ in October 2023 for use in the Alternatives Assessment. Hazard criteria provide a standard way to determine whether alternatives are safer than 6PPD for use in tires.

Alternatives assessments include assessing toxicity data on a wide range of endpoints to comprehensively understand a chemical's hazards. We modeled our 6PPD Alternatives Assessment hazard criteria on the Safer Products for Washington program hazard criteria.¹⁷

These criteria score 16 human and environmental hazards, such as whether a chemical causes cancer, is toxic to reproduction and development, affects endocrine activity, is toxic to aquatic life, and if it persists in the environment. The criteria also set maximum hazard profiles based on hazard endpoint scoring, which determine when an alternative could be called "safer." Because 6PPDQ is so extremely toxic to Coho salmon, we added criteria to ensure alternatives are safer:

- Alternatives must have data on acute aquatic toxicity to Coho salmon and Rainbow trout, as well as data on two other trophic levels.
- Alternatives must have data on the toxicity of transformation products after exposure to ozone.
- We will place a limit on the acute toxicity lethal concentration values allowed in the minimum criteria.

During the 6PPD Alternatives Assessment, we will evaluate the hazards of possible alternative chemicals using these criteria. Ecology will consider all relevant information as researchers continue their studies on possible alternatives. Alternatives that don't have all the needed data or that exceed the toxicity limit cannot be considered "safer," even if they otherwise would be based on the rest of the endpoints.

Relevant information may include results from the preliminary alternatives analyses submitted to [California's Department of Toxic Substances Control](#).¹⁸ In October 2023, California's Department of Toxic Substances Control began regulating 6PPD in motor vehicles tires through its Safer Consumer Products Program. Each tire manufacturer selling tires in California was required to submit a preliminary alternatives analysis by March 29, 2024. Manufacturers provided a list of potential alternatives they are considering. The final reports are expected in mid-2026 and should provide a more in-depth analysis of chosen alternatives.

¹⁶ <https://apps.ecology.wa.gov/publications/SummaryPages/2304036.html>

¹⁷ For a list of these criteria, see Appendix C of "[Regulatory Determinations Report to the Legislature Safer Products for Washington Cycle 1 Implementation Phase 3](#)" at <https://apps.ecology.wa.gov/publications/summarypages/2204018.html>

¹⁸ <https://calsafer.dtsc.ca.gov/cms/priorityproductdetail/?rid=1014>

Current toxicity research and preliminary results

We are currently funding research on specific species of concern (e.g., Coho salmon, Rainbow trout, Brook trout) to help us fill data gaps and compare the toxicity of 6PPD, 6PPDQ, and selected alternative chemicals. This research includes acute aquatic toxicity testing for 6PPD and potential alternative compounds. Toxicity tests on Rainbow trout were performed by Enthalpy Analytical, and University of Washington – Tacoma tested the leaching rate and presence of tire compounds from used and new truck and passenger tires. Washington State University is performing toxicity tests on Coho salmon. Final reports from Enthalpy Analytical and University of Washington – Tacoma, and a preliminary report from Washington State University, are included on our project webpage, [Research and Proposed Alternatives to 6PPD](#).¹⁹

Based on the findings in the hazard assessment, we funded toxicity research on:

- 7PPD [N-(5-Methyl-2-hexyl)-N'- phenyl-p-phenylenediamine], CAS #: 3081-01-4
- 77PD [N,N'-Bis(1,4- dimethylpentyl)-4- phenylenediamine], CAS #: 3081-14-9
- TMQ [1,2-Dihydro-2,2,4- trimethylquinoline], CAS #: 147-47-7

We chose these chemicals because each of them is currently used in tires in conjunction with 6PPD. Additionally, TMQ and 77PD have benchmark scores that indicated they may be safer than 6PPD. The U.S. Tire Manufacturers Association indicated that 7PPD may be closest to 6PPD in performance due to its very similar chemical structure.

Preliminary results from the toxicity research show:

- 7PPD is less toxic than 6PPD towards Coho salmon and Rainbow trout.
- 77PD is more toxic than 6PPD, but ozonated 6PPD is more toxic than ozonated 77PD or ozonated 77PD.
- TMQ did not show toxicity towards Rainbow trout at tested levels; however, manufacturers indicated that it does not have sufficient anti-ozone performance to replace 6PPD by itself.

These results suggest that neither 7PPDQ nor 77PDQ have as high aquatic toxicity as 6PPDQ, despite their similar chemical structure. This opens up the possibility that other PPD compounds could be safer alternatives to 6PPD. However, while 7PPD and 77PD may be less toxic than 6PPD, they do not meet the toxicity standards in our 6PPD hazard criteria to be considered safer alternatives. 7PPD is a Benchmark-1 chemical due to reproductive toxicity. 77PD does not meet our hazard criteria due to high aquatic toxicity to Bluegill.

6PPD Alternatives Assessment next steps

We will continue to fund research to evaluate potential alternatives to 6PPD. This includes contracts with Washington State University, the United States Geological Survey, and private

¹⁹ https://www.ezview.wa.gov/site/alias__1962/37732/research_and_proposed_alternatives_to_6ppd.aspx

toxicology and rubber testing labs. Although we rely on manufacturers and other groups to develop alternatives, they are not required to conduct any specific testing. To thoroughly evaluate alternatives against our criteria, we will need to conduct some testing ourselves.

We are interested in testing alternatives identified in the manufacturers' Phase 1 Alternatives Assessments submitted to the California Department of Toxic Substances Control, alternatives mentioned in journal articles, and those promoted by other parties. These alternatives include both PPD and non-PPD compounds.

Currently, Ecology has testing contracts extending through late 2025. If no safer alternatives have been identified by then, we may decide to extend those contracts or create new contracts.

6PPD Action Plan update

Action plans are non-regulatory plans developed in partnership with the Washington Department of Health, other state agencies, and interested parties. These plans include recommendations to reduce chemical exposure and environmental contamination. Each action plan covers a specific chemical or class of chemicals. Since they are non-regulatory, action plans don't ban chemicals, although in some cases they can identify where new regulations are needed for these chemicals.

In this section, we discuss the progress we've made on the 6PPD Action Plan, including convening and partnering with our advisory committee. Washington state agencies and the 6PPD Action Plan advisory committee developed the recommendations in this progress report based on the state's work on 6PPD to date (see [Appendix A](#)) and knowledge of existing research gaps and data needs.

6PPD Action Plan overview

6PPD's use in tires has broad impacts that require cross-agency interdisciplinary work. Ecology and a team of subject matter experts from Washington state partner agencies began work on the 6PPD Action Plan in fall 2023. This work included identifying data needs and drafting preliminary recommendations to reduce impacts from 6PPD and 6PPDQ.

In December 2023, Ecology led the cross-agency team in convening an advisory committee based on their 6PPD expertise and representation of Washington's communities. As noted above, the committee included 52 individuals from federal, municipal, and Tribal governments, researchers, industry, and community-based organizations. For a list of advisory committee members, please see [Appendix B](#). Ecology and our partner agencies consulted with the 6PPD Action Plan advisory committee to refine the recommendations developed in fall 2023 and identify additional recommendations.

Washington will continue to develop and update recommendations as we learn more about 6PPD and 6PPDQ. In the future, Ecology and state agency partners, in consultation with the 6PPD Action Plan advisory committee, will develop a set of comprehensive recommendations to reduce the impact of 6PPD and 6PPDQ on people and the environment. We will publish

these recommendations in the final 6PPD Action Plan, which will also identify, characterize, and evaluate uses and releases of 6PPD and related chemicals.

Washington state partner agencies

Given the broad impacts of 6PPD, Ecology convened a cross-agency team of subject matter experts to assist in developing and reviewing recommendations and consulting with 6PPD Action Plan advisory committee members. Staff from the following Washington state agencies helped scope, draft, and provide feedback on recommendations:

- Washington State Department of Ecology
- Washington State Department of Health
- Washington State Department of Fish and Wildlife
- Washington State Department of Commerce
- Washington State Department of Transportation
- Washington State Department of Natural Resources
- Washington State Recreation and Conservation Office
- Puget Sound Partnership

Advisory committee

Advisory committee members worked closely with state agency staff to review and further develop the recommendations. Their feedback and insights helped us consider as many perspectives and approaches as possible. Additionally, advisory committee members:

- Offered ideas for recommendations;
- Shared implementation barriers within their areas of expertise; and
- Identified data gaps and research needs surrounding 6PPD.

Ecology and partner agencies considered this feedback when planning 6PPD work for the 2025–2027 Biennium.

We will invite advisory committee members to participate in future work on the 6PPD Action Plan. Additionally, we will identify which communities are overburdened by 6PPD and 6PPDQ as part of our environmental justice efforts and invite community member participation in future advisory committee efforts.

6PPD Action Plan recommendations

Ecology and state agency partners developed recommendations in consultation with the advisory committee. A primary goal in recommendation development was responding to rapidly emerging research while state agencies continue identifying and implementing ongoing work. We provide more details on all recommendations on our [6PPD project webpage](https://www.ezview.wa.gov/site/alias__1962/37915/6ppd_action_plan.aspx).²⁰

²⁰ https://www.ezview.wa.gov/site/alias__1962/37915/6ppd_action_plan.aspx

Ecology requested funds in our 2025–2027 Biennium budget proposal to implement the following Ecology-led recommendations:

Data gaps

Several recommendations focus on increasing knowledge of 6PPD and 6PPDQ by filling known data gaps and identifying research needs.

- There is no known safer substitute chemical for 6PPD in tires, therefore we recommend continuing to fund research to assess hazards and performance of potential safer alternatives.
- Closing important data gaps related to 6PPD and 6PPDQ ecotoxicology is a vital step to understand the effects of these contaminants on environmental health. Therefore, we recommend continuing research that investigates which species may be affected by 6PPD and 6PPDQ and how these chemicals exert toxicity.
- Additional in-depth sampling is needed to better understand the extent to which juvenile Chinook and Coho salmon are exposed to tire-related compounds and where these compounds are entering waterways. In addition, sampling for tire-related compounds in other marine and anadromous species not currently monitored is needed; Health may use this information to determine potential for human exposure through fish consumption. We recommend providing long-term funding to continue research and monitoring of high priority tire-related compound threats to anadromous habitats.
- Stormwater best management practices (BMP) research has been limited to short-term pilot studies, mostly in laboratory settings. We recommend conducting two additional years of research and studies to identify how effective these practices are for treating 6PPDQ, including completing laboratory studies currently underway and implementing and monitoring BMPs installed in the field.

Inform future policy work

The agencies and advisory committee also developed recommendations based on knowledge from previous and ongoing work (see [Appendix A](#)) and identified actions to inform future policy work related to finding solutions to 6PPD and 6PPDQ.

- 6PPD is one chemical in a larger group of para-phenylenediamine (PPDs) derivatives that may share chemical and toxicological properties. Therefore, we recommend defining a broader class or subclasses of PPD chemicals for consideration as a priority chemical class under Safer Products for Washington and for developing future recommendations in the Action Plan.
- We should identify consumer products, in addition to tires, that may be significant sources and uses of PPDs. Based on this data, we can make recommendations for Safer Products for Washington to consider in future cycles. Focused work should include assessing recycled rubber-based outdoor recreational surfaces in Washington to identify safer options and developing replacement guidance, stormwater management guidance, and a replacement program.

- Ecology should conduct broad testing of 6PPD and 6PPDQ in waste generated from secondary tire lifecycle markets (e.g., tire recycling facilities) and waste generated by stormwater treatment technologies (e.g., street sweeping) by conducting a fish toxicity study to determine whether wastes from recycled tire products need special handling or stormwater control measures. If the fish toxicity study determines that waste generated by secondary tire lifecycle markets meets toxicity criteria under WAC 173-303-100, the waste will need methods for proper storage, handling, and disposal.
- Waste tire cleanups should be prioritized according to potential harm to the environment and human health with considerations for proximity to critical areas, overburdened communities, surface waters, and other areas with potential impacts to water instead of the current first come-first serve basis.
- The 2024 Phase I and II Municipal Stormwater Permits will have new requirements for street sweeping, retrofits, and project thresholds. These requirements are intended to help address 6PPD, 6PPDQ, and a range of other contaminants. However, the type of stormwater BMPs that stormwater managers and permittees will implement depends on site specific characteristics. Therefore, we should provide a toolbox for 6PPDQ municipal and industrial stormwater management and retrofit planning by regularly updating Ecology’s stormwater manuals, technical guidance documents, and communications materials. Additionally, we recommend implementing new best management practices through comprehensive project management of the Stormwater Work Group. Upon approval from EPA, we also recommend applying the new water quality criteria for 6PPDQ to water quality permits by working with the EPA, industry, and municipalities to identify any effects to permittees in the permit development process.

Improve communications

Other recommended actions will improve communication needs with Washington’s impacted communities, improve planning and understanding of the state of the science, and allow for work that isn’t required by state policies or doesn’t serve to fill data gaps.

- A 6PPD communications collaborative group that represents overburdened communities should guide the overarching environmental justice work for the 6PPD Action Plan recommendations. We recommend forming a statewide 6PPD and 6PPDQ communications collaborative group to support timely information sharing; identify and engage with overburdened communities; and implement reporting and hazard communication in overburdened, underserved community media outlets (e.g., radio, newspaper).
- Characterizing, mitigating, and eliminating impacts from 6PPDQ requires a coordinated effort across regions, organizations, and levels of government. Therefore, it is recommended that Ecology continue tracking and engaging with ongoing federal 6PPD and 6PPDQ work to ensure Washington’s work aligns with current federal knowledge, guidance, and initiatives.

Partner agency recommendations

Washington state agency partners identified these recommended actions for the 2025–2027 Biennium. Resources and funding for these actions are managed by each identified agency and are not included in Ecology’s 2025–2027 Biennium budget proposal.

- Expand research and monitoring of high priority tire-related compound threats to migratory, nearshore, and marine species (Department of Fish and Wildlife).
- Continue to assess emerging science and research on human exposure pathways and potential health hazards of 6PPD and its environmental transformation products, including 6PPDQ (Department of Health).
- Assess the potential for 6PPD and transformation products to reach Washington drinking water sources (Department of Health).
- Evaluate the potential for human health impacts of 6PPD due to consumption of aquatic species, including but not limited to salmonids (Department of Health).
- Investigate holistic effects on people’s health resulting from salmon decline due to 6PPD and 6PPDQ (Department of Health).
- Implement Tire Pile Removal Program for “reefs” installed in the 1970s and 1980s using surplus automotive tires to build artificial habitat on the bottom of Puget Sound. These “reefs” were deemed unsuccessful and risk becoming more harmful than beneficial. This would be a program implemented by the Department of Natural Resources and is separate from the current Department of Ecology tire waste cleanup program.

Recommendations under consideration

Ecology, Health, and other agency partners are exploring the feasibility of implementing the recommendations listed below. Scoping actions include developing project plans and continuing to discuss best approaches with committee members. We provide more details on these recommendations on our [6PPD project webpage](#).²¹

Department of Ecology

- Assess the feasibility of a tire industry fee program to support funding for tire contaminant research.
- When Ecology opens Chapter 173-350 WAC (Solid Waste Handling Standards) for revision, revise the current section WAC 173-350-350 (Waste Tire Storage) using current studies to evaluate the waste tire permit threshold. Additionally, establish location standards similar to those required for inert waste landfills. A timeline for revision of this section is under development.
- Revise requirements for using the statewide environmental vendor pool for 6PPDQ and contaminants of emerging concern.
- Create incentives and invest in initiatives to identify sustainable chemistry and materials for use in tires and other products that use PPDs.

²¹ https://www.ezview.wa.gov/site/alias__1962/37915/6ppd_action_plan.aspx

- Support Tribes exercising their Tribal Treaty Rights and sovereign rights when managing toxics in stormwater, including prioritizing salmon recovery in Usual and Accustomed Areas and maximizing the health and abundance of salmon at a watershed scale.
- Identify resource needs to create a dedicated funding pool for creating community co-benefits and addressing environmental injustices through the installation, operation, monitoring, and maintenance of stormwater BMPs. Report findings to the Legislature.
- Dedicate funding toward evaluating and implementing stormwater operations and maintenance best practices to ensure the long-term effectiveness of BMPs that address 6PPD.
- Support local efforts to implement the Retrofit Prioritization Framework developed by the Puget Sound Stormwater and Transportation Charter Group.
- Conduct a barriers analysis of factors that inhibit installation of stormwater BMPs for municipalities and permittees.
- Investigate alternative methods of funding stormwater BMP installation to reduce impacts to overburdened communities and permittees. Report findings to the Legislature.
- Expand lab capacity to support additional 6PPDQ monitoring and research.
- Provide capacity to review Ecology’s EIM (Environmental Information Monitoring) database to determine optimization needs for storing 6PPD data.
- Develop a 6PPDQ field method training and outreach program to support standardized spatial and temporal occurrence sampling and surveys to inform treatment prioritization efforts.

Department of Transportation

- Research the extent to which state programs that are intended to reduce vehicle miles traveled can reduce the volume of 6PPD and 6PPDQ released into highway stormwater.
- Implement the low-risk, high-reward stormwater treatment demonstration projects identified by the Federal Puget Sound Leadership Task Force Stormwater and Transportation Charter Group.

Other recommendations

- Develop a Washington State Tribal Leaders Advisory Board to support continuous engagement and participation in projects related to 6PPD and salmon recovery.

Ecology and Washington state agency partners continue to refine recommendations and consider other actions for inclusion in the comprehensive 6PPD Action Plan.

Environmental justice

According to the HEAL Act, as stated in [RCW 70A.02.010\(8\)](https://app.leg.wa.gov/RCW/default.aspx?cite=70A.02.010):²²

“Environmental justice” means the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the

²² <https://app.leg.wa.gov/RCW/default.aspx?cite=70A.02.010>

development, implementation, and enforcement of environmental laws, rules, and policies. Environmental justice includes addressing disproportionate environmental and health impacts in all laws, rules, and policies with environmental impacts by prioritizing vulnerable populations and overburdened communities, the equitable distribution of resources and benefits, and eliminating harm.

The 6PPD Action Plan will address disproportionate impacts, including mitigating and preventing disproportionate harms, through meaningfully involving and prioritizing benefits to overburdened communities and vulnerable populations. Future work on the Action Plan, including implementation of recommendations contained in this progress report, should address environmental justice in the following ways:

- Identify people from overburdened communities and vulnerable populations who are most adversely impacted by 6PPD and 6PPDQ.
- Research how these groups are adversely impacted (environmental, human health, cultural, and economic effects).
- Engage in meaningful involvement with people from these groups and develop opportunities for them to influence agency processes, activities, and priorities.
- Maximize environmental benefits for these groups.
- Follow the HEAL Act mandates, including following Tribal consultation plans, community engagement plans, environmental justice assessments of any significant agency actions, and budget equity requirements.

Identifying populations of concern

Under the HEAL Act, vulnerable populations are defined as population groups that are more likely to be at higher risk for poor health outcomes in response to environmental harms, including but not limited to:

- Communities of color
- Low-income populations
- People experiencing disproportionate environmental harms
- Workers experiencing harms

As stated in [RCW 70A.02.010](https://app.leg.wa.gov/RCW/default.aspx?cite=70A.02.010),²³ overburdened communities are “the geographic areas where vulnerable populations experience multiple environmental harms and health impacts,” including Tribal lands as provided in 18 U.S.C. Sec. 1151, and also includes sacred sites, traditional cultural properties, burial grounds, and other tribal sites protected by federal or state law.

The Department of Health has gathered and evaluated currently available research on human health effects and exposure. A summary is available on our [6PPD Action Plan project webpage](#).²⁴ We know that community members who face existing cumulative health impacts from disproportionate environmental harms will be most impacted by any health and ecological

²³ <https://app.leg.wa.gov/RCW/default.aspx?cite=70A.02.010>

²⁴ https://www.ezview.wa.gov/site/alias__1962/37915/6ppd_action_plan.aspx

effects from 6PPD. We also know that many groups' cultural and subsistence practices should be prioritized in order to achieve equal protection. Some examples of populations who are affected by 6PPD include:

- Tribes, indigenous people, and populations with higher fish consumption, including those who fish for subsistence or for sport.
- Communities of color and low-income communities in areas with sensitive salmonid populations, based on stormwater runoff and watershed mapping.
- Subsistence fishers from low income or communities of color in areas vulnerable to impacts from 6PPD.
- Workers who are disproportionately exposed to 6PPD compounds (e.g., people who work in the tire manufacturing industry, people who install artificial turf, workers who are overexposed to stormwater runoff in the construction, maintenance, and landscaping industries).
- Communities and groups that live, work, or play near areas potentially contaminated with 6PPD compounds with recycled tires (e.g., community gardens, landfills, artificial turf playfields).

We will use a variety of outreach methods and environmental justice mapping tools to further identify populations vulnerable to 6PPD impacts. This identification will help us understand any disparate impacts from 6PPD and work in partnership with representatives from these groups. It will also allow us to prioritize benefits from the 6PPD Action Plan recommendations to those most vulnerable from the impacts of 6PPD.

Conclusion

Since 6PPD is used in all automobile tires today, it and 6PPDQ are everywhere. Researchers continue to make progress on answering questions like which species are most sensitive to 6PPDQ and how it moves through the environment.

Ultimately, removing 6PPD from tires is the most cost-efficient and effective way to reduce its impacts to people and the environment. To find a safer replacement for 6PPD, we are evaluating whether chemicals that could serve the same function in tires meet strict hazard requirements. We've developed 6PPD hazard criteria that set a standard benchmark for identifying whether a chemical is a safer substitute. We also continue to fund research to fill data gaps for use in our Alternatives Assessment.

While researchers conduct these studies, Washington must identify the actions it can take right now to protect people, the economy, and the environment. The recommendations contained in this report have helped us define barriers and identify immediate actions we could take around 6PPD. Ecology will continue to update and develop recommendations as we learn more about these chemicals, ultimately developing a comprehensive Action Plan that maintains flexibility as new research emerges.

Since 2021, the Legislature has provided approximately \$11.5 million dollars to support finding solutions to 6PPD and 6PPDQ. We have made significant progress towards identifying recommendations that will benefit our communities and the environment. Ecology is

committed to implementing recommendations so we can continue to reduce and eliminate harm caused by these harmful chemicals.

Based on current research funding and progress, we expect to complete the Alternatives Assessment in late 2026 and submit the final 6PPD Action Plan to the Legislature in early 2027.

Appendix A. Ecology's 6PPD Work

The Washington State Legislature began providing funding to state agencies to address 6PPD in 2021. The following is a summary of legislatively directed work, including both complete and ongoing work at the date of report development. We provide updates on work funded by budget provisos in the 2021–2023 Operating budget, the 2022 Supplemental Operating budget, and the 2023–2025 Operating budget.

2021–2023 Operating proviso

In the 2021–2023 Operating budget, the Legislature directed Ecology to:

- Complete a 6PPD hazard assessment.
- Compile research on assessing and mitigating 6PPDQ in road runoff.
- Develop lab methods for detecting 6PPDQ in water.

We issued a report detailing environmental assessment strategies to identify where the locations of high concentrations of 6PPDQ and sensitive species intersect. This work helped us better understand the extent to which 6PPDQ impacts the health of salmonid bearing waterways. In June 2023, Ecology developed a method for detecting 6PPDQ in water and published a [Quality Assurance Project Plan](#)²⁵ to develop and evaluate field sampling methods.

We provide more detail about each of these efforts below. Our update on the 6PPD hazard assessment can be found in the main body of the report.

Compile research on 6PPDQ in road runoff and solutions

Our [6PPD in Road Runoff: Assessment and Mitigation Strategies report](#)²⁶ evaluated environmental assessment strategies for the tire contaminant 6PPDQ. This report also included information on best management practices that are potentially effective at reducing 6PPDQ in stormwater runoff before it discharges to waterbodies.

This work supports ongoing watershed, stormwater, and salmon recovery planning. Understanding the occurrence and persistence of 6PPDQ to salmon bearing streams helps communities prioritize urban watershed remediation projects. Remediation projects that require this baseline data include:

- Stormwater retrofits
- Fish barrier removals
- Floodplain projects
- City and transportation planning
- Conservation efforts

The proposed 6PPDQ environmental assessment strategies incorporate three main approaches:

²⁵ <https://apps.ecology.wa.gov/publications/documents/2303113.pdf>

²⁶ <https://apps.ecology.wa.gov/publications/SummaryPages/2203020.html>

- Studies to understand the spatial occurrence and persistence of 6PPDQ with variable watershed characteristics;
- Salmon in urban watersheds bioassay studies to develop and re-evaluate methods for measuring the health of salmon-bearing streams; and
- Studies to address the many data gaps around how and where to measure 6PPDQ in the environment (method development).

Our report confirmed the complexity of finding 6PPDQ in the environment and identifying the most vulnerable areas. We need more research to fill data gaps and develop an approach to prevent 6PPDQ from reaching our stormwaters and surface waters. The report also highlighted the need for feasibility studies and site assessments to compare the costs and benefits of mitigation actions among watersheds.

Additionally, we began research to test the effectiveness of new and existing stormwater BMPs for mitigating 6PPDQ. Several of these research projects were extended into the 2023-2025 biennium.

Develop lab methods for detecting 6PPDQ in water

In June of 2023, Ecology finalized “Standard Operating Procedure MEL730136, Version 1.2: Extraction and Analysis of 6PPDQuinone.” The report details laboratory detection methods for 6PPDQ in freshwater.

2022 Supplemental Operating budget proviso

In a 2022 Supplemental budget proviso, the Legislature directed Ecology to:

- Complete a full alternatives assessment;
- Research fate and transport;
- Identify possible best management practices to treat tire wear chemicals;
- Develop lab methods for detecting 6PPDQ in sediment; and
- Develop sampling methods to characterize how, when, and where 6PPDQ ends up in the environment.

We received funding for these projects as part of the 2022 Supplemental proviso. Because the majority of this work carried into the 2023–2025 biennium, we provide updates on the current status of these items in the next section.

Additionally, Ecology conducted field method development studies and stream reconnaissance sampling in spring and fall of 2023. We used this information to develop a [quality assurance project plan](#)²⁷ that we published in November 2023.

2023–2025 Operating budget proviso

In the 2023–2025 Operating proviso, the Legislature directed Ecology to:

²⁷ <https://apps.ecology.wa.gov/publications/documents/2303113.pdf>

- Identify effective best management practices to control 6PPDQ in stormwater runoff;
- Produce guidance on how and when to use stormwater best management practices for toxicity reduction;
- Conduct field studies to understand the occurrence and persistence of 6PPDQ in water, sediment and biota (the rate of detection is commonly used when evaluating aquatic life criteria);
- Complete a safer alternatives assessment of the 6PPD compound used in tires;
- Develop a 6PPD Action Plan that will identify, characterize, and evaluate uses and releases of 6PPD and related chemicals, and recommend actions to protect human health and the environment; and
- Report on the progress of developing an Action Plan and conducting an alternatives assessment by December 31, 2024. This report fulfills this directive.

As a result of this direction, we identified existing stormwater best management practice options and assessed their likelihood to manage 6PPD and 6PPDQ. We also planned research to confirm presumed treatment effectiveness and test new control technologies, updated stormwater guidance based on what we know today, and reissued stormwater permits with new requirements. These requirements are designed to reduce the amount of 6PPD and 6PPDQ that reach local waterways.

As part of our geographic assessment research, we developed [a tire contaminant story map](#) to visualize aquatic areas likely more exposed to 6PPDQ. This story map shows information about traffic; Coho salmon, Brook trout, Rainbow trout, and steelhead distribution; and watershed characteristics.

We provide details on our 6PPD Action Plan progress and Alternatives Assessment progress in the main body of this report.

Identify effective stormwater best management practices: completed and current research

Ecology is focused on two practices to capture and treat 6PPDQ before it is discharged into receiving waters.

- Remove tire particles from pavement before rain washes them into the stormwater system, where they need to be removed by treatment. An example of this practice is street sweeping.
- Treat contaminated stormwater before it flows to surface waters. This includes stormwater treatment practices like compost amended bioswales.

We presume that many of the stormwater best management practices already implemented as part of our stormwater manuals are effective at capturing and treating 6PPDQ. In June 2022, Ecology, university researchers, and industry experts issued a [stormwater BMP effectiveness report](#)²⁸ that assesses existing BMP options and their likelihood to manage 6PPD and 6PPDQ.

²⁸ <https://ecology.wa.gov/2022BMP6ppdreport>

The report was based on a literature review of best available science and the authors' best professional judgement. We are expanding upon these efforts by researching and testing how effective new and existing best practices are at capturing and treating 6PPD and 6PPDQ. We are also supporting on-the-ground efforts to increase stormwater BMP research and implementation through increased grant funding to local governments.

Additional funding will help us continue researching the ability of stormwater systems to filter out this toxic tire chemical and to develop BMPs to treat contaminated stormwater. Over the 2025–2027 biennium, with support from the Legislature, Ecology will:

- Assess how many and which BMPs reduce the toxicity in the different landscapes. More than one BMP may be needed in some settings;
- Provide technical assistance updates and guidance to municipalities;
- Fill 6PPD and 6PPDQ data gaps defined in the BMP Effectiveness Report;
- Characterize how much 6PPD, 6PPDQ, and tire wear particles are in stormwater across different landscapes, storm events, seasons, and years; and
- Fund retrofit projects through stormwater grants.

You can read more about our current stormwater effectiveness research projects on our [6PPD stormwater research page](#).²⁹

Produce guidance on how and when to use best management practices for toxicity reduction and incorporate guidance into stormwater management manuals and permit requirements

Our municipal stormwater general permits are designed to respond to emergent issues, like 6PPD. Multiple permits cover areas where 6PPD contamination in road runoff is likely. We also have detailed stormwater management manuals designed for eastern and western Washington to provide guidance to permittees. These manuals are updated throughout permit cycles as research on emerging issues infers new knowledge.

We updated the [Municipal Stormwater Permits](#)³⁰ and the [Stormwater Management Manuals](#)³¹ on July 1, 2024. Our updates are responsive to 6PPD, including new requirements that are designed to reduce the amount of 6PPD and 6PPDQ that reaches local water. Volume I, [Section 1.5](#)³² of the stormwater management manuals contain guidance for effective 6PPDQ best management practices. New permit requirements include:

- Incorporating more stormwater best management practices into new development and redevelopment projects;

²⁹https://www.ezview.wa.gov/site/alias__1962/40944/6ppd_stormwater_best_management_practices_research.aspx#kingcounty2

³⁰ <https://ecology.wa.gov/Regulations-Permits/Permits-certifications/Stormwater-general-permits/Municipal-stormwater-general-permits>

³¹ <https://ecology.wa.gov/Regulations-Permits/Guidance-technical-assistance/Stormwater-permittee-guidance-resources/Stormwater-manuals>

³² ecology.wa.gov/SWMMWW/pollutantsimpacts

- Requiring retrofits in areas without adequate stormwater treatment;
- Adding street sweeping requirements; and
- Prioritizing transportation-related projects in local Stormwater Management action plans.

The Industrial Stormwater General Permit is another permit covering areas that are likely to have 6PPD onsite. In May 2024, we proposed updates to this permit, including requiring 6PPDQ sampling and monitoring for larger transportation facilities. The reported sampling data will allow us to characterize 6PPDQ in stormwater discharges from these facilities and assess the effectiveness of BMPs and other permit requirements to reduce this chemical. It may also help identify certain discharges or sites for further investigation or corrective action. We plan to finalize permit updates by December 2024.

Environmental science and monitoring of 6PPD compounds

We are working with federal, state, Tribal, and local governments to develop mapping tools. These mapping tools will help us identify waterways where tire contaminants may limit salmon recovery efforts.

One of our challenges is identifying where 6PPDQ is found at detectable concentrations in the environment. Verified sampling methods can help us measure 6PPDQ in waterways and sediments. We are analyzing manual, active, and passive sampling methods to compare the most accurate, precise, feasible, and affordable options. We have verified that passive samplers are an effective tool for regional occurrence sampling and active samplers are effective for high-resolution source ID sampling.

We are sampling during storms to understand where elevated concentrations of 6PPDQ persist in natural waterbodies. We are also deploying telemetry stations that automate and standardize the collection of toxics in runoff. These stations make storm transported toxics sampling more cost effective, logistically feasible, standardized, and safer. In addition, we have designed innovative, customized mobile autosamplers that are currently being built. We will conduct sampling over specific time intervals during storm events to understand the persistence of 6PPDQ in waterways. The results of these sampling efforts provide technical guidance for upstream stormwater management mitigation assessments and planning.

These field methods will be employed to understand the geographic scope of 6PPDQ in streams, lakes, and estuaries and will help determine whether tire wear particles present a legacy source of the chemical in water, biota, and sediments.

In addition to understanding the geographic extent of 6PPDQ, we are conducting an intensively monitored urban stream study to evaluate fish and invertebrate bioassays in a south Puget Sound urban watershed. This will help us better understand when, how much, and how often 6PPDQ is detected throughout the year. Autonomous telemetry stations are programmed to start sampling at the onset of a storm. These 6PPDQ remote sensor stream stations are scalable depending on available resources and can be repurposed for additional toxics of concern in the future.

Ecology has a list of priority streams, developed during the 2021–2023 legislative proviso, for assessment and mitigation strategies. We chose sampling locations based on the presence of salmonids, traffic, and urbanization (as described in our [tire contaminant story map](#)³³). When possible, we co-located proposed sites with existing local, state, Tribal or federal monitoring programs or planned mitigation projects. Thus far, we have detected 6PPDQ in streams, lakes, and ponds in the Puget Sound area. Detection rates, as predicted, have been lower in less urbanized and rural areas.

³³ <https://gis.ecology.wa.gov/portal/apps/storymaps/stories/53b11807ac124735b281872a514809b5?>

Appendix B. Action Plan Advisory Committee

In 2023, we convened advisory committee members from industry, government, non-governmental organizations, Tribal governments and organizations, and community organizations to provide their expertise on an 6PPD Action Plan advisory committee. We'd like to thank the following individuals for their insights and participation:

- Taylor Aalvik, Affiliated Tribes of Northwest Indians
- Dylan Ahearn, Herrera, Inc.
- Vice Chairman Josh Bagley, Suquamish Tribe
- Stephanie Blair, Washington State University
- Angela Bolton, City of Bellevue
- Seth Book, Skokomish Indian Tribe
- Katie Byrnes, Washington Conservation Action
- Robert Campbell, LANXESS Corporation
- Rebecca Cook, Spokane Tribe of Indians
- Kathie Dionisio, U.S. Environmental Protection Agency
- Sean Dixon, Puget Soundkeeper Alliance
- Jeff Durant, Flexsys
- Tanya Eison, Affiliated Tribes of Northwest Indians
- Keith Estes, Long Live the Kings
- Marc Gauthier, Upper Columbia United Tribes
- Catherine Gockel, U.S. Environmental Protection Agency
- Emily Gonzalez, Puget Soundkeeper Alliance
- Justin Greer, United States Geological Survey
- Greg Haller, Northwest Indian Fisheries Commission
- Melissa Heintz, U.S. Tire Manufacturers Association
- John Herrmann, Snohomish County
- Sara Hutton, U.S. Tire Manufacturers Association
- Ed Kolodziej, University of Washington – Tacoma
- Augie Krupp, Molecular Rebar
- Steve Laing, Trout Unlimited
- Caitlin Lawrence, Washington State University
- Amber Lewis, Suquamish Tribe
- Haley Lewis, U.S. Environmental Protection Agency
- Holly Anna Littlebull, Yakama Nation
- Eli Mackiewicz, City of Bellingham
- Kiersten Maxwell, University of Washington
- Jen McIntyre, Washington State University
- Jamie McNutt, Flexsys
- Don McQuilliams, City of Bellevue
- Chelsea Mitchell, King County

- Aimee Navickis-Brasch, Evergreen StormH2O
- Tracey Norberg, U.S. Tire Manufacturers Association
- Alison O’Sullivan, Suquamish Tribe
- Marissa Paulling, Northwest Indian Fisheries Commission
- Mary Rabourn, King County
- LeeAnn Racz, U.S. Tire Manufacturers Association
- Gabby Rigutto, ChemFORWARD
- Katherine Saluskin, Yakama Nation Tribal Health Office
- Heidi Siegelbaum, Washington State University Stormwater Center
- Neil Smith, Flexsys
- Fran Solomon, Western Washington University
- Shirlee Tan, King County
- Heather Trim, Zero Waste Washington
- David Troutt, Nisqually Indian Tribe
- Laurie Valeriano, Toxic-Free Future
- River Wan, Pierce County
- Kenia Whitehead, U.S. Tire Manufacturers Association